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SUPPLEMENT TO "THE ELECTRICAL ENGINEER," DEC. 27, 1901.

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THE

ELECTRICAL ENGINEER.

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NOTES.

Submersion Test.—The French submarine boat "Narval" was recently subjected to a 12-hour submersion test at Cherbourg, the object being to ascertain the effects on the crew. The test proved that the strain is too much, and the confinement and lack of fresh air produced nausea and exhaustion among the men after a few hours. It is further stated that the tension was so great that the crew were unnerved.

Correction.—With reference to the letter of Messrs. Frank Suter and Co. which appeared in our last week's issue regarding an unfortunate contraction by means of which a block used to illustrate a description of the new engineering equipment of the new isolation hospital, Walthamstow, on p. 839 of our issue of June 7, was made to read "Westinghouse generators," instead of "Westinghouse gas-engines operating electric generators," we find that the mistake was ours, and are glad to have had our attention called to the fact. We hasten to set this right, as it appears to have given offence where none was intended.

Speed Indicator for Motorcars.—A correspondent to the *Morning Post* makes a rather good suggestion with regard to the vexed question of the speed at which automobiles shall be allowed to travel along the public highways. His project amounts to this: that all motorcars should carry a speed indicator which should automatically register the highest speed reached by the car, say, during every 100 yards. If an indicator of this kind were sanctioned by the Local Government Board and every car had to carry one, the police would have something to go on. "At the same time," the writer concludes, "the motorcarist would have a check on the police, who no doubt make numerous mistakes in estimating speeds at present."

An Electric Baggage Service.—We note that the Electrical Vehicle Company, of New York, has decided to introduce a system of electric trolley baggage cars, which will be run over the lines of the Metropolitan Street Railway Company in the boroughs of Manhattan and Bronx. In order that the passenger car service may not be interfered with, it is intended to run the baggage cars over the lower avenues of the city after nightfall. They will be equipped to use the same underground circuit at present in use on these roads, and also to connect with the Union Railway Company's lines in Bronx, where the overhead trolley system prevails. An express delivery of baggage and parcels will thus be obtained from various sources of supply.

Electric Shocks.—An amusing incident occurred in Liverpool a few days ago in one of the streets where the electric wires have been put underground. In passing over a particular spot on the footpath at the junction of Dale-street and Crosshall-street a number of pedestrians received an electric shock. The cause not being apparent the astonishment was great, and it remained a mystery until a gentleman, evidently of a technical turn of mind, came to the rescue. With the assistance of some Corporation workmen who appeared on the spot, the flagging was dislodged and a leakage discovered in the brickwork round one of the apertures in which are kept the apparatus for the regulation of the electric current. An hour's work put matters right again.

The Poulsen Telegraphone.—Herr Poulsen's telegraphone, which remarkable invention was recently described in this journal, has been experimented with in the States with regard to its possibility to repeat a message or speech spoken into a primary receiving telephone on numberless other telephones situated at distances from the central office. Although at present this is merely a possibility, it is stated that the inventor is taking steps to make it practical, the chief necessity being to add a satisfactory telephone relay to the instrument. In the experiments which have recently been conducted in America the ordinary telephone lines were used, the telegraphone being substituted for the receiver at one end. It is stated that a good and clear record of the transmitted speech was the result.

Water-Power Development in France.—We hear that in the course of the next three years it is proposed to erect extensive plants between Pyrimont and the Swiss frontier for the development of power from the River Rhone. Malpertius, 2½ miles below Bellegarde, is the first point at which work will be commenced. There the river falls 30ft. to 35ft., with perpendicular banks only 160ft. apart. It is estimated that by building a tunnel half a mile long a total fall of 51ft. to 55ft. can be obtained, equivalent to 25,000 h.p. at low water. Near Bellegarde another tunnel would secure a fall of 80ft. to 85ft., developing 30,000 h.p. Some eight miles from the Swiss frontier there is a narrow gorge only 80ft. wide, and a dam built at this place, it is said, would give a fall of 65ft., securing 30,000 h.p. at low water.

Mr. Carnegie's Gift to the American Institute.—The total cost of the Latimer Clark library, which was lately presented to the American Institute of Electrical Engineers by Dr. S. S. Wheeler, was close upon £1,400. This sum, we note, has now been duplicated by Mr. Andrew Carnegie, who has given the money in order to provide for the housing, cataloguing, and completion of the library. Mr. Carnegie's original intention, it is stated, was to purchase this collection of electrical books himself for the institute, but on hearing that Dr. Wheeler had stepped in and purchased it direct from the Latimer Clark heirs, Mr. Carnegie at once agreed to donate a sum equal to that paid by Dr. Wheeler to the completion of the library. We congratulate the members of the American Institute on their good fortune.

Filaments for Incandescent Lamps.—Mr. C. Kellner, of Vienna, has recently been granted an Austrian patent which, he claims, discloses a process securing an

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extraordinary light efficiency. Either one of two methods of making the filament may be used. The first consists of making a thread of the powder of an infusible metal, such as thorium, under great pressure. This is then oxidised superficially by making it the anode in an oxidising electrolyte bath. It is claimed that by this process the layer of oxide adhers strongly to the metal. The second method is to form the threads from metallic oxides which have the property of becoming incandescent at comparatively low temperatures, and using as a cementing material the least possible amount of cellulose dissolved in chloride of zinc. Upon the passage of the current, it is stated to become very compact, resembling graphite.

Electrical Pumps in Gold Mining. We understand from a note in the *New Zealand Mining and Engineering Journal* that electrically-driven pumps are coming more or less into use in connection with mine development in New Zealand. When electricity is available it is now generally taken advantage of, the triplex power pump being the machine most favoured. The principle of this pump is this: the crankshaft has three cranks equally spaced 120deg. apart, and as the pump has three single-acting plungers, actuated by connecting rods, with this arrangement of cranks the strokes follow and overlay each other, resulting in a very uniform flow from the discharge pipe of pump, and an equally uniform expenditure of power. This naturally results in the smooth operation of the mechanical parts, and is particularly useful where electric motors are employed.

Proposed New Australasian Cable. - In connection with the Duke of York's visit to New Zealand, the Hon. J. G. Ward, Minister of Railways and Telegraphs, made a speech in which he stated that it was his purpose shortly to introduce a scheme for the establishment of a State-owned cable between New Zealand and Australia. According to the *Daily Chronicle's* special correspondent, Mr. Ward taxed the cable companies with excessive charges, and unhesitatingly declared, after the closest investigation of all circumstances, that a cable between Australia and New Zealand under Government ownership could be profitably worked with a 70 per cent. reduction on the present cable tolls. This scheme, if carried out under Government auspices in combination with the all-British Pacific cable, would result in the reduction by one-third of the price of cabling to England under existing conditions.

State Ownership of Cables, Telegraphs, and Telephones.—We learn from a note in the *Electrical World* of New York that a circular letter has been drafted by the Ottawa Board of Trade, and will be forwarded to Boards of Trade and Chambers of Commerce throughout the British Empire, urging the importance of the establishment of State-owned cables connecting England with her Colonies. The proposal, it is said, requires that not only the connecting transmarine cables shall be under Government control, but that land telegraphs in the several British possessions shall be State-owned. Canada being, perhaps, the most important part of the British Empire in which the telegraph service is in private hands, is especially alluded to in this circular, which states that the transfer of the Canadian telegraph lines to the Post Office Department, and the laying of a State-owned cable across the Atlantic, are now under consideration of the Dominion Government. Very soon, also, the question of placing the telephone service in Canada under State management will be taken up.

Glasgow International Assembly.—The International Association for the Advancement of Science, Arts, and Education will hold its second international meeting at Glasgow, in the University and in the International Exhibition, from July 29 to Sept. 27, this year. Besides serving as a link among universities and learned societies, one of the most important functions of the meeting will again be, as at Paris last year, to study and interpret the matters of scientific, geographic, and other interest afforded by the exhibition, by means of lectures and conferences, with demonstrations and visits under skilled guidance. The various national groups which co-operated last year at Paris will, we understand, again be represented at Glasgow, and their lectures and conferences, etc., will include pure and applied physics and chemistry, electricity and engineering, agriculture and forestry, geography and colonisation, hygiene, Scottish history and archæology, fine art, etc. The general secretary is Mr. Liard, Permanent Secretary of State for Higher Education, Paris, assisted by Prof. Patrick Geddes.

Society of Arts. The annual general meeting of the Society of Arts was held on Wednesday, June 26, at the society's house in the Adelphi, when 57 members were elected, this bringing the total elected during the present session of the society to 376. The report of the council, which was read by the secretary, referred to the resignation of the presidentship of the society by the King, who, as Prince of Wales, held the office from 1863. His Majesty, however, while ceasing to be president, has become patron of the society. On the occasion of his resignation the council presented to his Majesty the society's Albert medal, which during the past 40 years has been awarded to a number of men distinguished for their scientific eminence, or for their services to industry and the arts. Over 15,000 candidates entered for the society's annual examinations, the results of which are now in course of issue. At the conclusion of the reading of the report the result of the ballot for the election of the new council was announced, the president for the coming year being Sir Frederick Bramwell, Bart., F.R.S.

The Institution "Journal."—The June number of the *Journal* of the Institution of Electrical Engineers embodies the following papers, with the discussions thereon: "Some Notes on the Electrical Transmission of Power in Coal-Mines," by Mr. H. Ravenshaw; "Electrical Miners' Safety Lamps," by Mr. Sidney F. Walker; "On Testroom Methods of Alternate-Current Measurement," by Mr. Albert Campbell; "Notes on the Use of the Differential Galvanometer," by Mr. C. W. S. Crawley; "An Instrument for Measuring the Permeability of Iron and Steel," by Mr. C. G. Lamb; "A Watt-Hour Meter," by Mr. Frank Holden; "Application of Steam Power to the Generation of Electrical Energy," by Mr. John S. Raworth (Manchester Section); and "Polyphase Equipment of Factories," by Mr. W. Wild. Original communications from Mr. H. H. Kingsford and Mr. Alexander Russell, entitled "Note on Duplexing of Cables" and "The Capacities of Polyphase Cables" respectively, also appear in this issue. The volume further contains the inaugural address of the chairman (Mr. F. G. Maclean) at the first meeting of the Calcutta Local Section.

Society of Arts Conversazione.—No doubt tired of walking the planks between a number of cases containing more or less extinct animals, the members of the Society of Arts this year abandoned the palatial grandeur of South Kensington and came back to the Botanical Gardens. Jack and Jill—or shall we say Adolphus and Evelina—had to change their tryst behind the big toe of the giant sloth—in plaster, another fraud—to the roses and rhododendron tents, if they preferred the light, or if they didn't there were plenty of nice walks where the fairy lamps were not, and the moon shone but dimly through the leaves when it did shine at all, which was not often on Friday last. The

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programme already sketched out by us in a previous issue was gone through faithfully. The gardens looked like fairyland at Christmas, with their avenues of Chinese lanterns and their trees laden to the ground with thousands of tiny lamps glittering in all the colours of the spectrum. The attendance was numerous—perhaps ladies predominated—and the bands, bellringers, glee singers, rhododendrons, roses, and refreshments all came in for their due share of appreciation. Even on a somewhat boisterous night the gardens and the live flowers were vastly preferable to the Natural History Gallery and its inhabitants—cast or killed.

A Marconi Patent.—Our American contemporaries for June 22 describe a patent which has just been granted to Mr. Marconi for a new type of wireless telegraph aerial wire. In this latest invention of Mr. Marconi there are two conductors, one concentric with the other. At the transmitting end one of the sparking balls of the induction coil is connected with the outer conductor, and the other ball connected, through an adjustable inductance, to the inner conductor, the latter being grounded. At the receiving end one terminal of the coherer primary circuit is connected with the outer conductor and the other terminal connected through an inductance with the inner conductor, which latter is also grounded. In the Marconi system of wireless telegraphy, it will be remembered, the aerial circuit is, by means of a transformer, in inductive relation with the coherer circuit. The specification of the new patent further states that communication of signals may be greatly facilitated by the employment at each station of two aerial conductors insulated from each other; and that advantageous results are obtained by the inclusion of the inductances referred to, which are capable of wide variations of self-induction. The resonance of the inductances at the transmitting and receiving stations are thereby enabled to be harmonised, and the receiving apparatus are caused to respond readily to the oscillations sent from the transmitting end.

German Wireless Telegraphy.—The German Postmaster-General has just issued a report giving the result of an enquiry held by his direction into the various systems of wireless telegraphy which have been patented in recent years. The Schäfer system is pronounced to be superior to all others on account of its simplicity and great sensitiveness. From the beginning of last April, the report states, extensive experiments have been made at Bremerhaven with the Schäfer system of spark telegraphy. An official of the Imperial Telegraph Administration, specially trained in receiving telegrams by the sound, took part in the experiments, and the North German Lloyd Company lent its steamer "Seeadler." The results obtained are reported to have been a perfect communication between the coast station near Bremerhaven and the ship, which steamed out to the Meyers Reef, a distance of 16 miles from Bremerhaven. The report further states that the experiments justify the hope that satisfactory communication between Bremerhaven and Rothersand, a distance of 28 miles, may be achieved. The telegrams are received with a telephone. The signals can, however, be transferred to a Morse apparatus if desired. From the present state of spark telegraphy in Germany, it is stated in conclusion, it may be said that the German systems can completely replace the Marconi one; but the incompleteness of practical experiments prevents any real decision as to the best German system.

Rapid Transit in New York.—Speculation is rife concerning the operating equipment which is to be adopted on the railways which will soon be running in the tunnels now being constructed in New York City, under the direction of the Rapid Transit Commission. It is regarded as a foregone conclusion that electricity will be the motive power employed on these lines, but the nature of the equipment still remains a secret. The *Electrical Review* of New York editorially commenting on the subject, says it is evident from the general details of the plan now being worked out, that the stations will be somewhat further apart than those of the elevated lines, making higher over-all speeds easily possible. Provision, it is stated, has also been made for express service in both directions on unobstructed tracks, where the stopping points will be located at such distances apart as to allow of very high intermediate speeds being attained. It is anticipated, further, that the service of the tunnel trains will eventually be extended out to a considerable distance along the lines of the existing steam railways, and will thus constitute an important factor in the conversion of these lines to electric traction. The three points upon which it is expected opinions may differ are, the voltage to be employed, the method of conductor installation, and the question of locomotives *versus* multiple-unit motor equipment. According to our contemporary, the probability is that the successful operation of the electric elevated railway system in Boston, Mass., will prove an object lesson, determining the choice of a multiple-unit system for the new underground roads in New York.

Electrolytic Manufacture of Metal Papers.—One of the most recent developments in the electrolytic manufacture of metal papers is embodied in a patent recently issued to one Carl Endrumeit, of Berlin, describing a continuous process for the production of metal papers or paper-backed foils. In this method an endless belt of metal moves past a rotary polishing roller, which removes stains or irregularities, then over a tank containing a dilute solution of potassium trisulphide, with which the polished face of the belt is moistened by means of a cylindrical brush. A layer of sulphide, imperceptible to the eye, but sufficient to prevent two close adherence of the metal afterward deposited, is thus made to form upon the surface. After wiping and rinsing, the belt dips into the first plating vat and receives, over the sulphide, a thin coating of nickel then into a second vat, where this film is reinforced by a heavier deposit of copper. This is followed by more brushing and rinsing, and a coating of glue is evenly applied to the layer of copper, a strip of paper is fed upon it from a roll, and belt, deposit, and paper pass together through rubber compressing rolls and a drying chamber. As the deposited film adheres far more strongly to the paper backing than to the polished and treated metal belt, the finished metal-faced paper can be easily stripped and wound, while the belt passes again to the polishing roll and the electroplating vats. Using a polished cathode belt, it is claimed that a paper with a brilliant nickeled surface is obtained, and by the addition of mercaptans or other sulphur compounds to the glue the backing adheres so strongly that the product is thoroughly serviceable.

The X-Ray in War-Time.—Mr J. Hall-Edwards surgeon-radiographer to the Imperial Yeomanry hospitals at Dielfontein and Pretoria, contributes an article to the *Lancet* of June 22, giving his experience of the X-ray as applied to military surgery in South Africa. The author explains that, on information received from certain pseudo-reliable sources, he was convinced before his arrival in South Africa that so few bullets found their billets in the tissues of the wounded that an X-ray outfit would prove an encumbrance instead of a help. This, however, was far from being the fact, for in the course of 12 months no less than 193 cases of gunshot or shell wounds came before Mr. Hall-Edwards, and in 65 of these there were found and localised either a whole bullet, portions of a bullet, or frag-

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ments of a shell. A particularly noticeable fact is that by far the larger majority of bullets retained in the tissues are, as a rule, found between the ankle and abdomen, whilst the upper extremities are practically free. Many other cases were examined by the X-ray in order to ascertain the amount of injury sustained by bone during the passage of bullets through it, and in addition to several medical cases over 50 accidental fractures were radiographed. Localisation by means of X-rays is based upon mathematical calculations, and has proved absolutely correct. With regard to other methods, Mr. Hall-Edwards says they are worse than useless, especially the telephone probe. There is no position in the body in which a bullet cannot be found and exactly localised by the X-ray, and when the much-talked-of reform in the Army Medical Department is brought about, the writer hopes that this most useful adjunct to military surgery will not be forgotten.

American Engines.—It is stated, upon the authority of the manager of one of the principal Swiss railways, that the American engines bought four years ago are a failure. Originally they were bought on account of their cheapness, but in future orders are likely to go to England. A consular report recently published states that "Japanese railway companies, with few exceptions, have discarded American locomotives in favour of those of British manufacture, merely using up, but not replenishing, their stock of the former, as they have experienced so much trouble from their boilers. It is only by one or two of the smaller railway companies and the Hokkaido Railway that orders for locomotives are still placed in the United States, and for two reasons: cheapness and dispatch. The Formosan Railway last year ordered six locomotives from the United Kingdom, and a quantity of steel and other materials for bridge-making. In a contribution to the July number of *Cassier's Magazine* on this subject, Mr. J. H. Converse, president of the Baldwin Locomotive Works, attributes the fact that within the past three years American locomotives have been extensively supplied to railways in Great Britain and France and Southern Germany chiefly to the remarkable development of industrial conditions in the United States. He also gives three other reasons for the introduction of American locomotives into Europe—viz.: the possibility of much earlier deliveries than European works can make; second, to some extent the preference for American locotives as to their type, and size, and details; and, third, the question of price. The writer further states that, owing to the design and character of American locomotives, they can be, and have been, constructed at a less cost per unit of weight than the ordinary European locomotives, although the wages paid in America are considerably higher than the wages in European locomotive works. This, he concludes, may be accounted for both by the characteristics of the American workman and by the probably more extended use of labour-saving machinery of all kinds in American shops.

"Electric Tramways."—This is the title of an interesting paper read by Mr. Philip Dawson before the members of the Exeter Chamber of Commerce a short time back, in which the author regards the provis.on of cheap and convenient means of rapid transit between dense centres of population and the outlying suburbs as the only satisfactory method of solving the question of the housing of the working classes. Having quoted figures showing the enormous growth of electric tramways, especially in America, Mr. Dawson says that electric traction, wherever introduced, brings with it a very large increase in traffic. In the order of their importance, the following are the four systems of electric traction more or less operated at the present day: the trolley or overhead system the conduit or underground, the surface contact, and the accumulator or self-contained. Of these, Mr. Dawson regards the first two as the only systems which have proved commercially and practically successful. The conduit system is, however, so costly that there are but few cases in which it is applicable. In proof of this, he proceeds to give figures showing that whereas the best conducted overhead system, including track and overhead work, costs from £7,000 to £8,000 per mile of single track, the conduit system runs to as much as £50,000 per mile. Of the two contact systems, there are in existence numerous devices, all of which, in the author's opinion, possess grave defects, rendering their application inadvisable. The chief fault lies in the fact that it is very difficult to be certain of the means adopted for connecting and disconnecting the contacts and the feeders. The accumulator system has been tried repeatedly, but has failed owing to the great cost of the batteries and their maintenance. The success and future of an electric line depends to no small extent upon the location of the power station. The conditions which govern its erection are in many ways entirely different from those which have to be considered in the construction of an electric lighting plant. The load is a constantly varying factor, and the variations are very large and unexpected. Breakdowns are more serious than in lighting plants, and such precautions must be taken as will render a suspension of service practically impossible under any circumstances. One of the greatest obstacles to the progress of electric traction has been the fear of electrolysis, but no fear need be entertained, says the author, as the shock from falling wires is only fatal under the most exceptional circumstances.

"Embarrassing Tramway Enterprise."—Lord Ebury writes to the *Daily Telegraph* under this heading giving reasons why, in his lordship's opinion, the proposal to amend Standing Order No. 22 so as to take away the absolute right of veto at present enjoyed by local authorities in regard to tramways should not be granted. The effect of the amendment, his lordship says, would be to compel every authority in the United Kingdom which objects to a tramway scheme applied for by Act of Parliament to put the ratepayers to the very heavy expense of appearing, with a full complement of counsel and witnesses, before a Private Bill Committee to prove "that its objections are reasonable." We may, perhaps, consistently remark at this point that his lordship is assuming the objections to be reasonable; but we have already had many instances in different parts of the country which would amply justify one in coming altogether to another conclusion. The letter then goes on to state that already the Standing Order in question is liberal in its attitude towards tramway promoters, "for it permits them to dispense with the consent of local authorities as regards one-third of the district to be traversed." This means that the promoters have to get the consent of two-thirds of the authorities concerned, which, having regard to the light in which many local authorities view private enterprise, would not appear to be the easiest thing in the world. Lord Ebury continues: "I have gathered that the ground put forward for giving additional facilities to tramway promoters, who in a large proportion of cases are not tramway constructors, but persons seeking powers which they can sell to constructing bodies, is that local authorities have been known to use the power of veto as a means of extracting from promoters conditions which either weigh unfairly upon them or prove fatal to the object which they have in view. As a cause this appears to me altogether insufficient, and as an argument it rests upon two inadmissible assumptions: (1) That

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local authorities ought to be debarred from the privilege belonging to everybody else of attaching lawful conditions to any consent for which they may receive application; and (2) that the feeling of electors has no influence upon the proceedings of their representatives." His lordship concludes with the statement that, "tramways being for the most part popular with the million, and local authorities being for the most part elected by democratic constituents, there is a strong presumption against the rejection of a tramway scheme by more than one-third of the local authorities who have jurisdiction in the matter, unless the general feeling in the locality is adverse to the scheme."

London Underground Railways.—The enquiry by the Joint Parliamentary Committee into the proposed routes of the various underground railway schemes for the Metropolis has now been going on for some weeks, during which time the committee have had before them all the "Tube" Bills promoted this session. Nominally, the enquiry is only as to routes proposed, but various other matters more or less relevant to the point have from time to time been introduced, and such a very large mass of evidence has been taken that it is perhaps somewhat difficult to follow the proceedings with ease. It may, therefore, be convenient to refer briefly to the chief features of the different underground electric railways promoted in this session of Parliament whose claims are now being considered by the Joint Committee. These were originally eight in number, and represented a total capital outlay of £23,626,000. The Victoria, City, and Southern scheme, however, has now been withdrawn, which brings the total capital outlay proposed down to £19,226,000. The remaining projected lines, therefore, are: the Charing Cross, Hammersmith, and District; King's-road; Piccadilly and City; North-East London; West and South London Junction; City and North-East Suburban, and the Islington and Euston. The total mileage represented by these schemes is just over 42 miles, including several miles of line in the open country of London suburbs. A 13ft. 6in. tunnel is proposed for two of the railways—viz., the Piccadilly and City and the North-East London; a 13ft. tunnel for the City and North-East Suburban; a 12ft. tunnel for the King's-road and the West and South London Junction; and a 11ft. 6in. tunnel in the remaining two cases—*i.e.*, the Charing Cross, Hammersmith, and District, and the Islington and Euston lines. The longest line proposed is that of the City and North-East Suburban, being just over 16 miles in length, and the proposed capital is £3,200,000. The North-East London comes next with 10½ miles, and £6,000,000 capital; the Charing Cross, Hammersmith, and District, five miles, and £2,800,000 capital; the West and South London Junction, 4½ miles, and £3,000,000 capital; the King'-road, 2¾ miles, and £1,666,000 capital; the Piccadilly and City, nearly two miles, and £2,000,000 capital; and the Islington and Euston last, with a length of just over 1½ miles, and £560,000 capital. The average borrowing power per mile of line comes out at £565,328. Turning now to the schemes already authorised, these are 11 in number, and represent a total mileage of 52 miles. Of these 13⅜ miles have already been constructed, while some eight miles are in course of construction. There thus remain 30⅝ miles of line yet to be laid down in connection with the authorised schemes. The total number of stations proposed is 79. The authorised capital of these schemes, together with that asked for this year, totals to £31,900,000, and the average borrowing power per mile of line is £490,663. The average size of tunnel adopted is as nearly as possible 13ft. In addition to these railways there is the Whitechapel and Bow line now in course of construction, which is not a tubular underground railway, but a 25ft. brick tunnel and covered way on the Inner Circle level. This line will be just over two miles in length, and will have three stations in all. The capital of the line is £1,280,000, which will make the cost of construction about £960,000 per mile.

The District Railway.—The vexed question of the system of electric traction to be adopted on the Metropolitan District Railway still remains an open one, and what is more, the point is not likely to be definitely decided for some time to come. It is true that the Bill promoted by the company for the electrical equipment of their line has passed committee stage of the House of Commons, but the system of electrical working to be applied remains a matter either for compromise between the District Company and the Metropolitan Company or for reference to a specially-appointed tribunal, who would take evidence and report to the Board of Trade. It is no secret that the Metropolitan Company favour the Ganz system, while the District Company have concluded a contract with an American syndicate headed by Mr. Yerkes which has undertaken the electrification of the line. The great point of difference between the two companies before Sir John Kennaway's Committee, however, was with regard to the proposed reference to the Board of Trade in the event of the parties being unable to arrive at a compromise. The objection taken by the Metropolitan Company was that the Board of Trade have given clear indication that they are not prepared to sanction the Ganz system until it has been tested, and they therefore wanted the question to be decided by a special tribunal, consisting of two electrical engineers, one to be named by either party, and an arbitrator, to be appointed by the Lord Chancellor, the names of Lord Shand and Lord James of Hereford being mentioned in this connection. They particularly insisted that the gentleman to hold the enquiry must not be an electrical expert, "because all the experts had made up their minds." The Metropolitan Company also wanted a period of four months from the passing of the Bill in which to consider the matter, but, as was pointed out, any further delay would be most disastrous, looking at the fact that the District Company are losing £800 a week by the competition of the Central London Railway, and the Metropolitan Company £1,000 a week. Eventually a period of one month from the passing of the Bill was agreed upon, at the end of which time "the companies shall declare and submit the system which each desires to adopt to the Board of Trade, and the Board of Trade shall appoint a special tribunal, consisting of an arbitrator (not an electrical engineer) and two engineers, one appointed by each company, to hear evidence and report to the Board, which will determine what system of electrical working shall be applied." This was practically the only opposition to the Bill as it stood, and the chairman, in declaring the preamble proved, subject to the insertion of this clause, expressed the gratification with which the committee had learnt of the steps being taken to bring about the use of electricity on these railways, and the adoption of a uniform system. Further, the committee sympathised with the companies in the severe competition to which they were being subjected, both under and above ground, and they hoped that what had been done in that room would tend to bring the two systems under one control and management altogether. We trust that whatever system of electric traction may eventually be decided upon, no more waste of precious time will be allowed. According to the promise held out by Mr. Yerkes's syndicate, the electrification of the District Railway should be an accomplished fact within two years of the passing of the company's Bill.

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THE VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO BERLIN.

The Berlin Electricity Supply Company.

(Continued from page 936, Vol. XXVII.)

A brief description of three of the most interesting stations—viz., Louisenstrasse, Oberspree, and Mariannenstrasse—is all that our space will allow, but it will serve to give our readers an idea of the arrangements and plant in use generally.

The Louisenstrasse station (Fig. 9) adjoins the older station in the Schiffbaurdamm, to which it is connected by an underground passage. One of its most novel features is the placing of the boiler-house above the engine-room, which was necessitated owing to the limited space at disposal, and involved the adoption of a special system of coal conveyors and elevators. The coal is shot into a horizontal conveyor driven by a 10-h.p. motor, and thus brought into two elevators, also driven by 10-h.p. motors, placed outside the engine-room wall. These elevators deliver the coal into another conveyor over the boiler-room, from whence it is tipped into the hoppers, and falls immediately in front of the boilers ready for firing. The boiler-house is furnished with eight water-tube boilers on the Heine system arranged in two rows. Each boiler has 3,400 square feet of heating surface, and generates steam at an initial pressure of 200lb. per square inch. The steam after leaving the boilers passes into three superheaters, each having a heating surface of 2,300 square feet, in which the temperature of the steam is raised from 190deg. C. to 320deg. C. The feed water for the boilers is taken from the town supply, a storage tank being provided in the boiler-house. It is forced into the boilers by two steam-pumps after passing through the economisers. The steam-piping is arranged on a special floor 10ft. in height, built between the boiler and engine rooms.

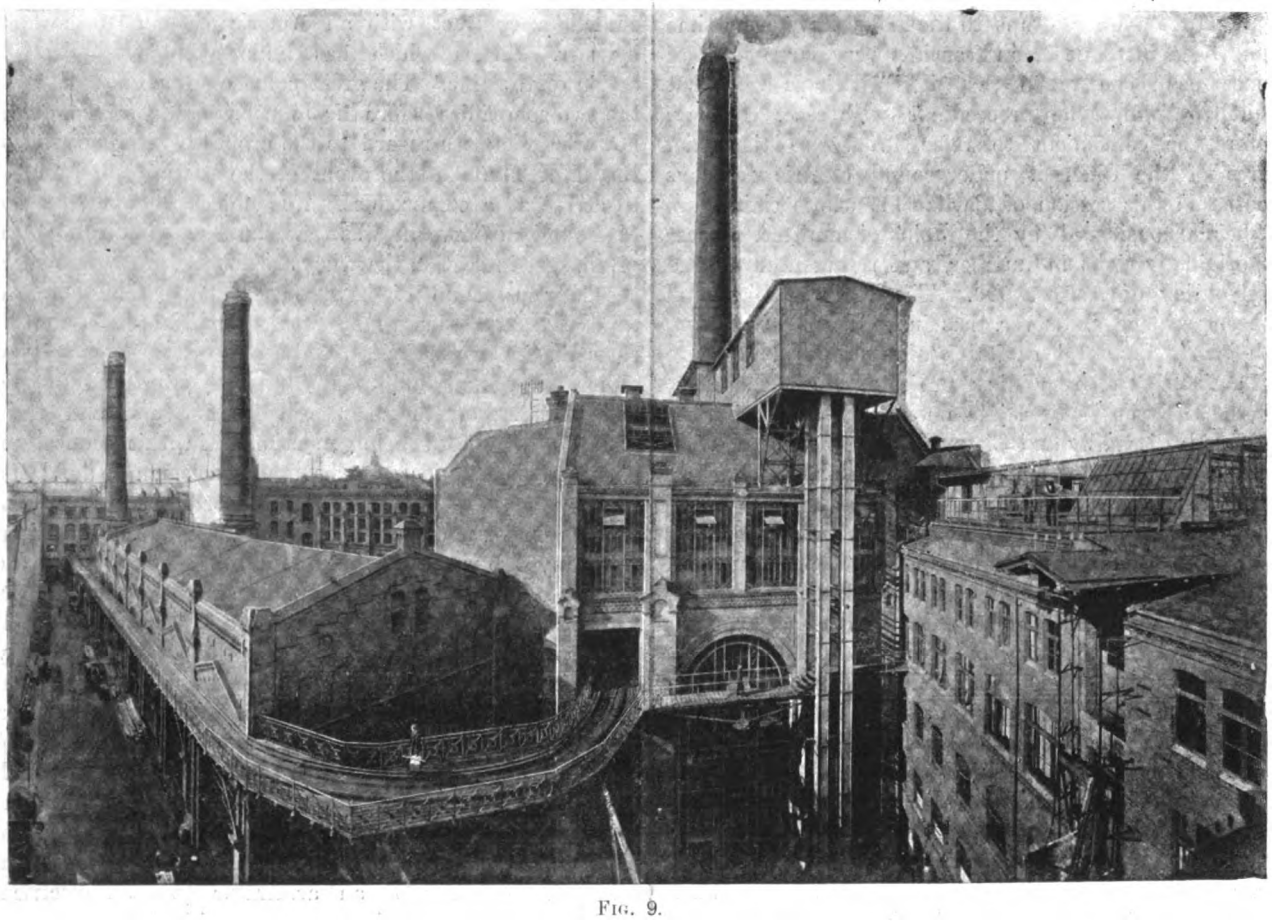

Fig. 9.

The engine-room (Fig. 10) is 48ft. in height, and contains three sets, each set consisting of a vertical steam-engine with a dynamo coupled at each end of the crankshaft. The combined output of these sets is 10,000 h.p. The engines are by Sulzer Bros., of Winterthur, and of the vertical triple-expansion four-cylinder type with two cranks. The high-pressure cylinder is 33in. diameter, the intermediate cylinder 49in. diameter, and the low-pressure cylinder 61in. diameter, the stroke being 51in. The engines run at 83 revolutions per minute, and develop 3,860 h.p. when supplied with superheated steam at a pressure of 175lb. per square inch at the stop valve and with a cut-off of 50 per cent. The temperature of the steam entering the high-pressure cylinder is 300deg. C. The intermediate and low-pressure cylinders are steam jacketed, but the high-pressure is not jacketed. The steam admission is effected by four conical valves placed at the top and bottom of the cylinders. These valves are suspended by double flat springs to enable the steam to enter the cylinder by the quickest possible path. One of these double springs is in itself able to overcome the weight of the valve and close it should the other fail. All the valves when closed are pressed upon the seating by the pressure of the steam. The admission valves of the high-pressure cylinder differ from the others, being arranged on the Sulzer system of steam cut off, in which the degree of cut off corresponding to the varying admission is controlled by the governor. The various valve motions are driven from eccentrics keyed to a horizontal shaft. The exhaust steam from the low-pressure cylinder is dealt with by jet condensers attached directly to the engine. The air-pump is double acting, the piston being driven directly from the engine. A special system of lubrication is provided by a slow-running oil-pump placed at the starting platform, to enable its ready control.

The two dynamos driven by each engine, each have a normal output of 1,000 kw. at 250-280 volts. The armature core is built up of soft annealed charcoal iron discs, which are bolted on to the spider by means of tough durance metal bolts. Air discs are placed at intervals in the core to ensure a thorough ventilation of the armature when running. The armature is drum wound, the winding consisting of high-conductivity copper bars, specially shaped into loops to avoid soldered end connections. The bars are heavily insulated with mica and sunk into slots in the periphery of the core. The commutator is built up on the armature spider, so as to avoid any vibrations caused by the engine. The

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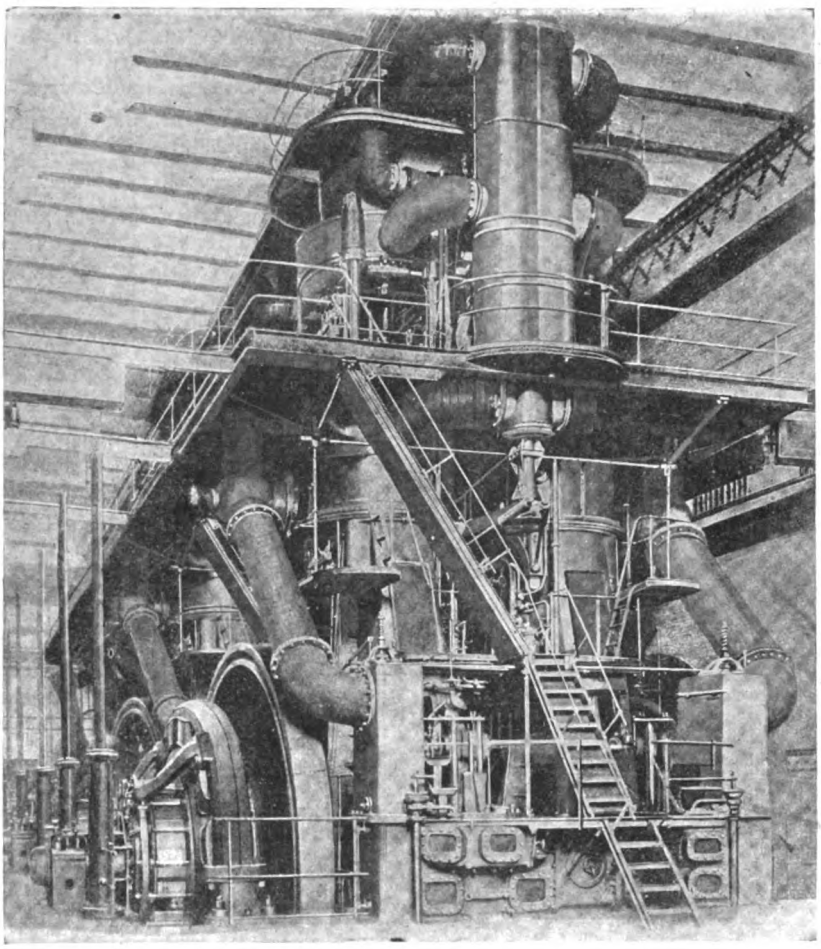

FIG. 10.

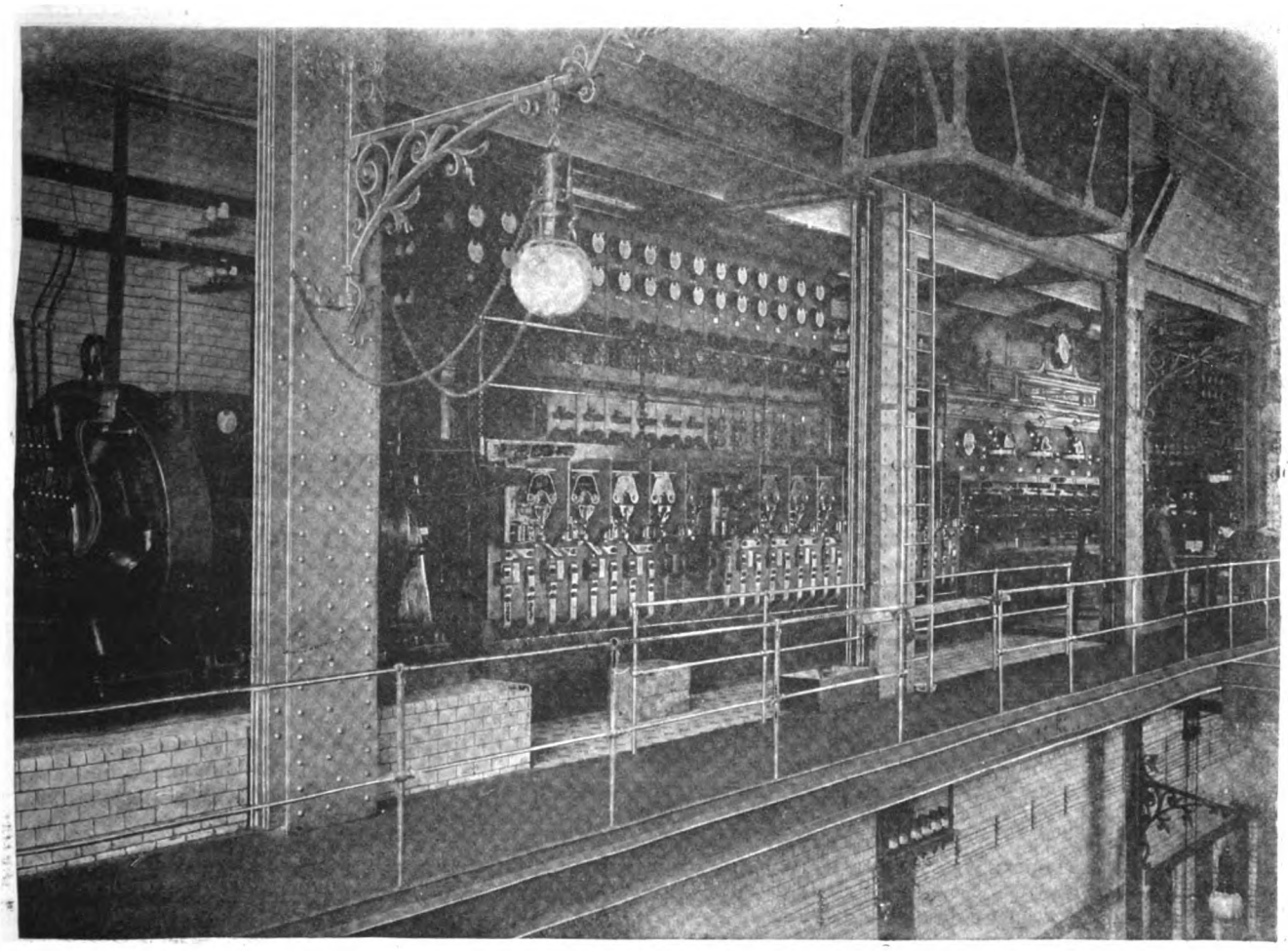

FIG. 11.

brush arms are carried on a rocker supported directly from the magnet yoke. The armature is parallel wound, there being as many sets of brushes as there are poles. The magnet is of cast steel, with 16 rectangular cross-sectioned poles projecting radially inwards from the yoke ring. The design of the machine is such that armature reaction is

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reduced to a minimum, so that the brushes may be maintained in a fixed position with a heavy load fluctuation. Copper dust is removed from the armature by a small air blast driven by an electromotor.

The switchboard (Fig. 11) is so arranged that the two outer pairs of dynamos are coupled to the traction 'bus bars and the two centre dynamos are connected in parallel with the lighting 'bus bars, which are coupled with the lighting 'bus bars in the Schiffbaurdamm station. The buffer battery on the tramway network contains 265 cells, and is capable of discharging 1,400 amperes for one hour. It is charged from the main dynamos with the assistance of two boosting machines, which also serve the purpose of raising the pressure of the mains to send current to either of the other stations for tramway supply. Boosters are also placed in the course of erection, and eight more now building. A brief description of these sets must suffice for our present purpose. The engines are of the Goerlitz Machine and Foundry Company's manufacture. They are of the horizontal triple-expansion type, having four cylinders placed two in tandem, and driving two cranks with the generator placed between. The low-pressure cylinders are nearest the crankshaft, with the high-pressure cylinder behind one and the intermediate cylinder behind the other. The high-pressure cylinder is 2ft. 9in. in diameter, the intermediate 4ft. 2in., and the low-pressure cylinders each 4ft. 10in. The stroke is 4ft. 11in. Each engine is capable of developing 4,000 b.h.p. when running at 83 revolutions per minute, and supplied with superheated steam at a temperature of 300deg. C., and a pressure of 170lb. on the square

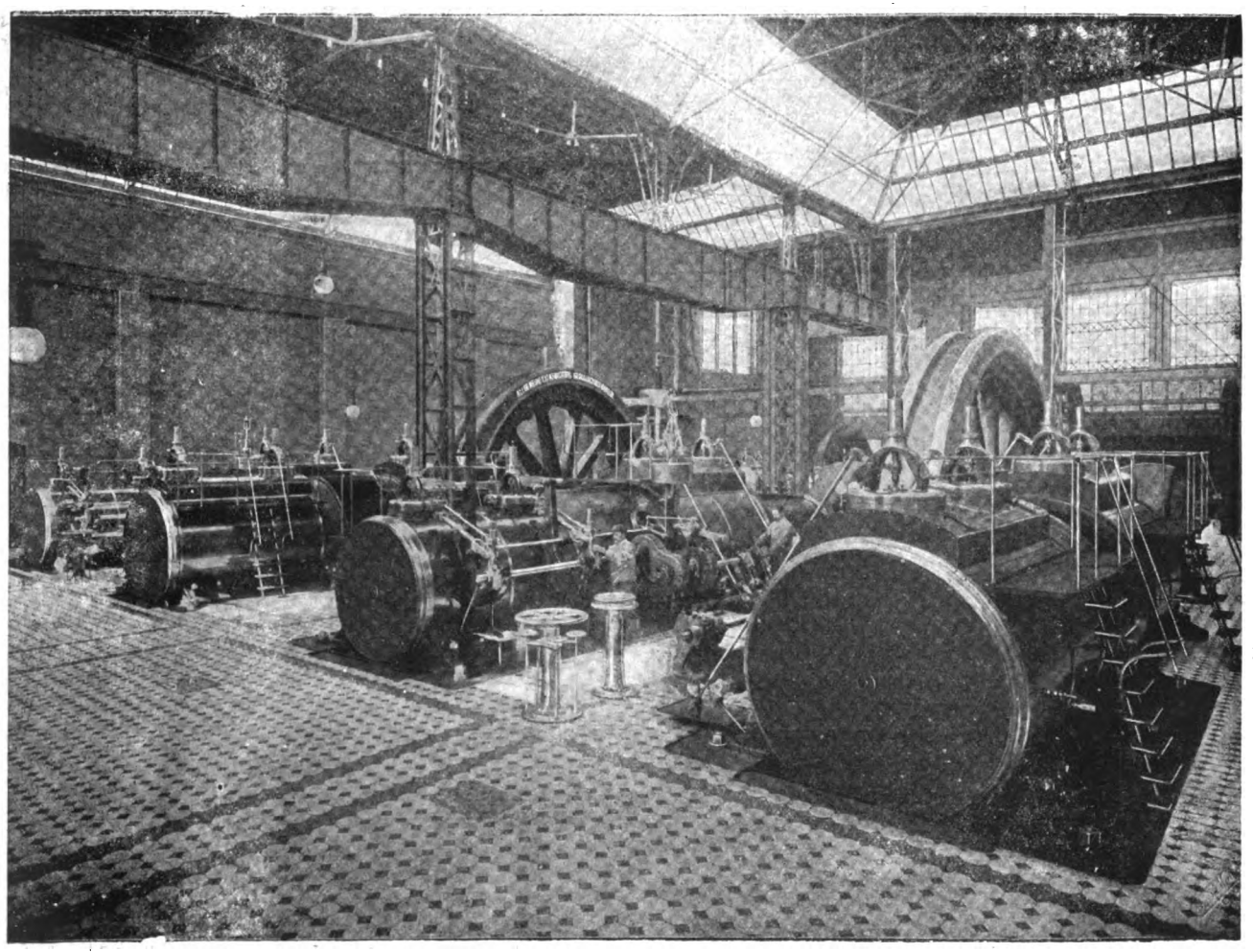

Fig. 12.

in the tramway feeders at the station to raise the pressure as is necessary.

The Oberspree central station is close to the cable factory of the Allgemeine Elektricitäts-Gesellschaft at Oberschöneweide. When finally equipped it will be the largest station possessed by the Berliner Elektricitäts-Werke, its output being 54,000 h.p. As mentioned above, three-phase current is generated here at a tension of 6,000 volts, and brought by underground mains to sub-stations in the city nine miles distant. The arrangement and type of boilers, superheaters, and economisers, etc., is similar to that at the Louisenstrasse station, excepting that the boiler-room is alongside the engine-room instead of above it. The coaling arrangement is, therefore, somewhat simpler, coal being brought directly from the wharfside by an overhead carrier to the hoppers over the boiler-room floor. As in all other stations possessed by the Berliner Electricitäts-Werke, the boilers are hand stoked.

There are two classes of engine in this station—the one being vertical triple-expansion engines by Goerlitz driving three-phase inductor alternators, and the other and most modern, horizontal triple-expansion engines driving three-phase generators of the revolving-field type (Fig. 12). There are three sets of the latter type now working—one

inch at the stop valve and condensing. The following table gives the outputs of the engines at different cut-offs:

Steam admission to high-pressure cylinder, per cent.	11	18	25	35	50
Indicated horse-power	1,840	2,550	3,080	3,720	4,400
Brake horse-power	1,570	2,220	2,710	3,310	4,000

The condensers are placed below the floor level, each low-pressure cylinder having its own air-pump and condenser. The guaranteed steam consumption within the limits of 2,000 i.h.p. to 3,500 i.h.p. does not exceed 9·4lb. per indicated horse-power per hour.

The generators rank amongst the largest low-speed machines yet built, the output of each being 3,000 kw. with inductive load, having a power factor equal to 0·9. The stator has a diameter of over 28ft., and weighs 80 tons. The core is built up of soft annealed charcoal iron segments of high permeability, which are insulated from one another, and is provided with ventilating holes. It is carried in a massive cast-iron casing, which is supported on the foundations by four feet, the lower half being also provided with adjusting screws to enable the stator to be exactly centered with the rotor. The three-phase windings are star connected, and consist of massive copper bars insulated by micanite troughs and carried in

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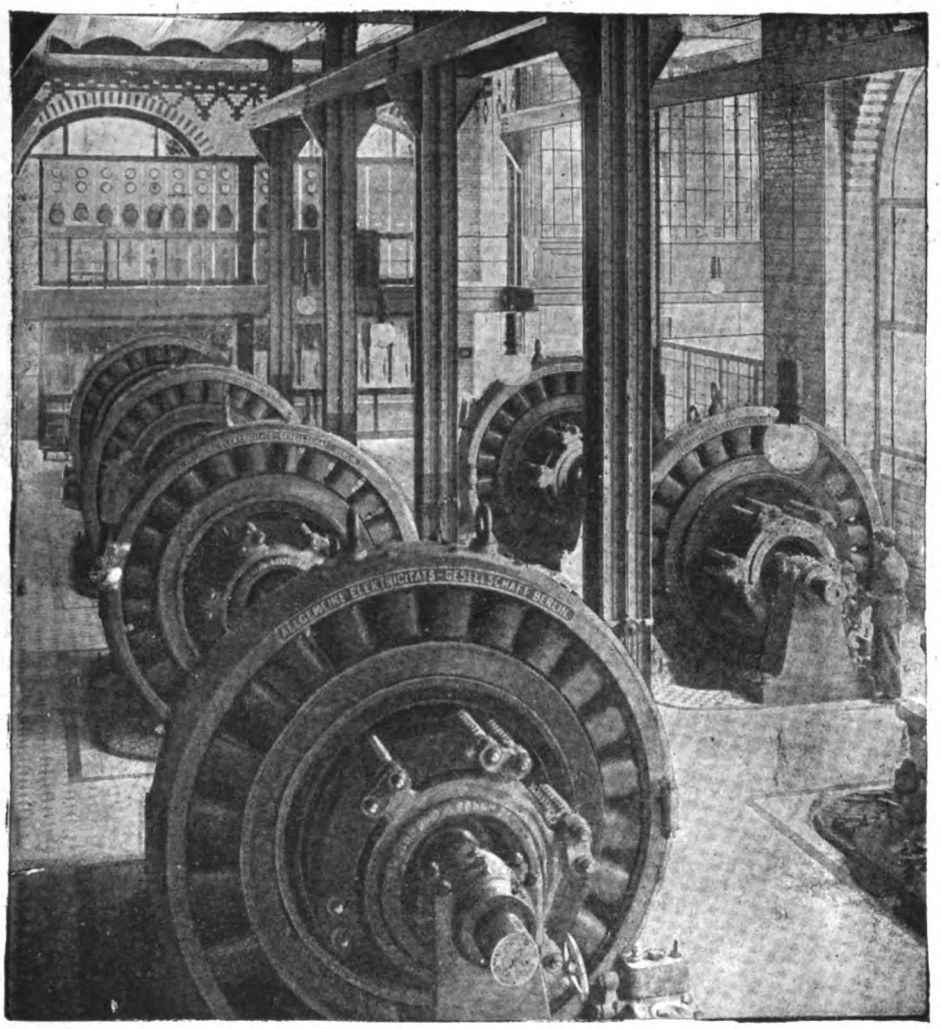

FIG. 13.

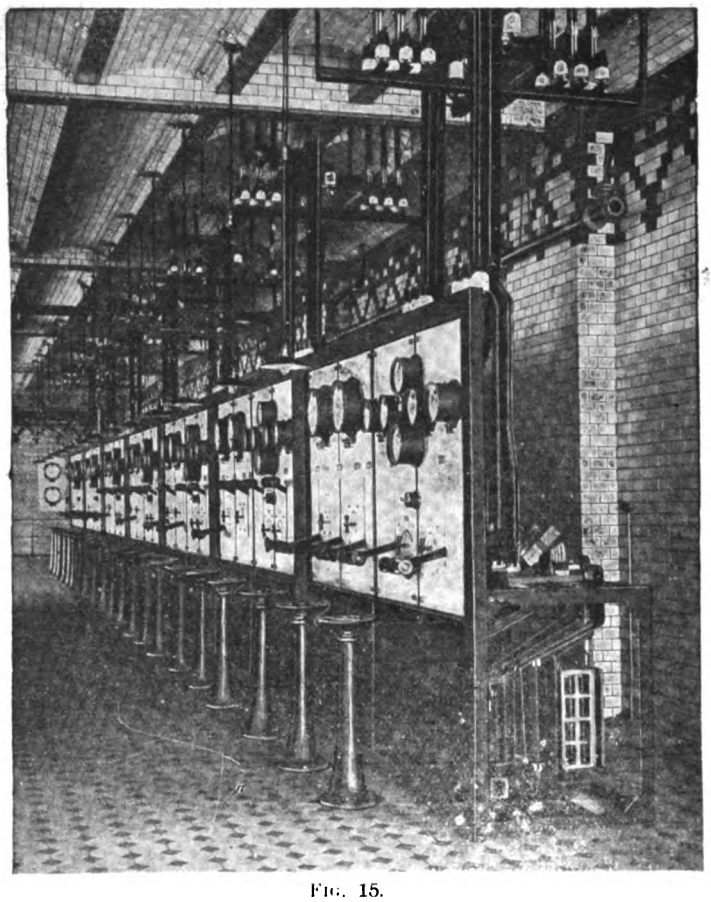

FIG. 15.

slots sunk in the inner circumference of the core. The end connections are made by winged connectors separated by air spaces to ensure perfect insulation. The current per phase is 290 amperes, and the resistance of each phase 0·98 ohm. The revolving field, or rotor, is 24ft. 4in. in diameter, and weighs 70 tons. It consists of a massive

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flywheel, with a ring of soft annealed iron built up chain fashion round its periphery and notched at intervals to receive the pole-pieces, of which there are 72, which are held securely in position by double wedges. At full load the excitation amounts to 31 kw., or 1 per cent. of the total output of the machine.

(Fig. 13): two of 1,250 h.p. at 500 to 750 volts; two of 1,100 h.p. at 440 to 600 volts; and two of 550 h.p. at 220 to 330 volts. Each of these rotary converters is provided with an alternating-current booster on the three-phase side, so that the pressure on the direct-current side can be varied as necessary, and the buffer batteries charged.

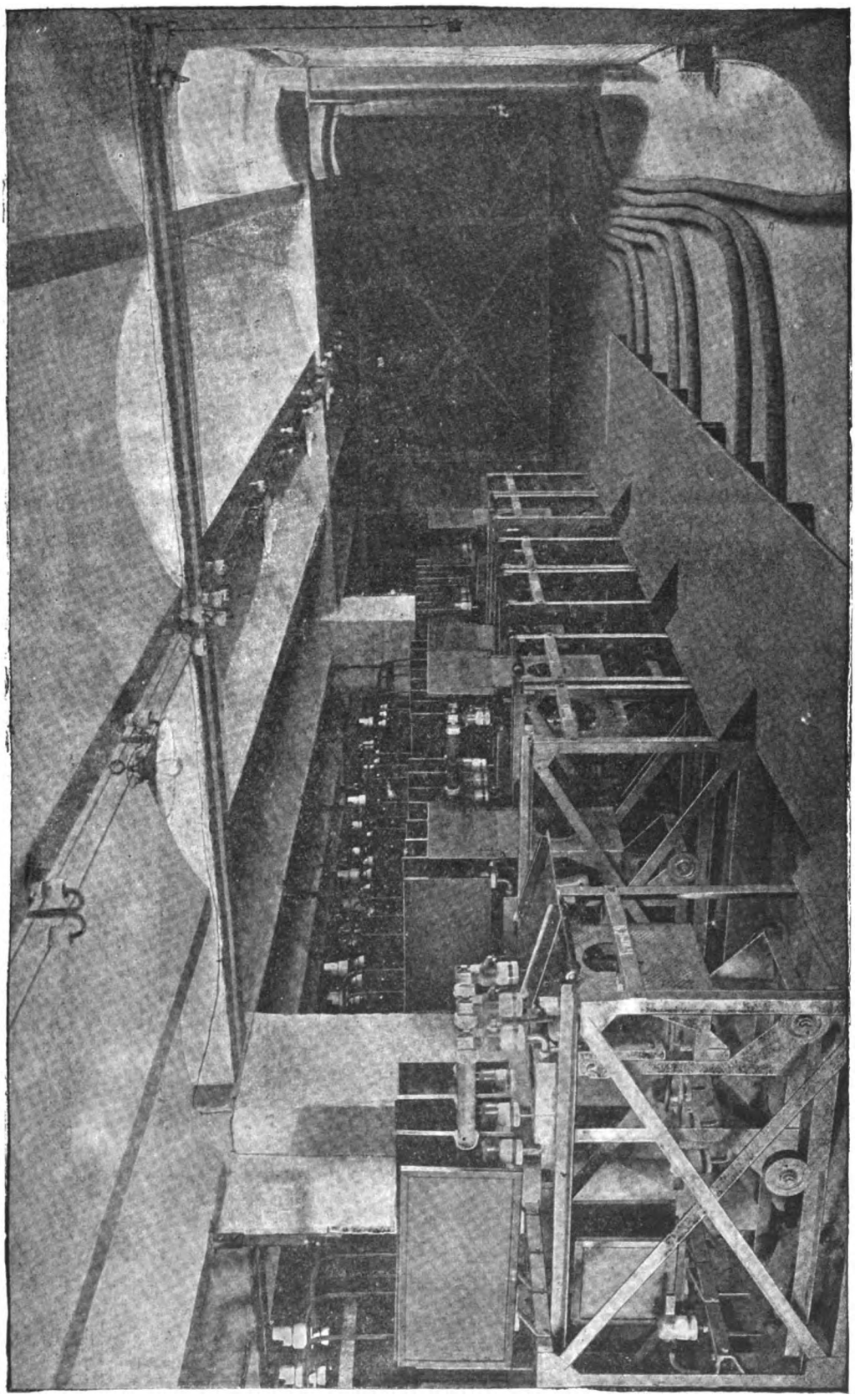

FIG. 14.

The sub-station at Mariannenstrasse is in the south-east of Berlin, and eight miles distant from the Oberspree station, from which it receives high-tension current at 6,000 volts. It distributes current on the three-wire system, with 440 volts across the outers, for light and power purposes, and current at 550 volts for the tramway system. It contains at present six rotary converters

The underground high-tension mains entering the sub-station from Oberspree are twisted triple-cored cables, lead covered, hoop-iron armoured, and asphalted. There are seven in all, which pass along the floor of the cable cellar under foot-boards into the room containing the high-tension switches and fuses (Fig. 14). There are two rows of fuses in this room, one on the mains side and the other on the trans-

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former side. The switches come in between these two rows, and are of the Allgemeine Elektricitäts-Gesellschaft's special "carriage" type, in which the break is made by running back the switch contacts, which are mounted on insulators on a four-wheeled trolley. The fuses are of the cartridge type, the wires being contained in glass tubes and buried in talcum. Special tongs are provided to enable these fuses to be removed without danger to the attendant. An ammeter is placed on each main, so that the current being taken from it may be seen at a glance. The mains pass from the cellar up through the converter room to the transformer chamber on the floor above, entering the oil-cooled transformers from the wall side. From the secondary side of these transformers six copper 'bus bars, each capable of carrying 1,000 amperes, are led to the main switches on the switchboard platform beneath (Fig. 15). Each rotary converter has its own controlling board, consisting of four panels, containing ammeter, voltmeter, phasemeter, synchronising device, and main switches. All live parts are at the back of the board, only the switch levers projecting through a slit in the marble panel. In front of each board are three pillars with hand-wheels, controlling the magnet regulator, starting resistance, and shunt regulating resistance, which are placed below in the cable cellar. The converter boards are separated from each other by a distance of 6in., the whole being mounted in a neat channel-iron framing. The lighting and power feeders are controlled from a board immediately below the switchboard platform by a marble board containing the maximum cut-outs, meters, voltmeters, ammeters, and switches; behind this board run the main lighting and power 'bus bars, which are dimensioned to carry 12,000 amperes. The connections between the rotary converters and the switchboard consist of twisted triple-cored cables to obviate line interference.

The electric traction switchboard runs at right angles to the lighting and power switchboard, and is similarly arranged in two platforms, the upper containing the switches and instruments and the lower the autmatic cut-outs. The 'bus bars of the traction board are nearly 10 square inches in cross-section. The lighting and tramway feeders pass from the switchboard below into another wing of the cable cellar. In each lighting feeder, before it passes into the street, is fixed an ammeter resistance, so that by means of a portable ammeter the load on the feeders can be measured from time to time. The accumulator batteries for both the lighting and traction networks are on the top floor of the building. The batteries are of the well-known Tudor type, and need no description here. The controlling apparatus, cell regulators, etc., are placed in the floor beneath.

The illustrations which accompany this brief description will serve to make more clear to the reader the general arrangement and nature of these stations, which we are sure will greatly interest their visitors.

MUNICIPAL ELECTRICAL ASSOCIATION.

Glasgow Congress.

(Continued from page 933, Vol. XXVII.)

On Friday, June 21, the ordinary meeting was resumed, when the President asked Mr. Highfield to read his paper on "Refuse Destructors."

Refuse Destructors in Combination with Electric Power Stations.

BY J S. HIGHFIELD, ELECTRICAL ENGINEER, ST HELENS CORPORATION.

In writing this paper, the author has found himself in a somewhat difficult position. He started off with the fixed idea that it was useless to deal with the subject without personal working experience of the plant of which he was writing, and from the results of working such plant. He endeavoured to gain such knowledge, so that he could write of plant other than the one for whose operation he is responsible, and so arrive at more general conclusions. He found, however, that the knowledge he could gain of other plant was exceedingly limited, and so he has kept to his original idea that nothing but personal working experience is of any use when writing on this subject; and at the risk of narrowing the issue, he decided to deal only with the plant whose working he controls, and draw general conclusions to but a limited extent. He writes, however, with the hope that other engineers who have charge of similar plant will give the results of their experience. It is absolutely certain that in most towns—in all but coast towns—there is no better method of getting rid of town refuse, gathered from ashbins, markets, abattoirs, etc., than by cremation; and the primary object of every destructor must be to cremate the refuse in a perfectly sanitary manner. The temperatures attained in modern destructor furnaces worked with forced draught are always sufficiently high to ensure that no fumes or foul gases come from the chimney. Any smell that comes from a destructor is due to decaying matter, or to the heating of the refuse before it enters the furnace.

Site.—The site for a destructor must be chosen so that the cartage is made through streets other than the main or residential streets, and also so that the average distance to be traversed, from the point at which the refuse is collected, to the destructor is as short as possible. In towns having 100,000 inhabitants or more it will generally be more economical to have two sites, and in very large towns more than two sites, as any saving that can be made by burning all the refuse in one large central destructor is more than counterbalanced by the extra cost of carting. In St. Helens there are two destructors: the cost per ton of carting to No. 1 is 2s. 6½d., and to No. 2, 2s. 6½d. If all the refuse were carted to No. 1 the cost per ton would be 2s. 11d. The policy of the committee responsible for the cremation of refuse must be decided very largely by this question of cartage, taking into account the value of the refuse as fuel to produce steam for the power station, which value will be treated of later in the paper. In considering the question of site, where two or more destructors are necessary, and where no power station already exists, it is advisable to place the largest destructor on a site also suitable for the power station, and to choose this site so that the cartage shall not be very heavy from the districts where the refuse having the best fuel value is obtained. If a power station already exists and the site is sufficiently large and in a sufficiently favourable position from the cartage point of view, then, of course, this is the position for the refuse destructor.

The Destructor.—Without any addition of boilers there are certain points that should obtain in any really first-class destructor. These points may be tabulated: (1) forced draught, preferably provided by a blowing engine as being more economical than a steam jet; (2) a suitable arrangement of duplicate flues, so that one set can be cleaned while the other set is working; (3) charging appliances, so that the refuse can be quickly transferred from the carts to the furnace without unnecessary handling; (4) baffling chambers, or other devices, to prevent dust entering the chimney stack; (5) arrangements for quickly and cheaply removing the clinker.

If, in addition to the destruction of the refuse, steam raising on a serious scale is contemplated, it is further necessary to provide: (1) a high-pressure boiler in connection with each furnace, of which there must be at least two, one as a stand-by; (2) each furnace must have two divisions or cells, one of which must always be in full blast when the other is being clinkered or charged; (3) by-pass flues, so that any surplus heat can be sent direct to the chimney; (4) arrangements to prevent cold air getting to the boiler during charging and clinkering operations; (5) duplicate flues to enable the furnaces to be worked continuously from week to week, one set of flues being cooled down for the necessary periodical cleaning operations.

Generally when a destructor is used as an adjunct to an electric power station, a separate grate is provided so that coal can be burnt under the boiler. This is only necessary when it is contemplated to steam the boilers without refuse—that is, with coal only—or when the refuse is of extremely variable quality. The writer has never yet used coal to help out the destructor fires, but occasionally the refuse is of poor quality, and then it is necessary to help the destructor with steam from other boilers. He has found it a good plan to burn the clinker and ashes from the electric works boilers in the destructor when the refuse consists largely of fish or paper; by this means he burns these substances in a better manner, and gets more steam and also gets rid of a waste product in an economical way.

Referring to the details above mentioned, the most important, so far as steam production is concerned, is a rapid means of charging and clinkering the furnaces; with regard to the latter, some form of chain grate seems to promise the best station; with regard to the former, the sloping platform is exceedingly simple, but it involves much labour in raking the refuse into the furnace doors. The arrangement the writer is now using is one due chiefly to Alderman Forster, and consists of a platform on to which the carts are tipped, and which can be tilted to an angle of about 45deg. by means of winding tackle operated by an electric motor. The refuse slides or is easily raked over the charging doors and against a screen; the doors can be racked open and the refuse falls and is raked into

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the furnace. This gear works well and enables more refuse to be burnt in the same furnace than could be done by the former method. The flue, as above mentioned, must be duplicated or arranged so that the furnaces need never be shut down, and the forced-draught arrangements should be also duplicated; in short, all the usual arrangements made by engineers to obviate a shut down at the power station must be made in connection with any destructor designed to supply steam to its engines.

Having noted the above general considerations, it is necessary to consider the conditions of steam production from a destructor, and the first point is that the steam is produced steadily for at least 16 hours, and possibly for 24 hours each day. It is not in any way desirable to operate the destructor to follow, for instance, the variations of a lighting load; if a lighting load only is to be worked, and the day load is small, the use of a destructor is limited to the working of only a small part of the load. In the case of direct-current plant, a large storage battery is a most useful adjunct in this respect as in others; it enables the plant load factor, and hence the utilisation of the steam, to be greatly improved. If a lighting station only is to be supplied, the remarks above as to the addition of an extra grate for burning coal do not apply. The correct way to design the destructor in such a case is to erect a boiler considerably too large for the destructor to steam alone to its full capacity; when the heavy load comes on, coal may be burnt in the second furnace to drive the boiler to its full capacity. The writer regards such an arrangement, however, as only suitable for small installations; in such cases it would be very useful. If, however, the steam is used in connection with a traction station, or a station which supplies energy for both lighting and traction, then the destructor steam can be put to very much better use.

The plant of which the writer has charge consists of two Beaman and Deas furnaces, each divided into two cells, each furnace serving to steam, to its full capacity, a Babcock boiler with 1,470 square feet of heating surface. The forced draught is provided by a 18-h.p. motor-driven fan, the average pressure in the closed ashpits being 3in. on the water gauge. The plant at the power station consists of five steam generators of a total output of 1,000 kw. In addition to the steam from the destructor boilers, steam is supplied from a battery of four 30ft. by 8ft. Lancashire boilers. The steam ranges are designed so that two steam sets, each of 125 kw. capacity, can be run from the destructor independently of the other boilers, or the destructor boilers and Lancashire boilers can supply the whole range in parallel; in each machine circuit a watt-hour recording meter is fixed to meter the output from the generator. The usual practice is to drive one or both of the 125-kw. sets from the destructors only for a part of the day, and later on, when more plant is required, to parallel both sets of boilers on the whole load. The working this year has been somewhat interferred with from the usual causes incident to any new installation; a considerable amount of alteration and reconstruction has been done, which has prevented the fullest efficiency of working being attained. The figures given below show the results of the first year's working of a new plant, and give a fair idea of the actual value of a small destructor plant in a town where the refuse has a good calorific value. It was found that the calorific value of the fuel was distinctly better in the summer than in the winter. The refuse varies somewhat from day to day, and, therefore, if no other boilers were available it would be necessary occasionally to use coal under the destructor boilers, or to hold a reserve of boiler ashes and clinker to use when the calorific value of the refuse was poor. The figures relating to 12 months' working from March 31, 1900, to March 31, 1901, are as follows:

FIGURES FOR ONE YEAR'S WORKING OF A TWO-FURNACE REFUSE DESTRUCTOR.

	Total for year.	Average per week.
Weight of refuse burnt	9,778 tons	188 tons
Electric energy used to drive fan and other motors	70 000 units	1,346 units
Units generated by steam	365,000 ,,	7,019 ,,
Wages on burning	£750	£14. 8s. 6d.
Wages on repairs	£86	£1. 13s. 1d.
Total wages	£836	£16. 1s. 7d.
Weight of clinker produced	3,900 tons	75 tons
Value of mortar sold	£221. 9s 8d.	£4. 5s. 2d.
Value of electric units generated at 3d. per unit generated	£450	£8 13s. 1d.

Averages per Ton of Refuse Burnt.

Units generated	37 3
Units used on works	7·1
Cost of burning, including wages, light, and power	22·1d.
Cost of repairs (wages and stores)	3d.
Total cost of destruction	25·1d.
Cost of removing clinker not otherwise used	5·5d.
Total cost of destroying refuse and removing part clinker.	30·6d.

From the above figures, it will be seen the net saving to the destructor department due to combining the electric works and the destructor works is £450, less £50 on boiler repairs, and less the interest and sinking fund charges on £1,500 (which represents the extra capital cost on the boiler plant above what would have been necessary for smaller boiler plant for working the mortar mills, the blowing fan, and other plant on the works), which may be taken as £90, leaving £310, or 41 per cent. of the total wage bill. The cost of cremating the refuse and removing the clinker is, therefore, reduced from 2s. 6·6d. per ton to 1s. 11d. per ton. It should be noted here that, in addition to supplying steam to the electric works, the destructor also supplies steam to drive two mortar mills and a steam winch. Considerable care was taken to prevent dust from the destructor getting into the power station; it is almost impossible to do this quite successfully, but no serious harm was done by the small amount that did enter.

In conclusion, the writer would say that in certain cases where a suitable site for destructor and electric works exists, and where the works are not very large, the combination can be usefully made when a traction or other good all-day load exists. For a very large works, or for a station which only drives a lighting load, there are not many instances where there is any economical value in the combination. Without desiring to generalise, the writer thinks that in these cases it is better to use the destructor furnaces to provide steam for driving mortar mills or other machinery, on which the calls are not so exacting as on an electric power plant.

Mr. C. H. WORDINGHAM complimented the author on the interesting information which he had given, and on the fact that he had not taken the abnormal view of the advantages of refuse destructors which were held by certain engineers a few years ago. In consequence of the extreme claims which were then made, the use of such destructors in conjunction with electric lighting plant was apt to be unduly discredited. With respect to the installation at Liverpool, he believed that they had erected a number of destructors, and that the steam which was got from these was to be used to help to supply the tramways with electrical energy. The idea was a good one, because the refuse destructors would thus be able to work always to their utmost capacity. He would like to ask the author if he believed in partially drying the ashbin refuse before burning. He had had the opportunity recently of inspecting the Rochdale destructor, where hand feeding was used. It was an exceedingly simple destructor to work. He believed that the steam jets used about one-seventh of the whole steam generated. If the use of steam actually resulted in the production of water-gas, it had an advantage over forced draught. At this Rochdale destructor the shaft was 250ft. high and 7ft. 4in. in diameter. The draught produced in this way was 1⅜in., while the steam jets produced about 1in. of draught. The result was that over the bars there was equal balance of draught, and no flames came out when they opened the charging doors.

Mr. S. CLEGG, of Darwen, agreed with the author that if there were more than 100,000 inhabitants in a town they would require more than one refuse destructor. There was no reason why any destructors should give rise to smell or smoke if they were correctly designed. He used at Darwen a steam blast, and he found that if correctly regulated it only took 12 per cent. of the whole steam generated. He believed in having complete duplicate units of plant of destructors and boilers, so that the one unit could be shut down for cleaning. He did not advocate, however, having duplicate flues, as this meant a longer distance between the boiler and the destructor furnace. Hand firing was even more required for destructors than for boilers with coal, as the refuse should be evenly distributed over the grate. If it were lumped on by the cartload as suggested, they were apt to get it baked, as Mr. Wordingham remarked, with the result that unconsumed fumes would be delivered from the chimney shaft. He did not think a chain grate would work satisfactorily owing to the high temperature which the firebars attained. He often got up to 2,000deg. F. in his furnaces. He could not understand why the author could find the ashbin refuse of more calorific value in summer than in winter; the opposite applied in Darwen.

Mr. H. MORTON, of Llandudno, wrote to the secretary to say that he agreed with Mr. Highfield in most of his conclusions. In the destructor at Llandudno they had constructed grates at the side for coal firing. It was found, however, that the dust carried over from the destructor furnaces actually damped out the coal fire. He had found

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considerable difficulty in getting an even steam pressure out of the destructor boiler. It was not enough to alternately open the furnaces for charging, as the manufacturers recommended. He found that the best way was to work the refuse destructor boiler in parallel with a coal-fired boiler, and let the regulation be done by means of the damper on the coal-fired boiler. In the summer they had an exceedingly poor kind of refuse to burn, and at times he had added a coke breeze to the fish offal which was delivered to them. Last year in the Llandudno destructor they had burnt 5,630 tons of refuse at a cost of 1s. 7d. per ton, without including repairs. He valued the steam obtained at 5d. per ton. The actual number of units obtained worked out at 32·7 per ton of refuse. He thought a fan was better than a steam jet, and that a steam-driven fan was more economical than an electrically-driven one. He would ask the members if they had had any experience of the hogging of the lower set of tubes of the boiler. It had occurred in Llandudno, and was due, he thought, to the alternation of high and low temperatures to which these tubes were subjected. It might interest those members present to know that his undertaking had showed a net profit of £700 for its second year's working.

Mr. V. A. H. McCowen, of Belfast, thought that the author's figures with respect to repairs and maintenance were unduly high. He noted that 20 per cent. of the electricity generated by means of steam from the destructors had been used to drive the auxilary plant. The clinker also was high, as he believed that in the usual case there was only from 25 up to 33 per cent. of clinker, as against the 40 per cent. which the author gave. With respect to Belfast they had put down a 12-cell destructor, and had asked the contractors to guarantee working cost and repairs in rates per ton. The accepted tender from Messrs. Goddard and Massey agreed to work the destructor, providing all labour at 10½d. per ton, and to do all the repairs at 1d. per ton, which made 11½d. the inclusive charge, as against the figure given by the author. He also noted that the firm in question would only charge 9½d. per ton for cremation if steam were not used for producing electricity. He would ask the author how much he had included in his figures as a capital charge?

Councillor Worthington, of Wigan, remarked that he had not much to say about destructors, but thought that the cost of getting the refuse to the destructor might be reduced in the following way: He would arrange small depôts in the various parts of the town, to which the refuse would be at first delivered at a less cost than if it had to be taken out to a destructor at one end of the town. He would then propose that after the ordinary tramway service had ceased, all the refuse so collected should be conveyed in special trucks over the electric tramways.

Mr. S. D. Schofield, of Shipley, said that in his town the destructor was put down some years before the electricity works, and that the steam had been wasted in consequence. He would ask the author as to how many hours he found he could work the water-tube boilers in connection with the refuse destructors without having to shut down to clean the tubes and the flues. He did not think it was well that the boiler should be placed too close to the refuse destructor furnace, because in that case the cold tubes were apt to check the combustion of the gases. With respect to the moisture in the refuse, he had found that this varied from 5 up to 90 per cent. in exceptional cases. He had obtained the following figures as a result of a 19-hour test with his destructor. They burnt 19 tons 6cwt. of refuse on a grate area of 45 square feet. The boiler evaporated 3,800 gallons of water, which worked out at 1lb. of water for every pound of refuse. From actual samples taken of the refuse used, he found that 51 per cent. of moisture existed in it. There was also 27 per cent. of clinker, so that 78 per cent. of the refuse was quite useless as a heat producer. The boiler worked at 120lb. per square inch, and was not lagged.

Alderman Ivey, of West Ham, referred to the nuisance which occurred in connection with refuse destructors in consequence of the dust they produced. In fact, they might almost be called "dust producers" instead of "dust destructors." The actual cost was a small matter compared with the good done if the dust was destroyed in a sanitary way, and he thought that this condition should be more thought of than the energy which they could produce. On the whole, he thought that a dust destructor could be combined with a sewage pumping plant to much more advantage than with an electric lighting station.

Mr. J. K. Brydges, of Eastbourne, explained that at Eastbourne they were combining the refuse destructor with the air-compressors used in connection with the sewage works. They had in Eastbourne an exceedingly poor class of refuse to deal with. With respect to the opening of the furnace doors, he remembered that at the Wakefield destructor the forced draught was automatically shut off when they opened the furnace. At the same place they also had a considerable trouble owing to the clogging of the outside of the economiser tubes. A scale was formed on these tubes which was almost as hard as the deposit often found inside boilers. There should be no odour from a refuse destructor, and he believed in drying the refuse by placing it behind the hearth in the first case. The design of the furnace should be such that the fumes given off in the drying process had to pass over the incandescent fuel. They had had no trouble with the hogging of the boiler tubes, but in one instance a damper, which was of wrought iron, had warped badly. The refuse destructors were of most service in connection with the day load. With respect to means of charging the furnaces, he did not believe in charging trucks which had a number of divisions. The refuse was brought in so irregularly that these were quickly filled up, and then the receiving platform became choked.

Alderman Forster, of St. Helens, said that the destructors were put down at St. Helens before the electric lighting plant. He personally did not believe in having their destructors in the outskirts. It was in the middle of the town at St. Helens, and they had had no complaint except on Sunday, when the coal fires only were used. The Belfast figures were obtained from the contractors, and hence were not to be relied on fully, as the order depended on the low quotation. Mr. Highfield's figures would, he believed, be found to include a number of items which were omitted in those given by Mr. McCowen. The refuse destructor was owned by the Sanitary Committee, who obtained enough income from the electricity department to more than meet the interest and sinking fund on the capital outlay.

Mr. J. H. Rider, of the London County Council, asked the author how much extra pressure was required in consequence of the baffling chamber, and also how he ascertained what should be paid for steam. He thought that this payment should be estimated on the units generated by the steam from the refuse destructor. He had arranged that this should be done at Plymouth, where the price fixed upon was ½d. per unit. The loss in the steam-pipes was then borne by the destructor department. His own advice would be that the refuse destructor was really required by another department of the Corporation than the electricity department, and that it would be well to let the borough surveyor have the steam to work the sewage plant, mortar mills, etc.

Mr. J. E. Edgecome, of Kingston-on-Thames, explained that he had known cases in which the dust coming out of the chimney had been complained of by householders living half a mile away from the station. This was so in the case of the South London Electric Supply Corporation. This company was obliged under penalties to burn the Lambeth refuse, and the local authority had both stopped them from so doing in consequence of this dust and also brought an action against them for damages, because they had discontinued the cremating operations. He felt, therefore, that in Kingston they could hardly use a refuse destructor unless it was placed near the cemetery.

Mr. Tremlett Carter explained that the formation of water-gas was advantageous for the following reason, although it could not increase the total heat available. With the formation of water-gas, there was more flame, as the high temperature was transferred to a certain extent from the firebars up into the furnace. He would like the members to experiment and see if a similar fact could not be produced with forced draught by having the air saturated with moisture.

Dr. Allfrey, of Hastings, said that the author's

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remarks with respect to seaside towns was hardly applicable, as the cost of conveying the refuse as far out to sea as was required by the authorities was more than the cost of burning it in the destructor. They had had considerable trouble in Hastings in consequence of complaints as to the smells emitted from their destructor, which was placed on the seashore under a cliff. The top of the shaft was about level with the top of the cliff, and the golf players and householders had, therefore, a good opportunity of ascertaining any faulty working of the destructor.

Mr. J. S. HIGHFIELD, in reply to the discussion, said that the figures he had given were averages for a whole year, and that they must not be compared with the figures obtained over a test of a day's duration. It was exceedingly easy to get the figures given by manufacturers on a 24-hour test, but what engineers really wanted when making up estimates for their schemes were the average figures over a long period of time. In his opinion, the ideal method of charging a destructor would be to tip all the refuse straight in from the cart, as it was abominable stuff to handle. A duplicate flue was most necessary, as they required to be cleaned out at least once a week. Also, he believed in working the one set of flues and destructors continuously over a week, in order to avoid the damage done by heating and cooling the boiler and boiler settings. As regards the payment, his figures were, of course, to a certain extent, estimates as to the units produced from the destructor, but he had a number of readings taken whenever the destructor was working alone, so that he was able to arrive at accurate results. The Health Committee paid for the whole equipment, so that they had no charge for the boilers or for wages, and the electricity department handed over to the Health Committee one-third for every unit generated.

Mr. R. A. Chattock then read the following paper:

Coal and Ash Conveying Gear.

BY R. A. CHATTOCK, CITY ELECTRICAL ENGINEER, BRADFORD.

The question of dealing with coal used in electric generating stations is one of the most important that presents itself to the electrical engineer, and of almost as much importance is the question of disposing of the ashes that are produced by the boilers. Taking the average of a number of works, the cost of the coal works out at ·71d. per unit, and this represents 46·6 per cent. of the average works cost per unit. In a station producing 5,000,000 units per annum, this means an expenditure of £14,791 per annum, or, at an average rate of 12s. per ton, a consumption of 24,652 tons per annum. The cost of conveying and handling this coal varies between very wide limits, according to the distance it has to be taken, the height to which it has to be raised, and the means at disposal. As a rule, coal contracts are drawn up to include the cost of cartage into the generating station, and it is consequently somewhat difficult to give an exact figure for this item. A charge of 6d. per ton for cartage from an ordinary railway siding for a distance of half a mile is, however, a fair estimate. This represents an annual cost of about £616 on the above quantity of coal. If it is possible to put in a conveying apparatus that will take the coal direct from a railway or water siding and deliver it to the generating station, and if the annual charge on this, represented by, say, 10 per cent. on the prime cost of the apparatus, does not exceed the above amount, it is certainly worth while to adopt this principle. If, however, the distance is great between the siding and the station, and cost of the apparatus excessive, it is better to have the coal carted to the generating station and distributed in the coal bunkers by means of a local conveying apparatus.

Horse traction for cartage purposes is a very unreliable means, especially in winter time when the frost is on the ground and when it is very important that there should be no interference with deliveries, and on this account, and also that the cartage may be under the direct control of the station engineer, a more reliable means should be provided. This may be effected by means of motor-driven trolleys, each capable of holding about five tons, so constructed that they can be backed under the coal drops of a railway siding or under the cranes used to unload a barge, and arranged so that they can be tipped into convenient hoppers in the generating station. Such vehicles can travel at a speed of eight miles an hour, and when not used for coaling purposes they can be utilised for conveying cable drums or other heavy gear about the town. They should be preferably steam-driven, and can be purchased for £500 or £600 each.

Once the coal has reached the station, the question of the most convenient means of storage presents itself to the engineer. The minimum amount which should be stored in a station is 100 tons for every 1,000 i.h.p. installed, and this amount can be conveniently contained in overhead bunkers placed above the boilers. It is, however, desirable to store four or five times this amount if possible, and to effect this an auxiliary coal store is necessary. This must obviously be placed outside the boiler-house. It should be near the ground level, and connected to the overhead store by means of conveying and elevating machinery. The coal store or bunkers, whether overhead or on the ground-level, may be constructed of brick or iron work. The flooring should be sloped at an angle of 45deg. to points in the centre, from which distributing shoots can be taken either to supply the boilers or the conveying apparatus. The maximum depth of the coal stored in such bunkers should not exceed 10ft. If this is exceeded, the coal is liable to become overheated and to catch fire. The construction of the bunkers, including the roofwork, should be entirely of non-combustible material, and fire hydrants should be placed in accessible positions. In an auxiliary coal store it is usual to have a conveyor running over the top of the store and returning underneath it. By means of this the coal can be collected from the points where it is discharged from the carts and can be distributed in the store. If it is desired to draw coal from this store, the return half of the conveyor, which runs beneath it, can then be fed by shoots, and arranged so that it will deliver to an elevating apparatus. The elevating apparatus should take the coal to the level of the coal bunkers over the boilers, and it should be possible to feed this either from the auxiliary coal store or direct from the carts. After the coal has been elevated to the desired height, it can then be distributed in the overhead bunkers by means of another conveying apparatus, and from these bunkers it should be fed to the boilers through shoots, which should be fitted with controlling valves.

There are many forms of conveying apparatus, and I will endeavour to describe those most in use, and point out their advantages and defects. The worm type of conveyor consists of a worm or screw which revolves in a semi-circular trough. The coal is fed into one end of this trough and is gradually pushed along by means of the worm; it is allowed to fall through doors in the bottom of the trough, which can be opened when necessary. This apparatus can only deal with small coal, and it is very liable to get out of order owing to lumps of coal becoming jammed between the worm and the trough. The power taken by this apparatus is also excessive owing to the friction between the worm and the coal, and between the coal and the sides of the trough. The chain type of conveyor consists of a chain formed of lines of bar-iron riveted together; this is dragged along a flat-bottomed trough having doors on the underside; the chain passes over a sprocket wheel which is driven by gearing, and is dragged along the trough pulling the coal with it. This conveyor is less liable to get out of order than the worm conveyor, but the friction between the chain and the trough and the coal and the trough is excessive. Another objection that this conveyor has, is the fact that the rivets in the chain, which form the pins on which the links turn, are buried in the coal, and in time these and the holes in the links become worn and cut away; the centres of the links consequently become elongated and the chain does not gear properly with the sprocket wheel. The life of such a chain is not more than from three to four years. The push-plate type of conveyor was devised with the idea of keeping the chain itself out of the coal. The chain of this conveyor runs on rollers above the trough, and attached to it are a series of rectangular plates which dip down into the trough and push the coal along as the chain is dragged forward. This is a better form of conveyor than the last, but it has the same objection owing to the excessive power absorbed in the friction of the coal when being dragged along the trough. The band type of conveyor consists of a broad endless indiarubber or fibre belt from 18in. to 24in. in width, running over pulleys at either end, and supported by rollers throughout its length. These rollers are shaped or inclined so as to cause the belt to sag in the centre, and so prevent the coal from falling off. In order to discharge the coal from the belt, the latter can be tipped on one side at any desired point, and the coal will fall off the other side, or the coal may be scraped off by an inclined scraper placed at any point. This form of conveyor takes less power to drive, and there is no power absorbed in friction as described in the previous types. This type of conveyor has the advantage of being about the cheapest in first cost, and rubber belts such as these have been known to last from 10 to 12 years, and even then to be in a very fair condition. The working parts of the apparatus can be lubricated, preferably by means of grease. The steel trough conveyor is composed of a number of steel plates, which are usually turned up at the edges, and which are fixed to the links of an endless chain. The chain may be run on rollers, or may be fitted with small flanged wheels, which run on a tramway. The plates are so arranged that when the chain is approximately in a straight line they form a continuous trough, which travels along. The coal, which may be of any size, is fed on to this trough and carried

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along by it to any desired point, where it can be discharged. It has the advantage that the working parts of the chain are kept away from the coal dust, and there is no power absorbed in friction, the coal being carried along bodily. The conveyor is not, however, adapted for the convenient discharge of the coal at any point along its route. The return chain also is useless.

All the above types of conveyors can only be used for conveying coal approximately horizontally, and if used for elevating they should not be run at a greater angle than 30deg. with the horizontal. Another type of conveyor that is being extensively adopted now is one in which the coal is conveyed by means of buckets which are hung on an endless chain. These buckets always hang vertically, and in this way the conveyor can be used either for conveying horizontally or elevating vertically, or at any desired angle. The chain itself is fitted with small flanged wheels, which run on an ordinary tramway composed of T-section rails. Where it is necessary to change the direction of the motion from conveying horizontally to elevating vertically, curved rails are fitted to effect this. The chain is a double-link chain on each side of the buckets, and the driving is effected by means of toothed wheels or pawls, which engage with distance blocks fixed between the double links. This conveyor can only run in a straight line when moving horizontally, but the direction of the motion may be changed to one at right angles if desired, where the chain is ascending or descending vertically, by allowing the chain to twist where it is hanging free. The buckets are filled by means of funnel-shaped spouts which fit into them as they pass along, and each spout allows just sufficient coal to enter in order to fill the bucket. This conveyor takes very little power to drive it, as there is only the friction in the wheels to overcome and the dead-weight of the coal to be raised. It is so free that the weight of the coal in the ascending buckets is enough to cause the chain to run backwards if the driving power is taken off, and means have to be taken to prevent this by using some form of ratchet and pawl. The working parts are protected from contact with the coal or ash dust, and in consequence have a maximum life. The buckets can be tipped at any desired point by means of a lever engaging with a pin on the side of the bucket. This conveyor can be used both for coal and ashes if it is arranged to travel over the coal bunkers and under the ashpits of the boilers, and in this way the cost of installing two conveyors and special elevating gear is obviated. Another type of conveyor and elevator that may be employed is as follows: A long girder of H section is supported at any desired height by means of lattice framework and tierods. On this is fitted a trolley which can be pulled backwards and forwards by a wire rope; on this rope is a pulley with a hook attached, and at certain points this hook can be lowered to the ground-level, where a skip, holding about a ton of coal, can be attached to it. The skip is then raised, and when the hook is brought to the level of the girder it is gripped by the trolley, and the whole is travelled along; the skip can then be tipped at any desired point. The motion is then reversed, the skip brought back again, lowered, unhooked, and a fresh skip attached. In this method it is necessary to fill the skips by hand; they can, however, be emptied at any desired point. The working parts are kept free from coal and ash dust, and the apparatus does not take an excessive amount of power to drive.

Turning now to elevators as distinct from conveyors. The most usual type adopted is that having an endless chain, which passes over pulleys at the higher and lower level, and has buckets fixed to it. These buckets dig into the coal at the bottom end, in what is called the boot of the elevator; they carry the coal to the top, and as they turn over the top pulley they discharge the coal down a shoot, which, as a rule, feeds on to a conveyor. This form of elevator takes a considerable amount of power to drive it, and it has the disadvantage that the working parts of the chain come into contact with the coal or ash dust, and in consequence wear takes place. For unloading coal from a barge the best form of elevator is an automatic grab which can be attached to a crane. This, while open, can be dropped into the coal, and as soon as the lifting chain begins to pull the grab closes, digs into the coal and fills itself. It can then be lifted to any desired height and discharged into a hopper, from which the coal can be taken by the conveyor. If desired each grab can be weighed, and an automatic register kept of the weight. Conveying and elevating apparatus is peculiarly liable to breakdown, owing to the rough nature of the work it has to do, and in order to guard against the serious results which a breakdown may entail during the heavy winter loads, some duplicate means should be provided for getting coal into the station and for getting the ashes away from it. Owing to the high initial cost of good conveying plant, it is not advisable to instal this in duplicate, unless the station be very large and the outlay be warranted. It would appear best to use some simple and effective means, such as a system of light tipping trucks, which can be run on a tramway in the boiler-house, and which can be filled by hand. Such an arrangement, of course, entails a considerable amount of labour, but, being only a stand-by, and to be used only in an emergency, this item cannot amount to very much. In some cases means may be provided for taking the coal carts themselves into the boiler-house and dumping the coal on to the floor.

With reference to ash conveying, the same type of apparatus can be used as is employed for coal conveying. The ashes should not be allowed to interfere with the handling of the coal in any way, and should, if possible, be dealt with in a cellar below the boiler-house flooring. In a boiler-house containing a large number of boilers, if the ashes are allowed to accumulate even for a couple of days, the whole place becomes so choked that it is impossible to work the boilers properly, and if there is a large space available below the floor, the ashes can be allowed to accumulate here for several days if it is impossible to get rid of them. The ashes should be taken to an overhead bunker, preferably at the end of the boiler-house furthest from that at which the coal enters, and from this bunker they may be fed into carts or trucks by means of shoots. It is most essential that they should not be allowed to accumulate, and it is quite as important to provide duplicate means of getting rid of them as it is for getting the coal into the station.

Mr. C. H. WORDINGHAM was also asked to open this discussion, and he remarked on the need there was for closely investigating all such problems, because one was apt to overestimate the value of the money-saving apparatus, and to exaggerate the cost of hand labour. He thought that the author's limit was not far wrong as to the point at which the coal conveyors became too expensive. He thought that the provision of a second store for coal involved much too much expense in transferring the coal stored into the hoppers over the boilers. He believed, therefore, it was better to get a bigger store over the boilers and to avoid one handling. As regards the source of the coal, it was well not to be dependent on either canal or rail carriage, so that there was a competition between the collieries. The coal grab recommended by the author might be all very well in a large lighter, but it was no use in the ordinary canal boat. He believed that hand labour was the best for unloading a barge on to an elevator or conveyor. He would ask the author as to where he thought the ashes ought to be quenched, as the fumes in the process were exceedingly injurious to the health of the stokers.

Mr. J. F. C. SNELL, of Sunderland, said there was great value in the information given in the paper, as most of them had had to consider the coal-handling problem. In his new station at Sunderland he had succeeded in getting the coal skips from the collieries to run over the main bunkers, so that no elevating gear was required. He thought that the author's limit of 100 tons of coal stores for every 1,000 h.p. of plant was too small. Also, he saw no reason why the slope of the bunkers could not be made 35deg., which was the natural slope of the coal. He had been interested to see the different conveyors in use at the Glasgow tramway station, and at the Edinburgh electric lighting station at Macdonald-road. The latter apparatus seemed to be considerably more simple than the former.

Mr. F. A. NEWINGTON, of Edinburgh, said that the design of the coal conveyor depended largely on the site and arrangement of the central station. In the Macdonald-road station they had a push-plate conveyor and a bucket elevator. He had no figures as yet as to the cost of upkeep, but believed that the quantity bucket conveyor referred to by Mr. Snell would cost about twice as much as theirs had done. They measured the coal in 4cwt. boxes, which was found a very satisfactory way. He quite agreed with the author as to the importance of having ash conveyors. These were badly wanted at Dewar-place.

Mr. COLLINGS BISHOP, of Wigan, said that the double storage gave no trouble as suggested by Mr. Wordingham, as the one chain conveyor could be made to do all the work required, and there was no objection to making the conveyor long, as had to be done. At Wigan he had provided an ash trench under the boiler.

Mr. MCCOWAN, of Glasgow, said that he recently had gone into the question of a gravity bucket conveyor for his station, and found that while he could save £70 per annum, the capital charges would be £150 per annum.

Mr. GRAINGER gave some figures to show that the author had been unduly hard on the worm conveyor. He said that for a small plant it would be cheapest and best, and that with 1 b.h.p. seven tons of coal could be moved 50ft,

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in an hour. He believed in making the slope of the coal bunker 55deg.

Mr. H. L. P. BOOT, of Tunbridge Wells, said that in his case the matter was made more difficult because they had to use the very best coal, which an ordinary conveyor would not handle.

Mr. A. B. MOUNTAIN, of Huddersfield, said that they must not forget the financial aspect of the case. He believed that while often it would not pay to put in conveyors for electric lighting plants, it would pay if there were electric traction supplied in the same station. He thought they should have at least three months' supply of coal in store, as the gas companies invariably did. These companies stored coal for over 10 years, and he saw no reason why electric light companies should not do the same.

Mr. NEWINGTON interposed that he had stored coal in an open yard for four years and found that it had not lost its calorific value.

Mr. L. ANDREWS said that Welsh coal he had found lost from 30 to 40 per cent. of its value in three months.

MR. CHATTOCK, in reply, said that he had not increased the size of his store over the boilers, because it would involve such heavy construction in the building, and also block out the light from the boiler-house. As a rule, the ashes would be conveyed before the floor, and if sufficient space were provided to store those produced in two days or so, there was no need to quench them. He did not agree with the figures as regards worm conveyors.

The meeting was then closed with a vote of thanks to the president, Mr. W. A. Chamen, for presiding over the three business meetings of the convention.

Visit to the Works of Messrs. Babcock and Wilcox, Renfrew.

On arrival at the works the party were conducted by guides, who explained the character of the work carried out in the various departments. The first place visited was called the "pipe shop," and this was an array of buildings in which not only the manufacture of the steel steam-pipes which are a speciality of the firm is carried on, but also their other specialities, such as mechanical stokers and superheaters. It was observed that this department of the works, which might well be called a works within itself, was fitted with every labour-saving appliance and every appliance calculated to produce the best workmanship. Screwing machines and hydraulic riveters for fixing flanges on pipes, hydraulic presses for curving pipes without unduly straining the material were pointed out, and finished steel pipes so neatly bent that they appeared as accurate as if cast in a mould. An array of the firm's patent mechanical chain grate stokers on order for various corporations and in various stages of erection enabled the engineers of the party to understand every detail of them.

The pattern and box-making shop, in which, to avoid fire, the machinery for planing and sawing is driven by electric motors, was next visited on the way to the foundry. This foundry is one of the largest in Scotland, and fitted up for machine moulding, and three cupolas with blowing engines, hoists, and every appliance for producing a large output in the best manner. Stoves in which the firm anneal their own malleable castings were also seen at work. Crossing the yard, in which large stacks of parts of boilers were to be seen ready to be dispatched, the party came to the boiler and engine rooms, in the latter of which were electric dynamos, pumping engines, and ordinary engines, the boiler-house containing four Babcock and Wilcox boilers, fitted with chain grate stokers and superheaters.

From this the machine shop was reached, an immense building covered entirely with glass to ensure that the work is carried out under the healthiest conditions for the men, and with the best of light. The enormous number of machine tools would take too long to describe; there were special machines for facing the flanges of pipes, so arranged that right-angled pipes would be machined in a mathematically accurate manner. There were multiple machines for accurately machining the headers which form part of the boilers, and multiple machines for the various operations on the various other component parts of the boilers. In the erecting bay were seen feed-water heaters in course of manufacture, the expanding of the sections for the boilers, and a plant of Babcock and Wilcox water-tube marine type boilers already erected ready for dispatch to the Shoreditch new electric lighting station, and others in course of erection for the borough of Hastings electricity works.

The next department to be visited was what is called the forge department, in which the headers and other forgings are made. Welding of headers at one operation, huge furnaces and hydraulic presses fill this department, and the productions in various stages of completeness can be described as masterpieces of the forger's art. The next department visited was that in which the steam and water drums of the boilers are manufactured. Every process through which the plates as they come from the mills pass before being turned out and dispatched were shown. The overhead cranes handling the plates, the machines for planing the edges, the automatic machines for drilling the rivet holes, the hydraulic riveters, and testing appliances and pneumatic caulking, tools all formed points of interest to indicate that every appliance for the best workmanship and for the manufacture of high-pressure boilers was available.

Crossing a portion of the yard, in which innumerable drums were stored ready for dispatch with the order numbers all neatly painted on, the marine department was reached. This is an immense new building, well ventilated and lighted, constructed of steel and fitted with electric cranes throughout. This department is just being put to work for the completion of large orders that the firm have received for boilers for H.M. navy. At the end of this department the electrical engineers had an opportunity of seeing the commencement of a fine electrical power station, from which it is intended to further increase the distribution of electric power throughout the whole of these works. The firm intend to discard the use of small steam-engines in various departments throughout, and from what was stated it is anticipated that this will be one of the most complete and up-to-date electric power plants for factory driving in existence.

To go into all that was seen in detail would occupy pages. The works cover the best portion of 34 acres of ground, and are capable of an output of 300,000 h.p. of marine boilers per annum, and an output of four boilers for stationary purposes a day, besides an immense quantity of steam-pipes, mechanical stokers, superheaters, and the various specialities for the generation of steam in which this firm are so eminent. Throughout one could not help being struck with the cleanliness, order, method, and organisation that was apparent, irrespective of the fact that the large amount of work in progress testified to the appreciation and esteem in which the manufactures of the firm are held; and the extent of the works would fully justify the claim that is made for them, that they are the largest and most complete boiler works of their kind in the world.

THE VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO BERLIN.

[BY OUR OWN CORRESPONDENT.]

(Continued from page 937.)

Before continuing my report of the above visit, I must apologise for the perversity of the office boy, who, presumably in the absence of his chief, took it upon himself to insert last week a description of the dynamo works at Charlottenburg in its unread state. The result is amusing, and I would commend the article for careful perusal to whosoever may wish to study German phraseology. Having divested myself of this humble apology, I will now return to the visit of Monday, June 24, brief reference to which has already been made. So far as the lecture delivered by Herr Bussmann on the development of the Nernst lamp is concerned, it was certainly calculated to convince one of the great possibilities of this type of lamp, if not of the complete success of the latest pattern. So many of the initial difficulties have now been satisfactorily overcome, that it is only reasonable to suppose the secret of

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long life will also find an ultimate solution. It is generally presumed that this is the one great problem now awaiting solution in connection with this lamp. I would point out, therefore, that the question is not one of life simply, but of length of life relative to the cost of manufacture per lamp. Nothing, so far as I am aware, has been said about the cost of manufacture. Assuming this can be kept reasonably low, there should be nothing to prevent the commercial success of the lamp in its present stage of development. Its economy as compared with that of the ordinary incandescent electric lamp is known to be very high, and the average life—about 300 hours—claimed, though low as compared with the same standard, should not be fatal to its commercial success, provided, of course, as I have said before, the cost of manufacture can be reduced correspondingly. It is here, then, wherein the real difficulty may exist. As for the lamp itself, there is no doubt about its excellence. The manner in which the problem of applying initial heat to the electrode has been solved is especially noteworthy, this being accomplished in the latest form of the lamp by means of a spiral-shaped resistance embracing the electrode. When sufficient heat has been imparted to the electrode to render it conductive—which is a matter of only a few seconds—the resistance is automatically cut out, whereby waste of energy is avoided. The lamp has already been constructed for voltages up to 250, so that arranged in series it might be used instead of arcs on high-tension circuits. It is stated that the efficiency of the lamp is maintained during its life, another point in its favour. I had an opportunity when in Berlin of seeing many examples of its practical application for indoor lighting, the effect being brilliant and pleasing in each case. I understand a rental is charged to customers by the Allgemeine Elektrictäts-Gesellschaft equivalent to about 3s. per annum per lamp fixed, no extra charge being made for necessary renewals of electrodes, but do not know in how far this arrangement has proved satisfactory. Another point affecting the practical possibilities of the lamp, to which I have not hitherto referred, is the very detrimental influence on its life produced by a small fluctuation in the terminal voltage. But provision has been made in the most recent form of the lamp to counteract such fluctuations, whereby it is hoped this difficulty has also been effectively overcome.

The inspection of the Louisenstrasse station of the Berlin Electricity Works, which took place immediately after the above-mentioned lecture had been delivered, was productive of much interest. A great deal has been written about the equipment of this station, but few of the visitors had seen it previously. What struck one most was the size of the Sulzer engines, three of which are at present installed, each developing an output of 3,000 h.p. normal and 4,000 h.p. maximum. It was fascinating to watch the steady running of these leviathans, each of which drives two 1,000-kw. continuous-current dynamos, one on either side. Some idea of the proportions of the station may be gathered from the fact that the engine-room is about 50ft. high. Incidentally, the Schiffbauerdamm station, which adjoins, was also inspected. This station is of earlier date, and contains some interesting continuous-current generators having stationary inner fields and armatures developed as commutators. This type of machine is, however, no longer constructed in Germany. The rest of the generating plant installed is of a more modern type. These two stations, one of which is really an extension of the other, have a collective output of 21,000 h.p. The detailed account of the stations is concluded in another column.

"BANDY" FANS AND BLOWERS.

Messrs. Bergtheil and Young, of 12, Camomile-street, E.C., have recently issued a new edition of their "Ventilating" catalogue, which deals exclusively with the "Bandy" type of electric ventilating fans and blowers. From a perusal of the list before us the firm would appear to be supplying these ventilators for a large variety of uses. Passing over the ordinary table or desk pattern of fan, we come to the bracket pattern, which is designed with swivel joint. This fan, the neat and compact appearance of which will be seen from the accompanying illustration (Fig. 1), is particularly adapted for fixing on the wall. The principal feature of this type, however, is that it has a swivel joint, and may thus be turned in any direction. The consumption of current also is decidedly low, the fan being able to be worked at pressures varying from 8 to 220 volts. As in most of the other patterns listed, this fan is suitable for either direct or alternating current. The guard with which the ventilator is provided obviates all risk of danger. The second illustration we give shows the cylindrical tension bracket and bearings for belt driving of the "Sirocco" cased fan or blower. From the figures given in this catalogue referring to the operation of the "Sirocco" centrifugal fans with free intake and free

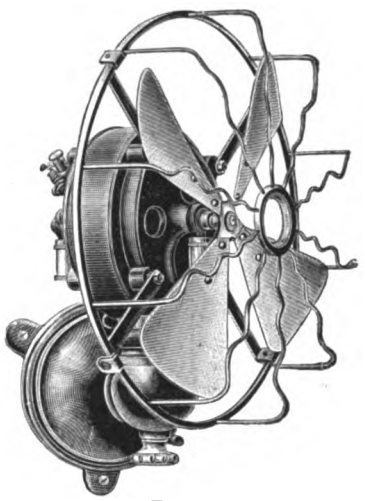

FIG. 1.

discharge of the air dealt with, we are enabled to make a comparison of the horse-power figures, which at once shows the advantage of employing a large size of fan running slowly as compared with a small size driven fast for moving a given volume of air, when resistance or back pressure has not been overcome. Thus a discharge of 42,000 cubic feet of air per minute with a No. 7 "Sirocco" fan at the maximum speed of 500 revolutions requires 33½ h.p., whereas with a No. 13 fan at 80 revolutions a discharge of 43,000 cubic feet per minute is obtained with only 3 h.p., the velocity necessary to pass this volume of air through the smaller discharge opening of the No. 7 fan being more than three times greater than for substantially the same volume through the larger opening of the No. 13 fan, due to the well-known fact that the horse-power rises as the cube of the velocity, under these conditions. This type of blower is particularly adapted for use in connection with forges, foundries, blast

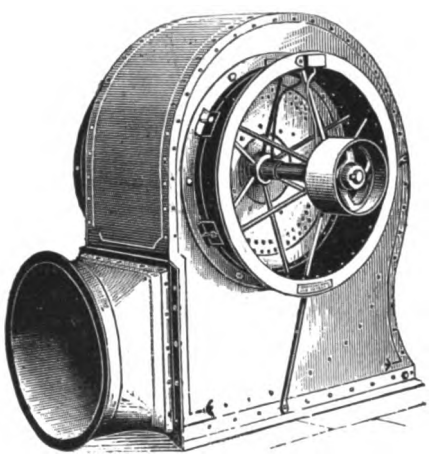

FIG. 2.

furnaces, boilers, etc. The firm, we are informed, have also put on the market a self-contained "Sirocco" cased blower, the motor being put on the same shaft as the fan itself. Other types listed in this catalogue include the ring pattern, which is essentially a ventilating fan, and, being provided with a circular hoop, it may be inserted into a suitable aperture in a wall or into an opening of a window. One point of difference from most of the other types of ventilators, is that the ring fan is not supplied with a speed regulator. With most of the other patterns, three, and sometimes four, speeds are obtainable. A wide range of ceiling fans is also illustrated in this list. These ventilators are now being extensively used in the tropics, and are rapidly displacing the old arrangement of hand-worked punkah wherever an electric supply is available.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE COMING TELEPHONIC FIGHT.

According to the statements of fiction, there was once an old lady who delighted in saying "I told you so," and was never so happy as when some prophetic utterance was justified in reality, and enabled her to use her much-loved phrase. If prophets about technical matters cared to emphasise their prophecies when fulfilled to the letter, there would often be a great cry of jubilation. In matters telephonic it has been easy for years past to prophecy, and as the years roll on most, if not all, the prophecies are being fulfilled. The reason for this simple state of affairs is that from the very first the Government of the day blundered, and from then to the present time it has consistently gone on blundering. The fact of the matter is, that no Government has had a real policy, but has done anything at any moment when a big enough row was kicked up—that was expedient to stop the row. No Government has ever assisted telephonic development towards perfection—they have been benevolently neutral when neutrality paid, they have badgered the companies when badgering paid, they took over trunk lines when public opinion required a sacrifice; they are going to compete with Imperial funds, and have allowed competition with local capital, all the time taxing the receipts of those who have done what has been done in this country to develop a telephonic system. We have little sympathy with the company that has exploited this industry, because its early days were devious, though later it has been more businesslike; but we have less sympathy with the Governments whose imbecility has brought about the present state of affairs. It may be that the capital employed in telephone enterprise is largely watered, yet it is certain that the majority of present holders are holders for value given, and the management is bound to fight tooth and nail in their interests. Tunbridge Wells, of course, is the latest text. Here we find a local authority and a company competing, the former with capital borrowed upon the security of the rates to foster a concern that may peter out in the course of ten years or so, when a parsimonious Government may follow the way of the Dutch by giving too little and taking too much. The absurdity of the municipal trading mania will be brought home to some of those who embark in it before long, for competition will lead to straits never contemplated by wire-pullers—and ratepayers will prove human. Who, outside of a lunatic asylum ever imagined that the company would give up its business without a tussle? And a little investigation will show that it is in a better position to fight more of the municipalities than the municipalities are to fight the company. A business man with ten shops in different places can better afford to cut prices at one shop against a competitor, than that competitor can working with borrowed capital and only one shop. In the abstract no doubt the view of local centres and trunk lines is fascinating, and such a system might be admirable provided there was no other system in existence. Hitherto the majority of people have schemed as if no telephone company was in existence, and only now realise that the company is a factor in the case, and can put an effective spoke in the wheel by lowering its prices. Why the nation has not recognised the cost of a competitor, and paid a fair price for a business it ought never to have allowed to exist, passes the comprehension of those who have watched the telephonic development from its birth. It is all very well to say, "We shall not renew the license at the time of expiration," and only compensate for what has been done at break-up prices for materials. The telephonic industry is not a small one, and no Government, when the time comes, dare act as is foreshadowed

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by those interested in putting off the day of trouble. The Government laid claim to a monopoly. When improvement came along, they permitted private enterprise to exploit and prove the value of that improvement. All this will have to be footed in the bill when it ultimately has to be paid. The permission for local authorities to compete with the company was simply to try and see if someone other than the Government would pull the nuts out of the fire. A few burnt fingers will not make the final settlement any more pleasant.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BRAKING APPARATUS FOR ELECTRIC CARS.

SIR,—On reading Mr. Fell's interesting paper on "Braking Apparatus for Electric Cars" in the current issue of the *Electrical Engineer*, it occurs to me that one point seems to have been overlooked by tramway engineers in connection with slipper brakes. This consists in boring several holes in the face of the wood block and filling them up with a hard mixture of rosin and sand. The effect is to immensely increase the coefficient of friction between block and rail, especially in wet, dirty weather, and to give better wear of slipper. This device is, of course, well known to old railway engineers, but with the advent of cast-iron brake blocks it has nearly vanished.—Yours, etc.,

BRAKEPOWER.

GILBERT'S SELF-DRIVING WEIGHT OSCILLATING MOTOR.

SIR,—"Oh, Evans," you are sceptical. There is nothing impossible under the sun, sir, after this invention of mine; and would I not be a fool to publish the details before such were properly covered by patent! I don't do things harum-scarum. Mr. Evans should tackle those engaged in the flying-machine business, and give them a preaching as to the fallacy of their ideas (there is no fallacy whatever in either), because it is no earthly use his throwing cold water on an invention that is a dead certainty, and of which he knows nothing about. To save space, will Mr. Evans guarantee to pay me, or the Royal Infirmary here, 1,000 guineas if the criticism on the principle of my machine is favourable?—Yours, etc.,

ARTHUR E. GILBERT.

Heaton, July 3, 1901.

[We imagine that everyone who paid attention to Mr. Gilbert's devices in the first instance, thought he was attacking the problem of perpetual motion. He now professes that this is not the problem, and we very much doubt if Mr. Evans, or any other correspondent, will take up a challenge about a principle unless they know exactly the principle involved. We are glad to hear of any invention that is a dead certainty, but remain certain that such a mechanical invention must comply with the law of "conservation of energy."—ED. *E. E.*]

VERBAND DEUTSCHER ELEKTROTECHNIKER AT DRESDEN.

[BY OUR OWN CORRESPONDENT.]

The annual meeting of the Verband Deutscher Elektrotechniker, held in Dresden on June 27, 28, 29, and 30 inclusive, was rendered especially noticeable by the participation for the first time of a number of the members of the English Institution. With the memory of the magnificent reception extended to our Institution in Berlin on the preceding days still fresh in mind, the welcome to Dresden on the Thursday evening may have seemed quiet to some, but was none the less sincere in its own way. There was, as is usual on such occasions, a plentiful supply of beer, and it afforded a novel sight to many of the English guests to see the German ladies taking such an active part in its consumption. A number of well-rendered songs helped to enliven the proceedings. For my own part I greatly appreciated the opportunity thus afforded of greeting my German friends, and was not disappointed in the number of familiar faces present.

The following morning was devoted to business, proceedings being commenced at 9 o'clock in the Vereinshaus, but to those of the English guests whose linguistic abilities were deficient the town itself proved a superior attraction. If not by personal acquaintance, it is at least known by repute that Dresden offers no mean attractions for sightseers, so that the alternative was good. The capital town of Saxony abounds in art treasures, handsome Government buildings, pleasant associations and surroundings, time devoted to its exploration being therefore well spent. So far as modern institutions are concerned, the town is also favoured, possessing, amongst other things, a splendid system of electric tramways, the motive power being obtained from overhead trolley wires in most of the newer streets, while the cars carry accumulators for working them over the lines situated in the centre of the town and principal boulevards, whereby unsightliness is avoided. A similar system of mixed electric traction, it will be remembered, has also been in operation with success in Hanover for some years past. Dresden, further, possesses a fine installation of public arc lamps, these being suspended in the narrow streets and even across some of the wide boulevards by means of span wires, to be illustrated in a further report, while side masts are employed in other thoroughfares. The first method of lighting is very effective, since the lamps are suspended over the centre of the roadway and an efficient diffusion of light thus obtained. I hope to return to the advantages and disadvantages of this method of suspension later on.

With regard to the first morning's business, this consisted principally in the reading of reports and the appointment of new commissions or reappointment of old ones. The president, Prof. Hartmann (of the well-known firm Hartmann and Braun), in his opening address thanked the town of Dresden for the hearty welcome extended to the Verband. He also dwelt upon the international character imparted to the ninth annual meeting of the Verband by the participation of their Austrian colleagues and a large number of members of the Institution of Electrical Engineers, to whom he (Prof. Hartmann) extended a hearty welcome. With regard to the general position of the electrical industry in Germany, it was difficult to specify the exact cause of the stagnation and partial retrogression in the development of the industry which was now making itself evident. Keen observers had foreseen the existing depression and taken the necessary precautions. It would be unjust to hold German engineers responsible for what had lately occurred in Dresden. (The speaker, it must be explained, referred here to the recent failure of the Aktien-Gesellschaft Elektricitäts-Werke (vorm. O. L. Kummer und Co.), in Niedersedlitz, by which the Sächsischen Akkumulatoren-Werke Actien-Gesellschaft was also involved, both of which works were to have been visited.) On the other hand, considerable progress had been made with wireless telegraphy, high-speed and full-gauge electric railways, and in improved methods of electric lighting. Continuing, the speaker pointed out that so long as the industry had continued in the ascendant course the flocking of young engineers to the technical colleges had been looked upon with satisfaction in electrical circles, but the question now arose whether sufficient and satisfactory occupation could be found for all of them. The annual increase amounted to some 1,000 young electrical engineers, so that it was more than ever necessary to be cautious in choosing electrical engineering as a profession. As a rule those who obtained a thorough knowledge of workshop practice, in addition to the theoretical knowledge acquired at the school, became the most competent engineers, and it was therefore incumbent upon manufacturers of electrical apparatus to arrange for as many apprentices as possible.

The annual report of the Verband, which was next read by Mr. Gisbert Kapp, the general secretary, showed that at least the affairs of the association were in a flourishing condition. During the past year the membership increased

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by 238, the total amounting now to 3,112, while the assets of the Verband represent upwards of £6,000.

(To be continued.)

ELECTRICAL ENGINEERS (ROYAL ENGINEERS) IN SOUTH AFRICA.

The headquarters are at Johannesburg. "A" Company have taken over all the electrical work in the Sransvaal south of Pretoria. "B" Company are looking after the work in the Orange River Colony.

The following shows the general distribution of the two companies, the names are given where known: Major A. Bain, Captain J. J. F. O'Shaugnessy, and Second-Lieut. T. Rich, Johannesburg; Captain the Hon. R. C. Craven, Bloemfontein; Lieut. E. H. Leaf, Vereeniging; Lieut. J. E. Pearce, near Johannesburg; Captain J. H. Field and four men at Simons Town; No. 1 Section, "B" Company, at Bloemfontein; No. 2 Section, "B" Company, at Vereeniging; three men (Second Corporal Pepper, Sappers Thomas and Venables) on armoured train running between Bloemfontein and Pretoria.

"A" Company: one N.C.O. and two men (Second Corporal Bell, Sappers Bayley and Peck) running searchlights at Springs; Corporal Rogers and two men running searchlights at Krugersdorp; two men ditto at Randfontein; two men ditto at Forrest Hill; four men (Corporal Shaw and three sappers) ditto at Klerksdorp; one officer and 14 men erecting steam plant and running lights at No. 3 General Hospital at Henry Nourse Mine, near Elandsfontein; one man in charge of lights at No. 6 Hospital, Johannesburg; two men running lights at Crown Reef Mine.

The entire lighting up, including laying down and fitting plant, of the Fort at Klerksdorp to be taken over shortly.

No. 13 Hospital and Forrest Hill lights were entirely erected by our own men, and the latter work was done in record time.

Three men are in hospital, but are all recovering, and are probably back at duty before this. C. T. Ruse, Acting Sergeant-Major.

GREENOCK ELECTRIC LIGHTING ACCOUNTS.

From the accounts of the Greenock Board of Police it appears that the total expenditure on capital account to Dec. 31, 1900, amounted to £40,424. Abstracts of the revenue account, general balance sheet, and statement of electricity generated, sold, etc., are given herewith:

Dr.	Revenue Account.	£	s.	d.
Generation of electricity		1,121	17	8
Distribution of electricity		29	17	4
Public lamps		171	4	2
Rents, rates, and taxes		177	9	3
Management expenses		210	9	5
		1,710	17	10
Balance carried to net revenue account		820	7	10
		£2,531	5	8
Cr.		£	s.	d.
Sale of current, private lighting		1,469	13	8
Ditto, motor power		110	4	5
		1,579	18	1
Less paid for free wiring		10	9	0
		1,569	9	1
Public lighting		953	6	8
Miscellaneous receipts—recharging batteries, etc.		8	9	11
		£2,531	5	8

General Balance-Sheet.

Dr.	Liabilities.	£	s.	d.
Balance due to Public Works Loans Commissioners		49,166	13	4
Sinking fund for repayment of loan		833	6	8
Accounts due		995	9	10
		£50,995	9	10
Cr.	Assets.	£	s.	d.
Capital account—amount expended for works		40,424	13	5
Stores on hand		1,766	11	11
Outstanding revenue		1,778	1	2
Cash in bank		5,560	17	6
Cash in hands of the treasurer		1	1	7
Balance at debit of net revenue account		1,464	4	3
		£50,995	9	10

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			226,668
Quantity sold	Public lamps	67,436	157,681
	Private consumers by meter	90,245	
Quantity used on works			54,125
Total quantity accounted for			211,806
Quantity expended in distribution and not accounted for			14,862
Number of public lamps			44
Total maximum supply demanded (kilowatts)			210

FORTHCOMING EVENTS.

Wednesday, July 10.

London United Tramways, Limited.—Inauguration of the West London electric tramways extensions. Meet at Shepherd's Bush at 12 p.m.

Borough of Luton.—At 1 p.m. opening of electricity works.

Saturday, July 13.

Institution of Junior Engineers.—At 3 p.m., visit to the Millwall Lead Works.

STAFFORD ELECTRIC LIGHTING ACCOUNTS.

From the accounts of the Stafford Corporation electric lighting department, it appears that the total expenditure on capital account up to March 31, 1901, amounted to £24,781. We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.:

Dr.	Revenue Account.	£	s.	d.
Generation of electricity		1,473	4	7
Distribution of electricity		154	2	1
Rents, rates, and taxes		174	1	1
Management expenses		38	17	1
Bad debts		27	7	11
Insurance		21	2	9
Total expenditure		1,888	15	6
Amount carried to net revenue acount		617	15	7
		£2,506	11	1
Cr.		£	s.	d.
Sale of current per meter		2,393	10	7
Public lighting		63	14	7
Rental of meters, etc.		3	4	0
Electric fittings		27	13	8
Rents		18	8	3
		£2,506	11	1

Balance-Sheet.

Dr.	Liabilities.	£	s.	d.
Capital account—amount owing		16,914	17	11
Sundry creditors		2,676	8	3
Loans repayment account		3,085	2	1
Amount due to bankers		4,849	9	10
		£27,525	18	1
	Assets.	£	s.	d
Capital account—amount expended for works		£24,780	19	11
Suspense account—repairs, etc., of mains		552	9	6
Stock of electric fittings, cable, etc.		652	16	5
Sundry persons for rental and fittings		1,036	8	2
Balance to debit of profit and loss account		503	4	1
		£27,525	18	1

Statement of Electricity Generated, Sold, etc.

Quantity generated in Board of Trade units			261,599
Output of station in Board of Trade units			235,905
Quantity sold	Public lamps	3,986	200,271
	By contract	86,827	
	Private consumers by meter	109,458	
Quantity used on works			11,692
Total quantity accounted for			211,963
Quantity not accounted for			49,636
Number of public lamps			4
Total maximum supply demanded (kilowatts)			171
Equivalent in 8-c.p. lamps connected			10,813

CATALOGUES RECEIVED.

The British Thomson-Houston Company, Limited, have forwarded to us their pamphlets Nos. 96 and 97 of rheostats for generators and motors and of electrically-driven ventilating fans and blowers respectively. With regard to the first, the various standard rheostats made by the firm will be found to be designed in such sizes as to readily meet most cases in ordinary practice. The standard rheostats are chiefly of three types—viz., packed card, spiral wire, and iron grid. They are made in a wide range of capacities for field regulation, motor starting, etc. For installations requiring rheostats of moderate capacity, and so proportioned as to vary the resistance uniformly, the "packed card" rheostats are recommended, while for larger units requiring rheostats of greater capacity, the firm are supplying the "spiral wire" type. For the largest generators requiring field currents of hundreds of amperes, the type "iron grid" is said to be the most serviceable and economical. The second pamphlet which we have received from the British Thomson-Houston Company deals solely with electrically-driven ventilating fans and blowers. Particular attention has

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been given to the design and construction of the motors for driving these fans and blowers, and the result has been the production of a highly efficient and practical article. The illustrations given in this list show the wide ranges of the Thomson-Houston motors in use for ventilating work. We have also received from this firm their latest lists of magnetic blow-out automatic circuit breakers, direct-current fans, motors, and lever station switches.

Messrs. Cole, Marchent, and Morley send us a wall card illustrating one of two vertical Corliss engines for electric traction work which they have recently installed for the Sheffield Corporation at the tramway generating station at Kelham Island. These engines are now being built by the firm in standard sizes of from 300 kw. to 2,000 kw. output, the revolutions per minute ranging from 75 to 100. We are informed that this firm are also building to standard designs horizontal and vertical Corliss engines, and that these are in successful operation in different parts of the country.

Messrs. Robert W. Blackwell and Co., Limited, have sent us their June list of various specialities in line work. These include, among other things, "flexible suspensions," there being a strong tendency to depart from the old system of attaching trolley wires rigidly to bracket arms. This flexibility has been obtained by arranging a small span on the end of the bracket arm, and using straight-line hangers or pull-offs in the same way as on a span-wire system. Special hangers have been designed for suspending the short span wire on the bracket arm. We understand that the firm have now developed a standard set of these hangers suitable for any conditions. A description of the new earthing device for telephone wires which has recently been perfected by the firm also appears in this list.

We have received from Messrs. Johnson and Phillips their new list of "Ark" lamps, for which the claim is made that they possess all the conveniences of the glow lamp combined with the advantages of the Ark lamp. From 80 to 100 hours is the tested life of the carbons, the lower number of hours being found with a rather larger current being passed in some of the lamps. From the list of testimonials we have seen it would appear that the "J. and P." Ark lamps are giving every satisfaction.

The General Electric Company recently issued their monthly progress sheet for June, on which the "Robertson" traction lamp for low voltage has a prominent place. The lamp comprises two short rigid filaments in series, and thus is specially recommended to withstand vibration without regard to position. A balancing coil for enclosed arc lamps on alternating-current circuits also has a front place on this list, while the other articles illustrated include wood pushes in "art" colours, battery boxes, and the "Queen" automatic torch. We have also received from this firm their list of "Freezor" electric fans and small power motors for continuous and alternating currents.

"The Servants' Morning Call" is a patent system of bell communication which is being put on the market by the International Electric Company. By this device the bell in the servants' room continues to ring until answer is made.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

391. In an overhead three-motor electric travelling crane describe and illustrate the best method of connecting the motors to the reversing controllers.—G. H.

392. A so-called differential booster in series with and charging a battery in a traction station is supposed, when a heavy discharge takes place, to boost up that discharge to line. Is this taking place when the motor ammeter and the booster voltmeter drop to zero? If not, what is the booster doing, and what are likely to be its defects?—S. B. W.

ANSWERS.

***Question No.* 384.—How would you start the design and the general design of a 1,000-watt four-pole dynamo with slotted armature, 1,000 revolutions, 100-150 volts? I know the general workings, such as construction of commutator, armature, bearings, etc., also a knowledge of the magnet and electrical calculations, but have had no experience in the designing of electrical machinery.**

Best Answer to No. 384 (*awarded* 10*s.*).—A full discussion of the electrical design of a dynamo, whether it be for 1,000 watts or 1,000 kw., would be all the same; a discussion giving the full method of design, together with the *raison d'etre* for each particular step, would be impossible, considering the allowable space, but we will endeavour to indicate in a general manner the *modus operandi* when commencing a design for first principles. We will assume that the dynamo is to have an output of 1,000 watts at 100 to 105 volts, machine running at 1,000 revolutions. To make a 1,000-watt machine with four poles would not be according to common practice, as being commercially more expensive than a two-pole for a corresponding output, and at the same time would not be any better from an electrical point of view; but since the questioner states a four-pole machine, we will deal with the design of such. We attempt first of all to give the size of the armature. This is done by a method of trial. For example, let us try a drum-type armature 6in. diameter and 3in. long. This gives a reasonable peripheral speed for a machine of this size of 1,570ft. per minute. Let us try a value of the magnetic flux of 500,000 C.G.S. lines to enter the armature per pole-piece, then we can now fix the number of armature conductors. We shall take the armature of the parallel-wound type, the reason for which there is not space here to discuss. The formula for the voltage of any generator of whatever the number of poles is expressed then as follows:

$$V = 4 \cdot T \cdot \frown\!\!\smile \cdot N \cdot 10^{-8},$$

where V = total volts generated by the armature;
T = turns in series between the brushes;
$\frown\!\!\smile$ = magnetic cycles per second;
N = C.G.S. lines included or excluded by each of the T turns in a magnetic cycle;

$$\frown\!\!\smile = \frac{\text{Revolutions per minute}}{60} \times \text{pairs of poles.}$$

Applying this to our case—

Let V = 111 (this includes drop of volts in the armature, etc.);

$\frown\!\!\smile$ = 33·33.

Then, $111 = 4\ T \times 33{\cdot}33 \times 500{,}000 \times 10^{-8}$;

$$T = 166 \text{ (approx.)}.$$

Therefore, the total turns on the armature

$$= 4 \times 166 = 664.$$

Let us then fix on 660 as the total number of turns on the armature; this could be split up into 60 sections of 11 turns per section. The number of sections will be discussed later. We have now fixed our turns on the armature as 660. Therefore, total number of wires = 1,320. Suppose we decide to make our armature with 30 slots, this will give 44 wires per slot.

We now fix the size of the slots. Suppose we allow a total copper loss in the armature of 60 watts. The mean length of one complete turn on the armature is approximately 115 yards. Now, let x = the ohms per yard at 125deg. F. of the wire, which will give a copper loss in the armature of 60 watts.

$$\therefore \text{ Resistance of 160 turns} = 115 \times x.$$

$$\therefore \text{ Resistance of the armature from brush to brush} = \frac{115 \times x}{4}$$

Say the armature current = 10 amperes,

Then $$\text{Copper loss} = 10^2 \times \frac{115 \times x}{4} = 60 \text{ watts.}$$

$$\therefore x = \cdot 0208 \text{ ohm per yard.}$$

Looking up a wire table we find that No. 19 S.W.G. has a resistance of ·022 ohm per yard at 125deg. F., so

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we decide to use this: diameter bare of No. 19 S.W.G. = ·04in.; diameter covered of No. 19 S.W.G. = ·052in.; sectional area = ·0012 square inch. We find that 44 wires of No. 19 S.W.G. will go into a slot $\frac{5}{8}$in. deep and ·26in. wide, the wires being arranged as shown in Fig. 1. This

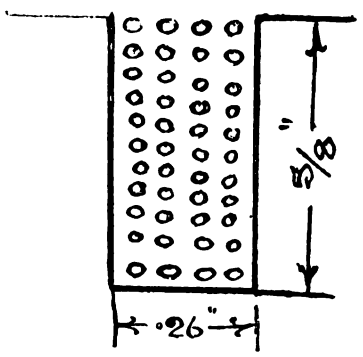

Fig. 1.

size of slot allows a fair amount for insulation. The ratio of the $\frac{\text{section of slot}}{\text{section of copper}}$ = ·324; this is called the space factor.

Having fixed the size of slot, we have now to see that the magnetic density in the armature teeth is suitable. Let us suppose that the polar angle of our machine is 66deg.; then allowing for the magnetic fringe round the air-gap, we find that each pole-piece embraces six teeth. Now the section of one tooth at its root, less 10 per cent. for insulation between the armature stampings = 4·16 square centimetres. Therefore, section of six teeth = 25 square centimetres. We then have that the density of C.G.S. lines at the root of the teeth, assuming that the whole of the lines pass through the teeth; this, of course, is not strictly correct, but is sufficiently near for the present purpose. The density at root of teeth = 20,000 per square centimetre. This may appear rather a high value, but it is found that a high magnetic density in the teeth is an advantage, in so far as it prevents much distortion of the main field due to armature reaction.

We should now be in a position to figure out the iron losses in the armature, the method of which we shall here indicate very briefly.

1. *Hysteresis Loss.*—

$$H = \beta^{1.6} \sim V \times \cdot 003 \times 10^{-7}.$$

H = hysteresis loss in watts. This we may divide into two parts: (*a*) that which occurs in the armature teeth, and (*b*) that which occurs in the other portion of the armature stampings;
β = the average magnetic density in each case;
$\sim$ = magnet cycles per second;
V = volume of iron in cubic centimetres.

The hole through the centre of the armature must be fixed by trial so as to give a reasonable iron loss.

2. *Foucault Current Loss.*—

$$F = t^2 \beta^2 \sim^2 V\ 10^{-16}.$$

The signification of the letters is the same as that for hysteresis, but in addition we have

F = loss in watts;
t = thickness of the armature stampings measured in mils.

Having now found the total loss in the armature, which consists of $H + F + C^2 R_a$, we can find the temperature rise of the armature; from the consideration that one watt dissipated in the armature per square inch of cooling surface will give in an unventilated armature a rise of approximately 40deg. C.

The method of winding armature is single re-entrant parallel lap-wound, each coil embracing seven teeth.

We should now go on to consider the self and mutual induction of the armature conductors, but space will not allow of this, so that the questioner will have to take the above winding as being an example of fairly good practice.

We will now indicate the method of fixing the size of the commutator, which must be sufficiently large so as to have a safe temperature rise of, say, 40deg. C.—*i.e.*, the watts per square inch of cooling surface should not exceed *one* for an unventilated commutator.

The chief commutator losses are (*a*) brush friction; (*b*) $C^2 R$ at brush contacts.

a = total brush pressure in pounds × peripheral speed of commutator in feet per minute × coefficient of friction = foot-pounds lost in friction per minute. The coefficient of friction for carbon brush of copper = ·3.

$$\frac{\text{Foot-pounds per minute}}{33{,}000} \times 746 = \text{watts.}$$

b can be obtained from the fact that the resistance of one square inch of contact for carbon brushes = ·03 ohm.

From this we get the watts lost in the commutator, which enables us to fix its size according to the cooling surface required.

The question now is to fix the length of the air-gap.

$$\text{Magnetic density in gap} = \frac{500{,}000}{3{\cdot}66 \times 3 \times 6{\cdot}45}$$

$$= 7{,}350 \text{ per square centimetre.}$$

Now, in fixing the length of air-gap we shall make the ratio of *twice* the ampere-turns spent on the air-gap equal to 1·3 times the cross ampere-turns of armature per pole-piece, this being compatible with good practice.

Cross ampere-turns per pole of armature for fixed central position of brushes

$$= 330 \times 2{\cdot}5$$
$$= 825.$$

$$\text{Ampere-turn on gap} = \cdot 8\ l_g\ \beta_g.$$

l_g = length of gap in centimetre;
β_g = density per square centimetre in gap.

Then
$$2 \times \cdot 8 \times 7{,}350\ l_g = 825 \times 1{\cdot}3$$
$$l_g = \cdot 092\text{cm.}$$

So we see that through using a four-pole machine we find that an air-gap of ·092cm. is sufficient, and would still leave a reasonable reversing field under the leading poles; but as an air-gap of this size would be too small mechanically, and also with an unlaminated magnet pole, we should

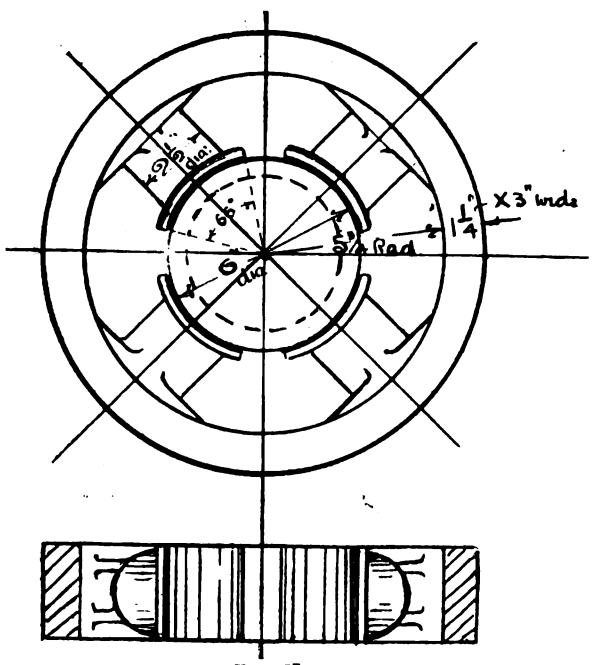

Fig. 2.

have large eddy currents produced in the pole face. Let us, then, fix our air-gap at $\frac{1}{8}$in. long. Our next step now is to fix the cross-sections of magnet limbs and yoke Allowing a coefficient of leakage of 10 per cent., we have

$$\text{Lines per pole in magnet leg} = 500{,}000 \times 1{\cdot}1$$
$$= 550{,}000$$

Then allowing the following densities: density of flux in pole-piece = 17,000 C.G.S. lines per square centimetre, and density of flux in yoke = 10,000 C.G.S. lines per square centimetre, we get yoke to have a section of 3in. × 1¼in., and making the poles circular we have the diameter of the pole to 2½in.; the poles to be fitted with a wrought-iron

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liner ⅛in. thick, as per sketch. We now revise the magnetic densities according to these sections; assume some length of magnet limb, and calculate the ampere-turns required on the field for each of the magnetic portions of the machine.

Having decided on the total ampere-turns, the next thing is to decide on the size of magnet bobbin which will carry these ampere-turns and have a reasonable rise in temperature. This is again done by method of trial and error. The watts allowable per square inch of cooling surface of the field bobbins should be on the basis that one watt per square inch of surface will give a rise of 80deg. C.

It will be seen that the design of the ampere-turns for the machine, and also the analysis of commutation, have scarcely been touched on; but if the questioner would communicate with me through the editor, I shall be pleased to give him any further information which he might require.—H. P.

Answer to No. 384 (*awarded* 7*s.* 6*d.*).—Space will not permit of going fully into all the details of dynamo design, and a general outline of the principal points to be thought of must suffice. The detail and formulæ for working out the different quantities may be found in any text-book on the subject. "W. H. H." has added rather to his complications by choosing a four-pole slot-wound machine. In designing a dynamo for a given output under given conditions, in the drawing office of a works a great deal of the work has been done, for in the drawing office there is always a list of standard patterns, forgings, stampings, etc., with all the particulars about them, in the form of ampere-turns suitable with corresponding lines of force that will be passing into the armature; these quantities have been arrived at partly by experiment and partly by calculation. All that the draughtsman has to do then is to choose a suitable carcase, look up on the table how many lines of force he will have passing through the armature core; then, as he knows the speed in revolutions per minute, the volts, and the current which the machine has to give, he can calculate the number of inductors from the formula

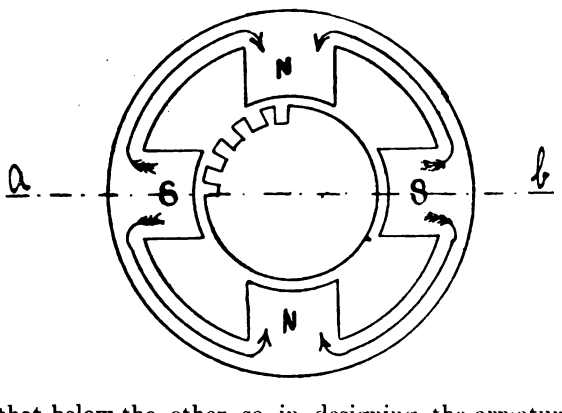
$$T = \frac{E \times 60 \times 10^8}{M \times n \times 2}$$

where T = number of turns on the armature (in a drum-wound machine two inductors go to the turn);
E = volts required;
M = total magnetic flux (total number of lines flowing from a north pole to a south pole);
n = revolutions per minute.

Example.—Suppose 1,000,000 lines pass through the armature from a north to a south pole in the machine stated in the question, the equation becomes

$$T = \frac{150 \times 60 \times 100{,}000{,}000}{1{,}000{,}000 \times 1{,}000 \times 2} = 450 \text{ turns.}$$

The next thing is to find out the size of the wire, which can easily be done when you know the temperature rise allowable, and can be found in a table for the current required for it to carry. A four-pole machine may be said to consist of two two-pole machines in parallel, the portion above the line, *a b* (in the figure), forming one machine,



and that below the other, so in designing the armature it will only be necessary to consider one half and design for half current, the other being identical. The number of commutator sections depends principally on the voltage of the machine, and should not be more than about three or four volts per section; but here, again, the table of standard sized bars must be consulted.

To design the exciting coils one has to know how many ampere-turns are necessary, also if the machine is to be series, shunt, or compound. To take the most likely case, we will suppose it to be shunt wound; about 2 per cent. would be a fair allowance for exciting.

If A = the ampere-turns required;
C = the current of the machine at full load;
N = the number of turns of wire required;
L = the mean length of one turn in yards;

$$N = \frac{A \times 100}{C \times 2} \quad \text{the total length} = \frac{A \times 100 \times L}{C \times 2} \text{ yards,}$$

which has got to have a resistance of $\frac{E \times 100}{C \times 2}$ ω, E being, as before, the machine volts. Therefore, when the total length of wire and the resistance it must have is known, the gauge can be found from the tables.

It has been assumed that the dimensions of the magnets and the ampere-turns required, also the number of lines that will be passing through the armature core, are known. The dimensions of the mild-steel castings are got at principally by experience. The length of the magnet limbs are designed so as to conveniently get the winding on. A suitable induction is chosen generally, about 14,000 or 15,000 lines per square centimetre. To calculate the ampere-turns required, you have to calculate the number required to push the lines through the two limbs, yoke, and two air-gaps, and add up. Then certain allowances have to be calculated for leakage. With slotted armatures the air-space is very small, but the induction in the teeth very high—about 18,000 lines per square centimetre. "W. H. H." will find it next to impossible to design a machine without the aid of a text-book, with the various tables and information about the angle of lead and methods of winding the armature, etc. A good book is that by Hawkins and Wallace "The Dynamo: Its Theory, Design, and Manufacture" and can be got from most public libraries.—C. L. E. S.

Answer to No. 384 (*awarded* 7*s.* 6*d.*).—If "W. H. H." will consider the very intricate nature of dynamo design, the long calculations that have to be made, the series of compromises between electrical, magnetic, and mechanical requirements which the designer has to allow for, and, above all, if he considers that even the simplest work of any value on dynamo design fills many pages, he will see that it would be far simpler, and would occupy less space, to give particulars of any machine than to explain how to calculate the size of each part and to give the reason for each result obtained.

With the very limited space available for answering this question, it will be advisable to refer to some standard tables and formulæ, and for this purpose the writer selects Weiner's "Dynamo-Electric Machines." A 1-kw. dynamo will be best arranged with a series-wound armature—usually termed a two-circuit winding—and with steel magnets and yoke. Turning to Table V., we find the average conductor velocity for a 1-kw. dynamo is 35ft. per second. Therefore, at 1,000 revolutions per minute an armature core 8in. in diameter will be required. Experience—and without experience "W. H. H." will never from theoretical grounds only design a good machine—teaches that this is rather large, so we will select a 7in. core.

Turning now to Table XV., we find a 7in. core should have 40 slots, each ¾in. deep. But as a two-circuit armature for a four-pole dynamo must have its slots divisible by four plus or minus one, we will say 41 slots. The current output will be 10 amperes, and as it will be permissible to work at a density of 2,000 amperes per square inch, the inductor must have a sectional area of 0·0025 square inch. This is practically equivalent to a No. 17 S.W.G., which is ·07in. in diameter over the double cotton covering. Eight wires can be put in each slot and allow room for insulation. The total number of inductors will therefore be 41 × 8 = 328. The lines of force required will be obtained from the general formula,

$$\phi = E \times 10^8 \times 60 \div C_a \times R.$$

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Substituting, we get:

$$\phi = \frac{150 \times 10^8 \times 60}{328 \times 1{,}000} = 2{,}800{,}000.$$

Allowing a leakage coefficient of 1·2, the total number which must flow through the magnets is 3,400,000. As the armature is of the two-circuit type, only half, or 1,700,000, will flow through each pole. If, now, we allow a density of 100,000 lines per square inch, the cross-sectional area of each magnet required will be 17 square inches. As the polar angle should not exceed 60deg., and room must also be left to get on the field coils without fouling each other, the magnets must not be more than 3½ ft. wide, and therefore they must be 5in. long.

The armature core should be made 5ft. long—*i.e.*, the same length as the magnets. Room must be left between the end of the core and the commutator in one case and the bearing at the other for the armature end windings. The size of hole in the core must be calculated so as to work with a flux density of 90,000 to 105,000 lines per square inch in the core; a density of 125,000 may be permitted in the teeth. Distance pieces for ventilating purposes should be inserted in the core, and these will decrease the cross-sectional area both of the teeth and the core.

The field-magnet windings must be calculated from the magnetic reluctance and permeability of each part of the magnetic circuit, as described in every text-book. The pitch at the back should be 11, and at the front 9—*i.e.*, each armature coil must be wound four times on itself so as to miss 11 slots, and then be coupled at the commutator end nine slots in advance. In other words, if the slots are numbered 1 to 41, coil 1 occupies the four lowest places of slot No. 1, the four top places of slot No. 12 and the top wire in slot No. 12 is connected in the commutator lug to the bottom wire in slot No. 21, and so on.

The writer does not profess that this will make a good machine, but it will make a workable dynamo. To make a really good and efficient machine, much more must be done besides showing how to start the design. When the whole design is finished, it must be carefully checked over to see if all is in accordance with good practice, whether the densities of the various parts are correct, whether the efficiency is high enough, whether the temperature rise is normal. It may be the final calculation is vastly different from the first. It is quite possible that it will be found advantageous to increase the number of slots to a large extent even with the same size core, and to reduce the field magnets. If cast iron is used in place of steel, the number of slots will most certainly have to be increased, or the machine will get very big for the output; but the writer thinks the above will be a guide to "W. H. H." as to how to start his design.—M.

Answer to No. 384 (*awarded* 5*s.*).—The starting point in the design of a dynamo is undoubtedly the armature in respect to the current it will have to carry at a given voltage. We must also have some definite idea as to the speed which is given in the question along with the output, and the output of any machine in watts at a given speed is approximately proportional to its weight—that is, if we double the output we double the weight, providing the form and speed remain the same. And since the voltage depends on the speed, it follows that the greater the speed the greater the voltage in proportion to the weight—that is, in respect to the above machine, if the speed were altered, say, to 750 revolutions per minute, the weight of the machine would approximately be 1·6 times that of the same with speed of 1,000 revolutions per minute.

The next step is to examine some well-established type of machine, so as to see from the dimensions of their several parts how they are adapted to their functions. The greatest current that the conductors on the armature will have to carry in the above dynamo will be 5·02 (about), that is, on the assumption the machine is designed for an output of 10 amperes at a pressure of 100 volts, remembering that the conductors on the armature carry only half the total current. Then, allowing the usual current density of 2,000 amperes per square inch, it is only necessary to refer to a wire table to find what size of wire will carry the necessary current. The small amount of current (0·2) above mentioned is on account of armature reactions, which, of course, depend on the type of machine, generally speaking, but the allowance made for this reaction need not be more than 2½ per cent. of the total current.

The number of conductors on the armature will depend on whether it is for such purposes as arc or incandescent lamps—that is, whether it is of the open or closed coil type. Having decided on some scheme of winding, and the number of sections in which the armature is to be divided, this will give the number of commutator bars, and also the number of conductors round the periphery of the armature. When having found the space taken up by the conductors, the width of the teeth, and insulation, from this the diameter of the core can be determined. Having found the number of conductors, C, round the armature core, then the total magnetic flux, N, necessary to generate or set up a difference of potential of 100 volts ($E + e$) at the speed, n, will be

$$N = \frac{E + e \times 10^8}{n \times C},$$

where E = useful pressure = 100;
e = lost pressure due to resistance of armature and field;
C = number of conductors round the armature;
n = revolutions per second.

It would be unnecessary to go into all the electrical calculations, as these may be found in almost any book on the subject. The relation between the cross-section of the magnet cores and the armature in machines with ring armatures is 1·66 when constructed of wrought iron, and are three times the cross-section of the armature core if of cast iron. In the case of drum machines the relation is 1·25 and 2·3, but the only true guide to proficiency in designing is practice and comparison of different types of machines.—K.

Answer to No. 384 (*awarded* 5*s.*).—From the question I take it that the enquirer wishes the magnetic calculations necessary for the design of such a machine. As this would take up too much of your valuable space to give the question justice, I will not trouble the reader with too many details or examples, but merely put forward the formulæ in the most concise manner. The first step to settle is the number of armature conductors which he, from past experience, considers it advisable to have.

This settled, then from the equation,

$$\frac{10^8 \times E \times 60}{n\ Z} = N,$$

where E = E.M.F.;
n = revolutions per minute;
Z = armature conductors.

N is the number of magnetic lines which must be cut by the conductors to maintain the required voltage. This must be multiplied by the coefficient of leakage, v, say about 1·4 for machines of this class; then v N = the total number of lines which must be generated by the field-magnet winding. Now, from the permeability curve of the steel at your disposal, select the flux density, B, which you consider most profitable to work by. Then v N ÷ B = the cross-section of metal required to carry the flux, but as therre are four paths in this type of machine, each is only one-fourth of this.

In calculating the cross-section of the armature, due allowance must be made for the paper insulation between the discs. From this a fair idea of the dimensions of the machine can be obtained, so after sketching roughly, tabulate the lengths, L, areas, A, flux densities, B, and permeabilities, μ, for the different parts. Then

Field magnet $= \frac{B_1}{\mu_1} \times \cdot 8 \times L_1 =$ ampere-turns required, A T,
Air-gap $= B_2 \times \cdot 8 \times 2\ L_2 =$ „ „ „
Armature $= \frac{B_3}{\mu_3} \times \cdot 8 \times L_3 =$ „ „ „

Add to this the back ampere-turns—viz., the conductors in twice the angle of lead, multiplied by half the armature current. Now, by adding the various ampere-turns

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required for the different parts of the circuit, we have the total ampere-turns necessary for the generation of the flux, v N. If the machine is to be a series-wound one, $\frac{AT}{A} = T$, where A = the current which the armature will safely carry, and T = the number of turns necessary for the field-magnet coils. Now, 1,000 revolutions per minute is not a very high speed for a machine of this size, so that if designed for 100 volts at this speed, the maximum voltage mentioned could be obtained by increasing the speed to 1,500, so that I think it advisable for the reader to consider this point and design his machine for the lower values, as by increasing the speed any intermediate E.M.F. could be obtained.—McC.

APPOINTMENTS VACANT.

Electrical Engineer, tramways, Council of the city of Wellington, New Zealand, July 20. Details in our advertisement columns.

Resident Electrical Engineer, borough of Swansea electricity works, £300 per annum, July 11. Details in our advertisement columns.

Electric Light Engineer, competent to make up designs, reports, and estimates. Details in our advertisement columns.

Jointers, used to high-tension paper cables. Details in our advertisement columns.

Assistant to manage small electrical installation, etc., £100 a year. Details in our advertisement columns.

LEGAL INTELLIGENCE.

ACTION AGAINST THE NATIONAL TELEPHONE COMPANY.

Alleged Breach of Contract.

At Brompton County Court last Friday, before Judge Stonor and a jury, Mr. John Cameron Graham, barrister-at-law, residing at 20, Eldon-road, Kensington, brought an action against the National Telephone Company, Thames-embankment, the claim being for damages for alleged breach of contract.

Mr. J. Lawless appeared for the plaintiff, and Mr. Compton Smith defended.

Mr. Lawless explained that his client had paid the defendant company at the rate of £12 per annum for the use of a telephone, the working of which, however, had proved so unsatisfactory that he felt justified in claiming the return of £6. 15s. as damages for breach of contract.

The **Plaintiff** stated that in February, 1899, the company put up a telephone at his chambers, 2, Gardens-court, Temple, and another at his residence at Kensington. Almost from the first the working of the telephone at the house was unsatisfactory. Something like the following occurred constantly: Wishing to communicate with his clerks at office, he would "ring up." Then the young lady at the Kensington exchange would shout out, "What number, please?" and when he gave his number, the young lady would ask again, half a dozen times or more, "What number, please?" After struggling for a considerable time, he would find himself at last "cut off" altogether. On other occasions, after the awful query, "What number, please?" had been repeated over and over again, he would at last have the joy of finding that he was being heard at the other end of the wire. His joy, however, was brief, for once more would come the dreaded formula, "What number, please?" and after waiting and struggling for some time longer, he would find himself cut off. At other times he would ring up without being able to get an answer at all. One more class of the troubles consisted in hearing scraps of conversation and buzzing when trying to use the instrument. Then he decided to give up that telephone. Later he gave the instrument some further chances, wrote "reams of correspondence" complaining of the telephone and of young ladies at the other end of the wire.

Mr. Compton Smith (cross-examining): I understand it is not very material whether you win this £6. 15s. or not?—The **Plaintiff**: Well, it's not of vital importance.

I mean that you have not been obliged to break any contracts through the working of the telephone?—No.

You came here, I understand, to expose the way that the telephone business was carried on?—That is exactly why I came here.

Mr. Lawless (re-examining): I understand it is suggested that the young ladies could not distinguish what you said; but isn't it a fact that you are in the habit of addressing judges in the law courts, and that you have no difficulty in making yourself heard?—No difficulty.

Mrs. Annie Graham, the plaintiff's wife, said that for the first few months the telephone behaved well, but afterwards it was so troublesome that when she wanted to communicate with Barkers, High-street, Kensington, for instructions, she found the easiest way was to go there.

For the defence, **Mr. J. Fearon,** who was switchroom manager at defendants' Kensington exchange during the year 1900, explained that when the plaintiff desired to speak from his private house at Kensington to a clerk at his chambers, the message would have to go first to the Kensington exchange (103, Gloucester-road, S.W.), then to the Holborn exchange, and from thence to the Temple. The witness went on to explain how, when there was a ring-up, the operator at the exchange would hear the bell ring, and that if this ringing was switched off, there would still be the indicator falling, and the small lamp lighted. If, therefore, the operator neglected her duty, the supervisors and manager would be able to see from the indicator and lamp that someone was ringing-up. A "black book" was kept, in which records of neglect and misbehaviour were kept, and in this they had a distinct inducement for the young ladies to attend properly to their duties.

In cross-examination, the witness said that there were 1,100 subscribers connected with the Kensington exchange, but complaints would not frequently be made.

Mr. John Churchman, another switchroom manager, gave similar evidence. He said that, of course, it might sometimes happen that when a subscriber rang up, a portion of the line would be engaged, and so he would not be able to "get on" at once. As far as he knew, the young ladies at the exchange attended well to their duties.

Miss Daisy Godfrey, Miss Nellie Lucy, and **Miss May Deakins,** lady operators at the Kensington exchange during the year 1900, each said that although there were complaints from "238"—the plaintiff's telephone—they gave their best attention to every call which they received.

Mr. James McKenzie Manton (a test clerk), **Mr. John Johnson,** and **Mr. Frederick Charles Perry,** the latter two being "fault clerks" in the service of the company, spoke as to testing the plaintiff's line and instruments on certain occasions and finding them "O.K.," which meant "all correct."

The **Judge,** in directing the jury, said it was for them to consider whether the defendant company had fulfilled their contract to give the services of the telephone to the plaintiff, and, if not, whether there had been such a breach of the contract to justify the claim for damages.

The jury returned a verdict in favour of the plaintiff, assessing the damages at £5, and his Honour gave judgment accordingly.

Mr. Lawless asked that, as the case was one of considerable public importance, the costs might be upon the scale above £10, and his Honour assented.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ELECTRIC TRACTION.

Directors: Sir Charles Rivers Wilson, G.C.M.G., C.B. (chairman), Charles Sinclair Drummond; the Hon. Sir Charles William Fremantle, K.C.B.; Emile Garcke, M.I.E.E.; C. Shirreff B. Hilton; the Right Hon. Lord Rathmore; John Smith Raworth, M.I.C.E. Managing director: Emile Garcke, M.I.E.E. Technical director: John S. Raworth, M.I.C.E. Chief engineer: Stephen Sellon, A.M.I.C.E. Secretary: Charles H. Dade.

The following report was submitted at the meeting yesterday, the 4th inst. Abstracts of the accounts are also appended:

The profits, including £43,783. 18s. 10d. brought forward from last year, amount to £157,382. 17s. 7d. This does not take into account the premiums, amounting to £128,855. 2s. 5d., received in respect of new share and debenture capital, and which have been carried direct to reserve. After deducting the proportion of general expenses chargeable to revenue, and also the expenses incurred in connection with schemes not proceeded with and written off, contributions to superannuation fund, and interest on debenture stock, there remains a net profit of £116,947, which the directors propose should be applied as follows: reduction of goodwill acount, £2,500; reduction of licenses and testing of new systems account, £2,500; reduction of furniture account, £366. 14s. 6d.; dividend at the rate of 6 per cent. per annum on the preference shares for the year ended March 31, 1901, including the dividend paid to Feb. 15, 1901, and proportion of dividend payable Aug. 15, 1901, accrued to date, £34,256. 7s. 11d.; dividend at the rate of 12 per cent. per annum on the ordinary shares for the half-year ended March 31, 1901, making with the interim dividend at the rate of 6 per cent. per annum paid for the half-year ended Sept. 30, 1900, a total distribution of 9 per cent. for the year, £55,866. 12s.; carried forward to next account, £21,457. 5s. 7d. A large part of the capital expenditure on construction of new lines and other works has only lately commenced to earn revenue, over 45 miles of new or reconstructed tramways and light railways having been opened for traffic since the interim report to the shareholders in November last. In accordance with the intention expressed in the last report, the directors issued in June, 1900, 15,000 ordinary shares and 10,000 preference shares to the shareholders at the price of £13 per ordinary share and £11 per preference share. In February last 30,000 preference shares were offered to the public at the price of £11. 10s., and were fully subscribed. This issue was guaranteed jointly by Messrs. J. S. Morgan and Co. and the Electric and General Investment Company, Limited, without commission, in consideration of an option given to them by the Company to call for allotment of the whole or any part of the unissued share capital of the Company during the period of eight months from Feb. 15, 1901, upon the following terms: (*a*) as to preference shares (ranking for dividend with the preference shares previously issued), at the price of £11. 10s. per share, together with an additional amount equal to the accrued dividend on an existing preference share; (*b*) as to ordinary shares at the price of £13 per share, less a deduction at the rate of any further dividend paid upon the existing ordinary shares of the Company for the year ending March 31, 1901, unless such option should have been exercised prior to the declaration of such dividend. A further 2,074 ordinary shares have been issued as fully paid up to the holders of 15,555 ordinary shares of the Brush Electrical Engineering Company, Limited, in exchange for their shares in the Brush Company. There has also been issued £250,000 5 per cent. perpetual debenture stock. The total premiums

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received in respect of these issues, after deducting the expenses, amount to £128,855. 2s. 5d., and the whole of this amount has been added to reserve, which now stands at £338,520. 13s. 4d. The subscribed share and debenture capital is now: £620,740 in ordinary shares of £10 each, £900,000 in 6 per cent. cumulative preference shares of £10 each, £600,000 5 per cent. perpetual debenture stock—total, £2,120,740. Of the authorised share capital there is at present unissued 37,926 ordinary shares of £10 each and 10,000 preference shares of £10 each, but Messrs. J. S. Morgan and Co. and the Electric and General Investment Company, Limited, have signified their intention to exercise their option to take up the whole of the unissued capital. The issued capital will then be £2,000,000 in shares, and £600,000 in debenture stock, with power to the directors to issue a further £400,000 in debenture stock. The total amount expended under the head of contracts and undertakings, after deducting the cost of undertakings transferred, and after writing off expenses incurred in respect of schemes not proceeded with, but including a proportion of general expenses, is £626,333. 13s. 11d., made up as follows: expenditure and profit on works and undertakings for account of other companies, £335,375. 2s. 7d.; expenditure on works and undertakings owned or leased by the British Electric Traction Company and for general stores, £236,643. 12s. 4d.; expenditure on negotiations, etc., in connection with schemes in course of development, and on Acts of Parliament, provisional orders, light railway orders, and other rights and powers secured or in course of promotion, £54,314. 19s. The total expenditure in investments, after deducting cost of securities sold, is £1,349,130. 8s. 5d., and is made up as follows: consols (cost), £102,901. 10s. 3d.; loans and advances to associated companies and others, £73,105. 10s. 10d.; mortgages, debentures, and debenture stock, and shares of associated and other companies (including (£24,940 in the British Electric Traction (Pioneer) Company, Limited (cost) £1,173,123. 7s. 4d. The British Electrical Superannuation Fund was duly established on July 1 last, but it is only since Jan. 1 last that it has been a condition of service that all new members of the Company's staff shall join the fund. At the present date the membership is over 60, while 23 associated companies and undertakings have signified their intention to contribute to the fund on behalf of their salaried staffs. In accordance with the powers conferred on the directors by the shareholders at the last ordinary general meeting the sum of £1,117. 14s. 10d. had been contributed by the Company up to March 31. The directors have had under their consideration the question of facilitating the best investment of sums set aside from time to time by the associated companies and undertakings, to provide sinking funds against eventual loss of capital upon compulsory purchase and for renewals of permanent ways and plants. The directors recommend the establishment of an associated sinking fund, to be under the control of trustees nominated by this Company. The British Electric Traction Company will deposit with the trustees interest-bearing securities sufficient to produce at specified dates a sum equal to the amount set aside, together with compound interest at a rate to be agreed, not exceeding 3½ per cent. Arrangements will also be made with insurance companies under which associated companies desiring to have the additional security of an insurance company's policies can obtain the same, the rate of interest allowed in such cases being smaller. Mr. C. Shirreff B. Hilton has been appointed a director of the Company, and Mr. J. S. Raworth has been appointed a managing director under Article 85*b* of the articles of association with the title of technical director. The directors who retire this year are the Right Hon. Lord Rathmore and Mr. Charles S. Drummond, and both are eligible for re-election. Messrs. Fred. W. Smith and Co. retire and offer themselves for re-election.

Dr. PROFIT AND LOSS ACCOUNT.

	£	s.	d.
General expenses—proportion of these not chargeable to contracts and undertakings, including expenditure on undertakings not proceeded with and written off	17,194	12	10
Superannuation fund—amount of contributions	1,117	14	10
Debenture stock interest—interest paid to Oct. 1, 1900, £8,682. 19s. 3d.; proportion of interest accrued to date, £13,440. 10s. 8d.	22,123	9	11
Balance carried down	116,947	0	0
	£157,382	17	7
Goodwill—amount written off	2,500	0	0
Cost of licenses and of testing and developing new systems of traction—amount written off	2,500	0	0
Furniture and fittings—amount written off	366	14	6
Preference share dividend—dividend paid to Feb. 15, 1901	29,581	6	11
Ordinary share dividend—interim dividend paid or accrued to Sept. 30, 1900	18,622	4	0
Proposed dividend on ordinary shares at the rate of 12 per cent. per annum	37,244	8	0
Balance carried forward to next account	21,457	5	7
	£116,947	0	0

Cr.	£	s.	d.
Balance brought forward from March 31, 1900	43,783	18	10
Profits on contracts and undertakings, commission, sale of investments, management, transfer and other fees, interest and dividends, etc.	113,598	18	9
	£157,382	17	7
Balance brought down	£116,947	0	0
	£116,947	0	0

BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital authorised — 100,000 6 per cent. cumulative preference shares of £10 each, and 100,000 ordinary shares of £10 each	2,000,000	0	0
Capital issued—60,000 6 per cent. cumulative preference shares of £10 each	600,000	0	0
30,000 6 per cent. cumulative preference shares of £10 each, upon which £2 per share has been paid up and instalments paid in advance	660,704	0	0
62,074 ordinary shares of £10 each fully paid	620,740	0	0
	£1,281,444	0	0
Debenture stock—£600,000 5 per cent. perpetual	600,000	0	0
Reserve—premiums on issues of shares and debenture stock as at March 31, 1900, £189,665. 10s. 11d.; premiums in respect of subsequent issues, less commission, brokerage, and expenses, £128,855. 2s. 5d.	318,520	13	4
Amount transferred from profit and loss account	20,000	0	0
Sundry creditors (including £25,000 owing to the British Electric Traction (Pioneer) Company, in respect of the purchase of its undertaking	159,021	6	5
Profit and loss account—proportion of preference share dividend, £4,675. 1s.; proposed dividend on ordinary shares at the rate of 12 per cent., £37,244. 8s.; balance carried forward to next account, £21,457. 5s. 7d.	63,376	14	7
	£2,442,362	14	4

Assets.	£	s.	d.
Contracts and undertakings — land, buildings, permanent ways, electrical equipments, rolling-stock, horses, general stores, parliamentary, etc.	626,333	13	11
Investments — consols, mortgages, loans and advances to associated companies and others, debentures and shares in associated and other companies (including £24,940 shares in the British Electric Traction (Pioneer) Company, Limited), parliamentary and other deposits	1,349,130	8	5
Sundry debtors (including £357,399. 5s. due from other companies in respect of sale of undertakings)	422,279	16	9
Goodwill account as at March 31, 1900, £5,000; amount written off at March 31, 1901, £2,500	2,500	0	0
Cost of licenses and of testing and developing new systems of traction as at March 31, 1900, £8,110. 17s. 9d.; expended since, £1,530. 11s. 6d.; amount written off, £2,500	7,141	9	3
Office furniture and fittings as at March 31, 1900, £1,876. 6s. 10d.; expended since, £1,790. 19s.; amount written off, £366. 14s. 6d.	3,300	11	4
Cash on current account and in hand	31,676	14	8
	£2,442,362	14	4

ELECTRIC CONSTRUCTION.

Directors: Sir Daniel Cooper, Bart., G.C.M.G. (chairman); James William Barclay (deputy-chairman); Philip Edward Beachcroft; John Irving Courtenay; Sir Henry C. Mance, C.I.E.; Sir James Pender, Bart. Manager: A. B. Blackburn, M.I.C.E. Secretary: James Gray.

Report of the directors, to be submitted to the shareholders at the eighth annual general meeting of the Electric Construction Company, Limited, to be held on Thursday, July 11, 1901, at Winchester House, Old Broad-street, E.C., at 12 noon:

The profit of the year ending May 31 last, including the balance of £4,777. 1s. 9d. brought forward, is £30,018. 18s. 2d., which your directors recommend to be appropriated as follows: in providing dividends of 7 per cent. on the preference shares (to be paid on July 31 next), £3,713; and of 6 per cent. on the ordinary shares (one-half to be paid on July 31 next, and one-half on Jan. 31, 1902), £13,452; and in adding to the general reserve fund the premium on the preference shares, £4,792. 10s.; and from surplus profits, £5,207. 10s., leaving a balance of £2,853. 18s. 2d. to be carried to next year's accounts. The general reserve fund will then amount to £30,000. The buildings and plant have been thoroughly maintained, and £5,000, as usual, has been credited to depreciation account, which now amounts to £38,000. The new factory is now equipped with the best labour-saving tools and appliances, capable of turning out economically and with dispatch the largest electrical machinery that may be required, but the full benefit of the expenditure has accrued only during the latter part of the year. The electrical equipment of the extension of the City and South London Railway, completed last year, has given full satisfaction both to the railway company and to the public, and another contract for a further extension has been entered into with the railway company. The works are well supplied with orders, and a great demand for electrical plant is anticipated in the near future. The relations with all classes of the employés continue satisfactory, and the directors have much pleasure in awarding the usual bonus in recognition of good service. The compensation paid under the Workmen's Compensation (1897) Act, is for the year £295. 15s. 7d. The Madras electric tramways have yielded a moderate return on their cost to the Company, and the traffic is steadily increasing. It is considered expedient to amend the articles of association to bring them into harmony with the Companies' Act (1900), and notice of the special resolution necessary appears in the report. The directors who retire by rotation at the general meeting

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(and who are eligible for re-election) are Messrs. Barclay and Courtenay. The directors recommend that Mr. James Gray, who has been for eight years secretary, be elected to a seat on the Board. The auditors, Messrs. James Meston and Co., offer themselves for re-election.

PROFIT AND LOSS ACCOUNT.

Income.	£	s.	d.
Gross profit on manufacturing and contracting	50,293	12	10
Less proportion of general charges	2,350	9	8
	47,943	3	2
Rents, pupils' premiums, and sundry profits	3,354	0	5
Profit on running Madras electric tramways	3,023	19	2
Dividends on shares of other companies	3,140	4	6
Transfer and registration fees	27	10	0
	57,488	17	3
Premium on issue of preference shares	4,792	10	0
	£62,281	7	3

Expenditure.	£	s.	d.
Interest on loans and debentures	11,619	7	5
Salaries of head office, staff, and engineers	10,624	18	8
Rents, rates, and taxes	1,189	10	11
Insurances	364	2	2
Advertising	496	17	7
Travelling expenses	345	9	9
Patent fees and royalties	856	0	9
Law charges	264	10	2
Printing and stationery, postage and telegrams	826	16	6
General expenses	783	8	5
Trustees' fees, under first and second mortgages	105	0	0
Auditors' fee	120	0	0
Directors' fees	1,500	0	0
Maintenance of plant and buildings	2,943	8	6
Depreciation account—amount set aside	5,000	0	0
	37,039	10	10
Net profit carried to balance-sheet	25,241	16	5
	£62,281	7	3

BALANCE-SHEET.

Capital and Liabilities.	£	s.	d.
Capital authorised—150,000 ordinary shares of £2 each	300,000	0	0
50,000 cumulative 7 per cent. preference shares of £2 each	100,000	0	0
	400,000	0	0
Capital issued—112,100 ordinary shares of £2 each, fully paid, £224,200; 31,390 cumulative 7 per cent. preference shares of £2 each, fully paid, £62,780	286,980	0	0
Debentures issued—4 per cent. perpetual first mortgage debenture stock (authorised issue, £200,000), £182,500; 4½ per cent. redeemable second mortgage debenture stock (authorised issue, £50,000), £50,000	232,500	0	0
Loans (secured by deposit of £12,500 debenture stock and by shares of other companies)	60,000	0	0
Sundry creditors, £58,468. 16s. 9d.; debenture interest accrued, £2,737. 10s.	61,206	6	9
Bills payable	2,421	18	9
Depreciation account—amount at credit per last account, £33,000; credited from profits for year ending May 31, 1901, £5,000; general reserve fund, £20,000	58,000	0	0
Profit and loss account—amount brought forward from last year, £4,777. 1s. 9d.; net profit for the year, £25,241. 16s. 5d.	30,018	18	2
	£731,127	3	8

Assets.	£	s.	d.
Properties, patents, and goodwill, etc.	357,919	6	1
Additions to plant and furniture during year	15,180	5	1
Additions to buildings during year	583	5	1
	373,682	16	3
Shares of other companies	83,510	2	0
Sundry debtors	106,110	8	1
Madras electric tramways	80,500	0	0
Work and contracts in progress—cost	42,483	17	1
Stock—finished goods and materials on hand	30,166	19	7
Bills receivable	2,896	18	0
Cash at bankers and in hand	11,776	2	8
	£731,127	3	8

UNITED RIVER PLATE TELEPHONE.

The annual general meeting of the shareholders in this Company was held in London on Tuesday, Mr. J. L. Courtenay presiding.

The **Chairman**, in moving the adoption of the report, said the Company's business was expanding in all directions, and while trade generally in the River Plate for the last 12 months had been poor, the interests of the Company had suffered but little thereby. Compared with the previous year, the issued share capital stood at £490,000 instead of £373,195. The debenture stock, £179,947, remained the same. The reserve fund was £40,000 as against £20,000, and the depreciation fund £8,495, against £3,495. The balance of profit is within £250 the same as last year. The credit side of the balance-sheet showed an additional capital outlay of £30,968, in the main represented by underground plant. On the credit side it would be noticed that the receipts from subscriptions and other sources had increased £8,370, and from dividends and interest £1,673, a total increase of receipts of over £10,000. The result was that in the proposed appropriation of profit they wrote off the whole of the expenses connected with the late issue of preference shares, placed £15,000 to reserve, and after providing for the final dividend on the ordinary shares, making 7 per cent. for the year, carried forward £6,958. The Board considered it most desirable that the reserve fund, already a strong feature in the balance-sheet (which would now amount to £55,000), should be substantially increased, and they had confidence that the earnings of the business will regularly permit this to be done.

The motion having been seconded was carried unanimously.

THOMAS PARKER, LIMITED.

In their report for the year ended April 30, 1901, the directors state that, after writing off the various depreciations, the balance standing to the credit of profit and loss account is £11,021. 17s. 6d.; out of this the directors propose to pay a dividend at the rate of 10 per cent. per annum, less income tax, to place £2,500 to the reserve fund, bringing it to £17,500, and to carry the balance forward to next year's account. The director who retires by rotation is Mr. W. Thomas, who is eligible and offers himself for re-election. The auditors, Messrs. Allen, Edwards, and Smith, also retire, are eligible and offer themselves for re-election.

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital—7,500 ordinary £10 shares, fully paid	75,000	0	0
Debentures issued, £57,100; deposited with bankers, £25,000	32,100	0	0
Sundry creditors (less reserve for discounts)	19,572	10	1
Amount due to bankers	18,532	7	3
Reserve fund	15,000	0	0
Profit and loss account	11,021	17	6
	£171,226	14	10

Cr. Assets.	£	s.	d.
Sundry debtors (less reserve for discounts)	55,879	5	5
Freehold land, buildings, plant, machinery, etc.	80,120	9	11
Stocks on hand and work in progress	34,059	16	8
Investments at cost	1,167	2	10
	£171,226	14	10

NEW COMPANIES.

The following companies have been registered since our last issue:

Dickson Mantle Syndicate, Limited.—Capital, £40,000. Object: to adopt an agreement with W. K. L. Dickson to inventions connected with gas lighting and electricity, etc.

Thomas Sudron and Co., Limited.—Capital, £25,000. Objects: to adopt an agreement with Thomas Sudron and Co., Limited, and the liquidator thereof, and to carry on the business of boilermakers, brassfounders, bridge builders, electrical, mechanical, and general engineers, etc.

Metals Corporation, Limited.—Capital, £25,000. Object: to adopt an agreement with the Electrical Corporation, Limited, for the acquisition of the benefit of certain inventions and letters patent in relation to the electro-deposition of metals, the manufacture of tubes or sheets of copper or other metals, and the manufacture of copper wire or strip, etc.

L'Auto-Regulateur Moteur Hydraulique "Cassel," Limited.—Capital, £15,000. Object: to adopt an agreement with E. F. Cassel, and to carry on the business of ironfounders, marine, hydraulic, mechanical, civil, consulting, and electrical engineers, makers of rolling-stock, etc.

R. and A. Parker, Limited.—Capital, £25,000. Object: to adopt an agreement with R. and A. Parker for the acquisition of the business of coppersmiths, etc., now carried on by them at Chorley Lancashire, and to carry on the business of engineers, brass and iron founders, electrical engineers, etc.

Chepstow Electric Lighting and Power Company, Limited.—Capital, £2,000. Object: to carry on at Chepstow and elsewhere the business of an electric lighting and power company in all its branches, and the general business of electricians, engineers, and suppliers of electricity.

Warren, Beattie, and Co., Limited.—Capital, £10,000. Objects: to take over the business of electrical engineers and contractors carried on by J. W. F. Warren and J. Beattie, at Middlesbrough, as Warren, Beattie, and Co., and to carry on the business of electricians mechanical and electrical engineers, manufacturers of electrical apparatus and appliances, suppliers of light and power, etc.

St. Helens.—The Town Council have resolved that a special meeting of the Works Sub-Committee be held to meet the representatives of the district tramway company and their officials and investigate the financial position under the lease, and report fully to the committee.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Funchal (Madeira).—The Municipality require tenders for installation and working of tramways. Tenders by July 13.

Lewes.—Tenders will be invited for the installation of the electric light in the town hall and corn exchange in three sections.

Dartford.—The Council invite tenders for meters (direct-current) and cut-outs. Tenders by July 24. Details in our advertisement columns.

Plymouth.—The Corporation invite tenders for tramcars, trucks, motors, trolley arms, etc. Tenders by July 19. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for feeders, mains, and roadwork and arc lamps. Tenders by July 20. Details in our advertisement columns.

Amsterdam.—The Corporation invite tenders for tramcars for electric traction with overhead wire (perhaps 140). Tenders by Sept. 2. Details in our advertisement columns.

Shoreditch.—The Borough Council invite tenders for high and low tension continuous-current switchboards and instruments. Tenders by July 10. Details in our advertisement columns.

Stepney.—The Electrical Committee invite tenders for steam and other pipework and paper-insulated cables, earthenware conduits, etc. Tenders by July 18. Details in our advertisement columns.

Brecon.—The Committee of the Talgarth Joint Asylum invite tenders for the electric lighting of the asylum. Particulars can be obtained from the architects, Messrs. Giles, Gough, and Trollope, 28, Craven-street, Strand. Tenders by Aug. 5.

Amsterdam.—The Municipality invite tenders for 5,000,000 kilos of tramway rails, with plates, bolts, etc. Specification, 2s. 7d. Tenders by Sept. 2. Information is given at the office of the Director of Municipal Street Railways, Nieuwe Achtergracht, 164.

Cleckheaton.—The Council invite tenders for Lancashire boilers, economiser, jet condenser, feed pumps, suction pumps, Meldrum's destructor furnaces, balancers and boosters, accumulators, cables, switchboards, and travelling crane. Tenders by July 13. Details in our advertisement columns.

Epsom (Surrey).—The Asylums Committee of the London County Council invite tenders for steam boilers, pumps, and fittings, cooking apparatus and fittings, and installation of electric lighting (excluding generating plant), at the Epileptic Colony, Horton Estate, Epsom, Surrey. Tenders by July 23. Details in our advertisement columns.

Erith (Kent).—The Urban District Council invite tenders for the construction of (Section L) engine and boiler house; (M) chimney shaft; (N) sanitary work, water and fire services; (O) rain and surface water drains; (P) approach roads at site. Specifications, etc., can be obtained of Mr. W. Egerton, quantity surveyor, 12, Queen's-road, Erith. Tenders by July 15.

RESULTS OF TENDERS.

Eastbourne.—The Town Council have accepted the tender of Geipel and Lange, at £1,517, for the supply of 400 Vulcan meters.

Loughborough.—The Guardians have accepted the tender of Messrs. Swindall and Moss to fit up electric bells at a cost of £6.

Worthing.—The tender of W. W. Smith and Son, at £135, has been accepted for the wiring of the generating station and buildings.

Liverpool.—The Town Council have accepted the tender of Willans and Robinson, Rugby, for the delivery of three sets of plant at the Lister-drive station, at £6,939 per set, less 2½ per cent.

Dundee.—The Gas Commissioners have accepted the tender of Aiton and Co., Western Works, Hythe-road, Willesden Junction, London, N.W., at £1,048, for steel steam piping, valves, and accessories.

West Ham.—The Town Council have received the following tenders for the supply of tramway machinery, etc., for electrical purposes:

Tramway machinery.

Ferranti	£12,700
Verity and Co.	13,998
General Electric Company	12,700
Brush Electrical Company	12,270
Witting Bros.	11,790
J. Fowler and Co.	12,855
Siemens Bros.	12,774
Thames Ironworks Company	13,200
Scott and Mountain	14,598
Cole, Marchent, and Morley	20,577
J. and H. Maclaren	18,002
Mather and Platt	12,530
Johnson-Lundell Electric Traction Company	12,084
British Schuckert Company	12,349
British Westinghouse Company	14,433
Parsons	11,829
F. Suter and Co.	12,108
Bergtheil and Young	13,597
V. Coates and Co.	22,000
Lancashire Motor and Dynamo Company	13,407
Lancashire Motor and Dynamo Company (alternative)	13,425
Lancashire Motor and Dynamo Company (alternative)	14,318
International Engineering Company	11,710
Dick, Kerr, and Co.	17,750
Allgemeine Elektricitäts-Gesellschaft, Berlin	10,840
Allgemeine Elektricitäts-Gesellschaft (alternative)	8,926

Engineer's estimate, £25,000.

Eleven water-tube boilers and fittings.

J. Thompson, Wolverhampton	16,250
Babcock and Wilcox	14,720
R. Hornsby and Sons	13,791
Stirling Boiler Company	15,214
Rowland and Co.	17,520

Engineer's estimate, £18,000.

The tenders have been referred to committee.

West Ham.—The Town Council have received the following tenders for the construction of three transformer chambers:

Foster Bros., Suffolk-road, Norwood	£467 0 0
C. North, Manby-road, Stratford	382 8 0
Works Manager, Town Hall, Stratford	341 8 9
Gregar and Son, Jupp-road, Stratford	330 0 0
J. Jackson, Broadway, Plaistow, E. (accepted)	328 6 11

Aberdeen.—The Gas and Electric Lighting Committee have accepted the tender of Messrs. Wm. M'Kinnon and Co., for the structural iron and steelwork in connection with the Ferryhill electricity works, at £3,781. Apparatus for smoke prevention, supplied by the British Fuel Economiser and Smoke Preventive Company, at a cost of £50, and another, known as the Hamilton smoke-consuming doors, at a cost of £37, are to be tried.

Aldershot.—The Urban District Council have received the following tenders for erection of buildings and shaft in connection with their electric lighting station:

	Shaft.	Buildings.
W. Garland	—	£3,329
Martin, Wells, and Co.	£989	2,931
Bateman and Son	1,112	2,868
Spear and King	*795	2,850
Musselthwaite and Son	898	2,723
G. Kemp, Aldershot	1,025	*2,695
R. H. B. Neal	998	—

* Accepted.

BUSINESS NOTES.

TRACTION.

Blackpool.—The Corporation have decided to introduce 1d. fares on the trams.

Padiham.—The ceremony of laying the first rails of the new tramways to Nelson took place last week.

Preston.—The Town Council have resolved to lodge a petition against the proposed Preston and Lytham light railway.

Southampton.—Mr. Wm. Orchard has been appointed electrician in-charge of the electrical equipment of the Corporation tramways.

Coseley.—The District Council have approved the proposed cable route, feeder pillars, etc., of the Dudley and Wolverhampton tramways in the Council's district.

Halifax.—Major Druitt, inspector to the Board of Trade has inspected the completed tramway extensions — Luddendenfoot to Mytholmroyd and Northowram to Shelf.

Bilston.—In connection with the proposed tramways, the British Electric Traction Company have made an agreement with the District Council with regard to tracks and margins.

Gateshead Tramways.—We understand that the Bensham-road and Coatsworth-road route of the new electric tramways to Saltwell Park was opened to the public yesterday morning.

Beckenham.—A special committee have reported to the Urban District Council on the question of the introduction of tramways into the district, and the report will shortly be circulated.

Devonport.—The formal inauguration of the 10 miles of electric tramways in the borough took place, with full ceremonial, at the latter end of last week, and the public service is now in full swing.

Salford.—A number of improvements have been carried out at the Blackfriars Bridge tramway terminus, the result of which has been a more regular service, owing to the decrease in the congestion on the bridge.

Elland.—The District Council have appointed a deputation to wait upon the Tramways Committee of the Halifax Corporation to request an extension of the Halifax tramways system to Elland at as early a date as possible.

Little Lever.—At the monthly meeting of the U.D.C. it was stated that satisfactory arrangements would probably he made which would render it unnecessary for the Council to petition against the South Lancashire Tramways Bill.

East Ham.—The electric tramways, which have been constructed at a cost of £89,980, are now open to the public. According to the engineer's calculations, the cars should produce £20,475 per annum yielding a profit of £3,098.

Oldham.—The Town Council have decided to inform the Bury, Rochdale, and Oldham Tramway Company that they will not require the company to continue to work the lines leased by them through Oldham after the expiration of the lease on Oct. 31 next.

Woolwich.—The Borough Council have decided to make a contribution of one-third of the net cost of the necessary street widenings at Eltham, estimated to cost £11,400, in connection with the proposed London County Council tramway from New Cross to Eltham.

Dudley.—The Tramway Committee recommend that the Council consent to the British Electric Traction Company laying a double track from Queen's Cross to Hall-street on condition that all the cars from Old Hill and Kingswinford are brought into the Market-place.

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Newcastle.—The Corporation have adopted a report from the New Tramways Committee containing its proposal as to routes to be taken on the new system. The question of fares and distances, however, stand over for a month.

Southport.—The Board of Trade inspection of the newly-laid tramway track from Duke-street to Churchtown took place on Monday. The receipts from the Corporation electric cars for the fortnight ending the 22nd ult. are £580. 7s. 6½d. The total number of passengers carried was 124,096.

Pontypridd.—Lord Clonbrook's Select Committee of the House of Lords has passed the preamble of the Bill to confirm a provisional order of the Board of Trade authorising the Pontypridd Urban District Council to carry out an electric tramway scheme for the district. The Bill will be reported for third reading.

Tipton.—The District Council have adopted a report recommending the Council to take steps for the promotion of a Bill in Parliament to authorise the Council to take over and work the tramways within the borough. It is stated that a public meeting had requested the Council to take the steps recommended.

Birmingham Tramways.—The Bill promoted by the Birmingham City Tramways Company to authorise the construction of additional tramways, etc., is now being enquired into by the Select Committee of the House of Commons presided over by Mr. Holland. The measure has already been before a House of Lords Committee.

Paris-Berlin Motor Race.—The international motorcar race from Paris to Berlin at the end of last week resulted in a win for M. Fournier, who also carried off first honours in the Paris-Bordeaux contest. The only English car in the race encountered difficulties with the tyres, and was forced to stop at Sedan with a broken spring.

Blackburn.—The receipts from the Corporation tramways for the week ending June 21 amounted to £487. 6s. 2d., against £482. 10s. 2d. last year, an increase of £4. 16s. The receipts on the Darwen section (Blackburn borough only) were £151. 10s. 10½d., as compared with £124. 19s. 4½d. last year, an increase of £26. 11s. 6d.

Auckland (New Zealand).—The first shipment of rails (1,150 tons) for the proposed electric tramways has arrived in Auckland from New York. The laying down of the track will be commenced at several points immediately. Work will also be started on the Custom-street power house, and the necessary excavations are in progress.

Aberdeen.—The Tramways Committee have given renewed instructions that the rate of speed of the electric cars is not to exceed that fixed by the Board of Trade regulations. The line of tramway from Holburn-street to Mannofield is to be equipped on the span wire system, supported from poles placed on each side of the street.

Exeter.—The question of the introduction of electric tramways into Exeter was discussed at the last meeting of the Chamber of Commerce, when it was stated that "the City Council in the new electric station intended to provide machinery capable of supplying any amount of tramcars, any amount of motors, and six times the electric light current now used."

Dundee.—With the withdrawal of the horse-car service from over the Arbroath-road, which has now been sanctioned, it is expected that the Tramways Committee will take steps to convert the line for electric traction. The extension of the electric system would be an important one, as Arbroath-road is looked upon as one of the main arteries of the town.

Private Bills.—In the House of Lords the West Cumberland Tramways Bill has been read a second time. In the Commons the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board Bill and the City and South London Railway Bill have been read a third time, and the Central London Railway (No. 2) Bill and the Worcester Tramways Bill a second time.

Broadstairs.—At the last meeting of the Urban District Council a letter was read from the secretary of the Isle of Thanet Light Railway Company with respect to the tramway lines No. 7 and 8, stating that application had been made to the Board of Trade to inspect those lines, and it was the intention of the company to open them when the certificate of the Board of Trade was obtained.

Isle of Thanet.—The Thanet trams last week were, as already stated, the subject of a Board of Trade enquiry into the frequency of accidents. In the course of the proceedings it was stated that they are carrying 70,000 persons a week. This result is looked upon as excellent, but compared to the Dover system it is at least moderate. At Dover 50,000 is the ordinary out-of-season traffic.

Sheffield.—The receipts from the running of the Corporation trams during the last three months show a remarkable improvement. For the 13 weeks just ended the total receipts have been £47,354, an advance of nearly £11,000 over the previous quarter. The sudden snapping of the electric tramway overhead wire along South-street on Saturday interrupted the tram service for a few hours.

Nelson.—Application is to be made for sanction to borrow a further sum of £25,000 for a new electric lighting station at the refuse destructor site and the equipment thereof. The Nelson Light Railways order (authorising the construction by the Corporation of light railways from Nelson centre to Colne boundary, and from Nelson centre to Barrowford boundary) has been confirmed by the Board of Trade.

Handsworth.—The Committee of Ways and Means, presided over by Mr. Lowther, had under consideration on Wednesday the Bill promoted by the District Council conferring upon them further powers with respect to electric tramways, electric lighting, and other purposes. The Bill having already passed the House of Lords, was now passed as an unopposed measure, and ordered to be reported for third reading.

Hull.—It was stated at the last meeting of the Works Committee that the negotiations with the North-Eastern Railway Company with regard to the level crossing over the Hedon-road in connection with the proposed tramway were progressing very satisfactorily, and that as soon as the committee could see the possibility of making good progress with the laying of the rails, the work would be commenced.

Ilkeston.—The Town Council have adopted the following resolutions: "That tenders for the construction of the whole of the proposed tramways be invited forthwith; that mains for electric lighting be laid the whole length of the tramlines; that 20 arc lamps be provided and fixed at the most important points between Holy Trinity Church and White Lion-square; and that nine motorcars be provided."

Bishop Auckland.—At Tuesday's meeting of the Rural District Council the Surveyor reported that on a recent visit to London he met the promoters of the proposed electric tramway system for Auckland and district, and was assured by them that it was their intention to proceed with the scheme, notice of which would be given directly. A beginning with the work will probably be made next autumn.

Hammersmith.—The Law and Parliamentary Committee recommend, with regard to the West London Tramways, "that the Board of Trade be informed that the Borough Council strongly recommends that regulation vi. be amended so as to provide that the speed at which the tramcars shall be driven or propelled in King-street, between the Broadway and Rivercourt-road, shall not exceed the rate of six miles an hour."

Hastings.—The Town Council have adopted the following resolution: "That it is advisable that the number of licenses for vehicles of the omnibus, wagonette, and char-a-banc classes be forthwith increased with a view of additional licenses being issued for motorcars to ply for hire in the borough, and that the Licensing Committee be authorised to issue such additional licenses as they may think fit."

Glasgow.—The Corporation tramway drivers and conductors have resolved to approach the Town Council with a request for shorter hours and increased pay, the general understanding being, it is said, that a stoppage of work would be resorted to unless the request was granted. The electric cars were on Monday placed on the Mount Florida route, so that the whole of the horse cars on the route between Mount Florida and Maryhill are now withdrawn.

Gravesend.—The Town Council have approved the following recommendation of the Electricity Committee: "The committee see no reason to advise any alteration in the terms for the supply of current to the trams, but recommend the Council to rescind their resolution to oppose the transfer of the undertakings to the Gravesend and Northfleet Tramways, Limited, and to consent to such transfer if such terms be previously accepted, the British Electric Traction Company, Limited, to guarantee the construction and completion and fitting of tramways."

London United Tramways.—We understand that the extensions of the electric tramways to Southall and Hounslow will be opened for public use on Wednesday next, the 10th inst. The cars from Shepherd's Bush are at present running no further than the upper end of Acton, but after the 10th inst. they will continue the journey from that point through Ealing, Castle Hill, and Hanwell, to Southall, which will thus be brought within a short and easy ride of the Bank by means of the Central London Railway and the tramway. In the same manner, Brentford, Isleworth, and Hounslow will be brought into easy communication with the centre of the City by the extension from Kew Bridge.

Allis Engines.—With reference to the two Allis engines which have been installed at Glasgow for the operation of the Corporation tramways, we take the following extract from a report presented by Mr. Parshall, the consulting engineer to the Corporation, at last week's meeting of the Tramways Committee: "The little trouble at first experienced from warm pins with the Allis engines has entirely disappeared. No. 1 Allis engine has been carrying the car load for 11 days, and the No. 2 for 16 days. The average load on an engine for 250 cars amounts to some 1,400 kw. The average output from the station amounts to 93 Board of Trade units per car mile, which figure will indicate to you that the system generally is working efficiently and well."

Worthing.—The Town Council have adopted a report of the Electric Lighting Committee on the subject of the introduction of electric tramways in the borough. The committee did not advise that the Corporation should commit themselves to any present outlay of capital, but what they recommended was that they should not shut themselves out from acquiring control over a valuable property, and so allow it to fall into the hands of private speculators, without being safeguarded by a carefully-drawn agreement. A motion that application be made to the Light Railway Commissioners for an order under the Light Railways Act, 1896, authorising the construction of one or more light railways in the borough and adjoining parishes, has been rejected.

Wolverhampton.—The present deadlock between the Corporation and the British Electric Traction Company with regard to providing tramway communication with the outlying townships has resulted, it is said, in a serious loss to the tradesmen of the town. It is urged in the local Press that the matters in dispute could easily be submitted to an independent arbitrator, in whom all concerned would have confidence; or, failing that, to the Board of Trade, the members of which can be relied upon to act justly and fearlessly, and with a single eye to the welfare of the suffering tradesmen and the public generally. The British Electric Traction Company have deposited with the Council route and construction plans of the new electri tramway to Stourbridge.

Sunderland.—The profit from the Corporation tramways at the end of the year 1900, on both horse and electric sections, reached nearly £5,000. During the present year other sections have been opened, and if business continues as it has been doing, the profits when the 12 months end will be, it is estimated, from £12,000 to £15,000.

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We understand that the tramways have now been fitted with a telephonic system. At each of the section boxes, at intervals along the route, there is a neat portable instrument, which is connected to a spare cable which runs under the roadway between the pairs of metals. Each driver has a key to the section box, and in case of emergency he can ring up the car-sheds and communicate with other parts of the system and notify them as to what is wrong.

Nottingham.—After considerable delay the Bulwell and Basford section of the Corporation tramways has again been opened for traffic as far as the Great Market-place. At present only horse traction is possible, and it is anticipated that the electric service will not be available till towards the end of the month. At the last City Council meeting the chairman of the Tramways Committee said it was not the intention of the committee to put electric lamps on the Bulwell section any further than Alfreton-road and Derby-road. They hoped to set to work on the Lenton-boulevard section early in the spring of next year or very early in the summer. The committee are now engaged with the Trent Bridge section. After that there would be two or three other sections in hand, and probably the Lenton route would be the next one undertaken.

West Hartlepool.—The Borough Engineer submitted a report at Tuesday's Council meeting with respect to a plan of the tramways company for an additional line through Upper Church-street and Church-square. Such a line, he submitted, would not facilitate in the least the working of the cars. The alleged inconvenience of working them on the north side of the municipal buildings he said could be at once obviated, and 10 times more traffic conveniently dealt with, if curves of proper radii and double lines were provided in Clarence-street and Clarence-road. Moreover, the disadvantages and dangers of the overhead wire system would be emphasised in the case of Upper Church-street, which was used as a crossing street nearly its entire length. It was decided to submit a copy of this report to the tramways company, and to convene a special meeting to consider their reply.

Manchester.—The electric car service from Deansgate to the Salford boundary at the Grove Inn, Bury New-road, was inaugurated last Tuesday. What the local Press regards as the greatest boon in connection with the new electric tramway system in Manchester will be the adoption of the queue system of loading the cars at certain points. A special staff of police, it is said, will be provided to insist upon people who wish to board the cars taking their places in line, and, if necessary, temporary barriers will be provided in order to secure that the new system is properly started. It is anticipated that very little difficulty will be experienced in maintaining the system. As the cars will unload from one door and load at another, there should also be a considerable saving of time in the dispatch of the cars. The new ½d. cars started on Friday by the Corporation are reported to have proved highly successful, the receipts far surpassing the anticipations of the department.

Tyneside Tramways Bill.—This Bill, of which the object is to authorise a company of local gentlemen to construct tramways and a tramroad in the urban districts of Walker, Wallsend, Willington Quay, and Gosforth, the borough of Tynemouth, and the parishes of Willington and Longbenton, in the county of Northumberland, and for other purposes, has passed the Select Committee of the House of Commons presided over by Mr. W. H. Holland. The committee gave its decision as follows: "The committee have arrived at the decision that the preamble of the Bill is proved, except so far as the part which relates to Walker. They feel there are special circumstances in regard to Walker, both local and in respect of its proximity to Newcastle. In arriving at this decision, they have been greatly influenced by the pledge given by the Corporation of Newcastle to promote a Bill in the next session of Parliament for, and to proceed with forthwith, after the passing of the Bill, the construction of tramways in Walker."

The Proposed Electric Railway under the Solent.—The construction of an electrical railway under the Solent, giving direct communication between the London and South-Western system on the Lymington and the Freshwater, Yarmouth, and Newport Railway at Freshwater, is now practically assured. The South-Western and Isle of Wight Junction Railway Bill, promoted with this object by the Earl of Egmont and others, having already received the sanction of the House of Lords, has passed the committee of the House of Commons presided over by Mr. Tatton Egerton as an unopposed scheme. Including the tunnel under the Solent, the railway, from its commencement in the parish of Sway to its termination at Freshwater, will be about 7½ miles in length, and, subject to the consent of the two companies whose systems it will connect, it will be worked by electricity. The capital required is £600,000 in 60,000 £10 shares, and the maximum period for the completion of the scheme is fixed at seven years.

The Proposed Tube Railways.—Before the Joint Parliamentary Committee which is considering which of the numerous tube railways proposed for London will offer the best public facilities on Tuesday, Mr. Pember, K.C., representing certain owners, lessees, and occupiers, applied for a *locus standi* to oppose the Bills in Parliament. He maintained that the ordinary law did not sufficiently protect owners under the peculiar circumstances of the case. A *locus* should be given to owners in the neighbourhood of the route whose land was not taken, but which was affected by, any of the proposed railways. It was his contention that owners ought to be heard against such Bills as these, and if there was no *locus* in such cases, then the ordinary practice should be relaxed. The *locus*, however, should not be confined to clauses, but should be extended. It was the view of the owners and occupiers that they ought to be heard on the question of route, as they might wish to contend that a deviation was necessary so as to secure that no damage from subsidence or otherwise might be caused. The committee adjourned, and no further proceedings will be conducted by it in public unless the committee notifies the parties that it desires to hear further argument or evidence.

The Manchester-Salford Deadlock.—The inconvenience which has arisen from the decision of the Manchester and Salford Corporations to carry on their respective tramway systems independently of each other, has, we understand, given rise to much public dissatisfaction, especially among the people living in the outer districts of Salford, Pendleton, and Broughton. It is in the interests of all that the present deadlock between the two corporations should be removed as speedily as possible, and we trust before long to hear that the through service of cars from Manchester to Salford has been resumed. At the meeting of the Salford Corporation on Wednesday the following resolution was adopted: "That this Council is of opinion that no tramway system in Salford will be satisfactory to the people that does not provide transit into Manchester, and hereby expresses its readiness to reopen negotiations with a view to the equitable and amicable settlement of the terms upon which the Manchester Corporation shall work the borough tramway in Bury New-road and the Salford Corporation shall work the city tramways from the bridges to St. Mary's Gate." The Manchester City Council, at their meeting on Wednesday, also expressed their readiness to reopen negotiations.

Lancaster.—At the last Town Council meeting an amended offer of a Birmingham syndicate to take over the powers to construct electric trams within the borough was rejected, as was also the application by the same syndicate for an extension of the powers of the Lancaster and District Tramway Company, postponing the time when the Corporation can acquire the line to Morecambe from 10 to 35 years. The advisability of reopening the negotiations with the tramway company, who refused the previous offers of the Corporation, is being considered. An important step was taken at this meeting with regard to the construction of electric tramways on the overhead system within the borough. The electrical engineer submitted estimates for the construction of a line from Dalton-square to Scotforth, 1¾ miles, and from the Pointer (a third of the way to Scotforth) to the Golgotha entrance of the Williamson Park, 1¼ miles. The estimated cost of the lines and construction of cars and a car-shed off Dalton-square is £26,960. Considerable discussion took place as to the desirability of adopting a circuitous route to the park instead of the steeper ascent up East-road. It was explained that the cost of traction would be much heavier on the shorter route, and the committee wished to open out the suburbs as soon as possible. The scheme was eventually approved.

London County Council.—At Tuesday's meeting of the London County Council the important announcement was made, in regard to the Council's tramway schemes, that instead of waiting for the completion of their own generating station, arrangements had been made for the supply of electricity from other sources, so that it was hoped that electric cars would be running in South London within 18 months. A long discussion took place on the question of imposing further restrictions on motorcars on the public roads. The Berkshire County Council wanted London to join it in an appeal to the Home Secretary to order that every car should be registered and carry a number, but eventually the London County Council decided to take no action in the matter. The Improvements Committee reported favourably as to the construction of a double line of tramways from a point near the Marble Arch, along Edgware-road, Maida-vale, High-road, Kilburn, and Shoot-up-hill to the county borough at Cricklewood. The widenings incidental to the scheme will take place in Edgware-road, High-road, Kilburn, and Shoot-up-hill. It is also proposed to widen the Edgware-road near Harrow-road by setting back certain properties having a frontage of about 123ft. on the western side of Edgware-road. The net cost of the improvement is estimated at £97,100.

New Issue.—An issue is being made by the New General Traction Company, Limited, of £200,000 5 per cent. mortgage debentures at par. This company was formed in 1896 for the purpose of installing systems of traction for light railways, street railways, and tramways. It has acquired a majority of the shares of the Douglas Southern Electric Tramways, in the Isle of Man, and also the Coventry Tramways. Acts of Parliament for the installation of electric tramways in Norwich were also obtained, and the system was open for traffic in August last. The company has also interests in a system of tramways in the suburbs of Philadelphia. The share capital of the company has been from time to time increased from £170,000 to £370,000 by the issue of 40,000 preference shares of £5 each; but it has been considered in the interest of the company to retain the shares and debentures taken in payment for work done. The magnitude of the contracts carried out have required a larger capital than was at the disposal of the company, and a floating debt of about £160,000 has gradually accumulated. The present issue of debentures is made in order to repay this indebtedness, and to provide sufficient funds to enable the company to undertake new business. The directors state that the minimum subscription on which they will go to allotment is £140,000 of the debentures now offered. The list of applications will close to-day.

Liverpool.—The Corporation Tramways Committee have adopted a report of the general manager with regard to lifeguards on the cars and the ventilation of the cars. The report, which was of an interesting character, showed that for the year 1900 there were 510 cases of persons run over in Liverpool by vehicles of all kinds. Of this number 162 were knocked down by horse and electric cars and omnibuses. The experience of the past two years had shown that there was less risk of fatal accidents under electric traction than horse traction, having regard to the magnitude of the traffic. During 1900 there was one person killed under horse traction in every five millions, and under electric traction there was one in every 10 millions. In 1898, the last year of horse traction, the fatalities amounted to one in six millions; in 1899, when it was mixed traction, one in eight millions; in 1900, one in 7,500,000; and in the first half of the present year, one in nine millions. Since the introduction of the electric cars seven persons had been killed. With regard to the lifeguard, the general manager recommended one of the plough type, which he thought afforded the greatest safety, and that 100 cars be

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fitted with it. The estimate of cost was £6 per car, but in reality it would cost a little less. The traffic returns for the fortnight ended June 22 show that the receipts for both electric cars and horse vehicles amounted to £18,291. 2s., an increase of £1,946. 12s. 2d. over the same period last year. The mileage totalled 426,868, an increase of 77,997. The total passengers carried was 3,959,620, an increase of 767,209. There were 323 cars (including six horse vehicles) working, showing an increase of 26.

The District Railway Bill.—The Select Committee of the House of Commons presided over by Sir J. Kennaway has passed the preamble of the Bill of the Metropolitan District Railway Company for the confirmation of an agreement between it and the Metropolitan District Electric Traction Company, Limited (formed by an American syndicate headed by Mr. Yerkes), in respect of the electrical equipment of the Metropolitan District Railway. At the opening of the proceedings on Friday, Mr. Pember, K.C., stated that the London and North-Western Railway Company, which had petitioned against the Bill and cross-examined witnesses, had withdrawn counsel and abandoned its opposition. Major Mellor, deputy-chairman of the Metropolitan Railway Company, recalled, stated that the Metropolitan and the District Railway Companies had worked amicably together on the traction question until the American deal, when Mr. Yerkes came on the scene with the attraction of a million sovereigns. The joint committee on traction appointed by the two companies had practically agreed to the Ganz system when Mr. Forbes stated that he had entered into an agreement with Mr. Yerkes, and that he intended to have the American system of traction not only on their own line, but that part of the Inner Circle worked jointly. A clause was ultimately agreed to that, if within a month of the passing of the Bill the parties do not agree to a uniform system, "the companies shall declare and submit the system which each desires to adopt to the Board of Trade, and the Board of Trade shall appoint a special tribunal consisting of an arbitrator (not an electrical engineer) and two engineers, one appointed by each company to hear evidence and report to the Board, who will determine what system of electrical working shall be applied." The question of workmen's trains was left for the House of Lords.

Bournemouth.—The vicar and people's churchwarden of St. Peter's Church have lodged a petition in the Private Bill Office signifying their intention of opposing the Tramways Bill of the Corporation in the Committee of the House of Commons in connection with the proposed encroachment on the churchyard. The Poole and District Electric Traction Company have also lodged a petition against any alteration of the Bill from the shape in which it passed the House of Lords. The following is an extract from the report of the Brussels deputation with regard to electric traction in the borough, which has been adopted by the Town Council: "Having regard to the information obtained, the deputation has confidence in making the following recommendations—viz.: (1) That it is desirable to work the proposed tramways in Bournemouth on the conduit system through the main road of the town—namely, from the County Gates to the Ashley-road, Boscombe. (2) That it would be advisable to work this system on a double track throughout, and, in order to prevent complications, to avoid interlacing the lines and points as far as possible. (3) The additional cost of the conduit system over the trolley system was stated at Brussels to be about £2,000 per mile of single track, but the deputation cannot think it would cost less than £4,000 per mile additional in Bournemouth, considering the diversion of pipes, etc.; in addition to this the system would involve some extra cost in cables, etc., at the generating station, but as to this the deputation advise that the consulting electrical engineers be instructed to prepare a report and estimate. (4) That application be made for sanction to borrow the additional sums required for carrying out the proposed works, and that tenders be obtained for the work forthwith." These recommendations have been referred to the consulting engineers and the borough engineers to prepare estimates of cost.

Torquay.—At the Town Council meeting on Tuesday, Mr. P. Storey, electrical engineer, reporting on the proposed electric trams, stated that the foremost subject which presented itself in connection with the scheme was the building of a power-house and shaft, providing a suitable and copious water supply for condensing purposes, etc., for the removal of the plant from the present works, and the re-erection of the new works. This was a matter which would under any circumstances force itself upon the Council in the course of two or three years, when the extensions now in hand are nearing their full capacity. It was, therefore, more economical to seriously consider this very important subject in the first place and to build a power-house sufficiently large enough for both lighting and traction purposes and all future extensions. In order to save a portion of the capital which had been expended in the engine-room of the existing works, he would propose that it should be used as a battery sub-station, which would be a necessity in connection with the tramway scheme. The removal of the generating plant to a new site, presumably near the refuse destructor, would necessitate the laying of high-tension feeders in order to connect up the present lighting system. The estimate for this work was apparently heavy, owing, in the first place, to the estimate being based on the present prices of cables, which are high; and in the second place by allowing a generous amount of copper in the cables, which was to be strongly recommended, as provision would then be made for a very large increase in the supply without further expenditure on the high-tension mains. The estimate for the tramway scheme did not include parliamentary or engineer's fees. The estimate was as follows: erection of new power house and shaft and providing water for condensing and other purposes, £10,500; removal of present generating plant and re-erection, £1,500; providing and laying new high-tension feeders to connect present lighting system, £4,755; contingencies, £837—total, £17,593. Tramway equipment—Tor Station to Beacon Quay, 2,750 yards, £12,500; Torquay Station to Castle-circus, £7,500; Castle-circus to Horn's nursery, £7,182; Horn's nursery to St. Marychurch town hall, £1,591; Horn's nursery to St. Marychurch flagstaff, £5,877; power-house to triangle in St. Marychurch-road, end of Hatfield-road, £2,750; contingencies, £1,870—total, £39,279. 13s. From Horn's nursery *via* Cary Park to the flagstaff, Babbacombe Downs, was separately estimated at £7,087. 10s.; and from the Strand to Wellswood, £7,875; while the double-decked cars to carry 45 passengers each were estimated to cost £6,000 (£600 each). The subject was referred back to the committee for further consideration.

South Lancashire Tramways Bill.—This Bill, which, among other things, sought to make it clear that the company had the power to supply electrical energy in bulk to local authorities or other authorised distributors through whose area their tramways passed, came before the Select Committee of the House of Commons presided over by Mr. W. H. Holland last week. Mr. E. Moon explained that the promoters were under the impression that their Act of last year, which authorised the construction of a network of "linking-up" tramways in South Lancashire, gave them power to supply electrical energy in bulk to local authorities through whose districts they carried their tramways and who might apply to be so supplied. But doubts had arisen as to the exact position of the company in this respect, and so, in the present Bill, clauses were introduced giving them power to supply electrical energy in bulk upon the application of the local authorities. The Bill was opposed in the House of Lords by the Lancashire Electric Power Company, who urged that the tramways company were really seeking to convert themselves into a power company without coming under any of the restrictions and limitations which had been imposed on all the Power Bills, promoted as such, by Sir James Kitson's Committee. Mr. Balfour Browne then said that if that was the view entertained by the Lancashire Power Company, he was perfectly willing to accept all the conditions and obligations placed upon his opponents by Sir James Kitson's Committee, except as regarded the financial clauses. The House of Lords Committee acceded to this suggestion, and passed the preamble of the Bill after these protective and restrictive clauses had been brought up by the tramways company. These clauses were now before the present committee, and he asked them to approve them as the other House had done. Mr. Pember, K.C., asked the committee to strike out the electrical clauses, urging that they were clauses which, in their application to a tramways company, ought not to commend themselves to Parliament. The Chairman asked Mr. Moon if the committee were to understand that the tramways company had already power to provide electricity for their own use. Mr. Moon said that was so—for their own use and for the lighting of the streets through which their tramways passed. The Chairman: That being so, and in view of the Lancashire Electric Power Act of last year, the committee feel that they must for the present defer the granting of powers to the South Lancashire Tramways Company for the supplying to the public of electrical energy. Should the Lancashire Power Company fail to commence their works substantially within two years from the passing of their Act, then a new situation will have been created, which will be suitably dealt with when it arises. The decision of the committee is an important one, in view of the fact that the action of the House of Lords Committee is thereby reversed.

LIGHTING AND GENERAL.

York.—Application is to be made for sanction to borrow £10,850 for mains and extensions.

Montrose.—The electric light was tested for the first time in various parts of the town on Saturday night.

Hull.—The proposal to extend the electric light supply to Hessle has been referred to the electrical engineer for report.

Dunstable.—The Town Council are discussing the advisability of taking steps to secure the electric light for the town and district.

Leyland.—The Lancashire Electric Power Company propose to bring the current to Leyland from a generating station at Chorley.

Share Market.—There were only few enquiries for electric shares during the week, but debenture issues continue to attract investors.

Radcliffe.—Mr. W. A. Ducat has held an enquiry into an application for sanction to borrow £21,500 for electric lighting and traction.

Burnley.—The Local Government Board have agreed to the plans for the proposed electric lighting works for the workhouse at a cost of £8,303.

Frome.—The Urban District Council have deputed the Electric Lighting Committee to visit three or four places which are lighted by electricity.

West Ham.—The rectified open arc lamp system, at present being experimentally tried in High-street, Stratford, is to be adopted for Barking-road.

Telegraph Clerks' Pay.—The Postmaster-General has assented to the application of the London branch of the Postal Telegraph Clerks' Association for an interview.

Electric and General Investment Co.—The warrants for the dividend, payable July 1, on the 6 per cent. cumulative preference shares have been duly posted.

St. Annes.—Estimates are being prepared in readiness for an application to the Local Government Board for £7,000 for extensions of electric lighting plant and cable.

Barnsley.—The Town Council have received sanction to borrow £19,800 for extensions of the electricity works. The accepted list of tenders appears in another column.

Little Lever.—The directors of the Lancashire Electric Power Company have definitely decided to erect the company's first generating station at Little Lever.

Stretford.—The Urban District Council have adopted the report of Mr. C. H. Wordingham, consulting electrical engineer, as to the supply of electricity in the district.

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Colchester.—The Electric Lighting Committee are to supply for lighting the public lamps on the south side of High-street at £3 per lantern per annum.

Lancaster.—The Town Council have authorised extensions and alterations at the electricity works at a cost of £1,640, as well as extensions of mains at a cost of £120.

Bathgate.—The Town Council propose to apply for an electric lighting provisional order, and to enter into an arrangement by which Messrs. Crompton and Co. will expend £14,000 on plant.

Maidenhead.—Tenders are invited by the Corporation for a loan of £25,000, required for electric lighting, repayable by equal half-yearly instalments of principal and interest within 25 years.

Private Bills.—In the House of Lords on Tuesday the following Bills were read a second time: West Cumberland Electric Tramways, Metropolitan Electric Supply, Clyde Valley Electrical Power.

Eastern Telegraph Co.—Payment is announced on the 17th inst. of a further dividend of 1½ per cent., and a bonus of 2 per cent., making a total distribution of 7 per cent. for the year ended March 31 last.

Penzance.—Another adjournment has taken place in regard to the draft agreement of Edmundson's Electricity Corporation, Limited, setting forth the terms on which they would be prepared to take over the electric lighting of the borough.

Dudley.—It is proposed to borrow a further sum of £20,000 for electrical plant at the generating station. Arc lamps are to be fixed in Priory-street, Wolverhampton-street, Wellington-road, Union-street, New Mill-street, and St. James's-road.

Teignmouth.—A committee of the District Council is considering a notice from the Provincial Electric Supply and Traction Company, who intend to apply for a provisional order authorising the supply of electricity for public and private purposes.

Belfast.—The price of current for motor and heating purposes has been reduced after the first hour's use of the consumer's maximum demand from 1½d. to 1d. per unit. A loan of £90,822 has been sanctioned in connection with the electric light undertaking.

Electric Punkahs.—*Indian Engineering* understands that it is under contemplation by the Oudh and Rohilkhand Railway authorities to introduce electric fans for use of the administrative offices. The cost will, perhaps, not exceed 50,000 rupees for the equipment.

Barnstaple.—The Town Council have resolved to apply to the Local Government Board for power to borrow £27,000 for the purposes of the electric lighting scheme, and also to take the necessary steps to use premises in Castle-street and Commercial-road as an electric lighting station.

Stoke-on-Trent.—Messrs. Peers and Trentham have been instructed to prepare plans and specifications for the erection of an electric lighting station. A proposal to approach the electric traction company to ascertain the terms on which they would supply the necessary current has been rejected.

Nantwich.—The preliminary and sketch plans, description, estimates, and report of Messrs. Trentham and Peers, as to the electric lighting works and mains and refuse destructor, have been approved by the Urban District Council, and application will be made for sanction to borrow £13,780.

Broughty Ferry.—An application of Messrs. Crompton and Co., Limited, on behalf of the Electric Supply Corporation, Limited, who intend to apply to Parliament for a provisional order giving them statutory powers to carry out the electric lighting of the burgh, is being considered by the Lighting Committee.

Hammersmith.—Since the last Council meeting seven additional consumers have been connected, representing a maximum of 260 8-c.p. lamps. These, added to the number previously reported, show a total of 900 consumers taking current from the mains. Six additional arc lamp columns are to be ordered at a cost of £55. 10s.

Hereford.—The Electric Lighting Committee have requested the Town Council to take the necessary steps for borrowing £5,000. The estimated income and expenditure for the ensuing year show that a balance would be required of £206, against which the expenditure included repayments of principal to the extent of £900.

"Rhineland."—We have just received an advance copy of a beautifully illustrated pamphlet, "Rhineland," which opens up fresh holiday districts in the little-known side valleys of the Rhine, a country even more charming and varied than the Ardennes, which were made known by Mr. Percy Lindley through "Walks in the Ardennes."

Electrical Trades Union.—A public meeting of electrical workers of Walthamstow and district will be held on Monday, July 8, 1901, at the Workmen's Hall, High-street, Walthamstow, for the purpose of opening the Walthamstow branch of this union. Amongst its objects we note that it is proposed to establish an apprentice system.

Mansfield.—The Corporation's Bill, which has already passed through the House of Commons, has been allowed to pass as an unopposed measure Lord Morley's Committee in the House of Lords. The object of the Bill is to empower the Corporation, *inter alia*, to make further provisions with respect to electrical undertakings.

Lincoln.—At this week's meeting of the City Council Mr. C. Vesey Brown (the electricity works engineer) was reported to be leaving, to take up a more lucrative position in the North of England, and the Chairman of the Electricity Committee (Alderman E. Harrison) said he was sure every member of the Council wished him all success.

Bermondsey.—The Borough Council expect to be able to switch on the electric light in October. They have adopted the continuous-current system of supply at a pressure of 240 volts, this system being used by the majority of corporate bodies throughout the United Kingdom as better adapting itself to commercial and private enterprise.

West Hartlepool.—The Electric Lighting Committee's report for June states that 9,800 units were generated during the month, and that 16,399 8-c.p. lamps or equivalent were in use. The income for the quarter ending June 26 was as follows: units sold, £448; street-lighting, £164—total, £612. The amount generated during the quarter was 39,200 units.

Electrical Power Storage Co.—The report of the directors for the year ended May 31 last states that the profit for the year is £5,665, making, with the balance brought forward, £5,923. Of this £1,000 has been carried to contingent fund, and the directors recommend a dividend of 5 per cent. on the ordinary share capital, leaving £432 to be carried forward.

Stock Exchange.—The Stock Exchange Committee have ordered the under-mentioned securities to be quoted in the official list: Eastern Telegraph Company, Limited, further issue of £103,919 3½ per cent. preference stock; British Columbia Electric Railway Company, Limited, further issue of 6,400 non-cumulative 5 per cent. preference shares of £10 each, fully paid, Nos. 38,601 to 45,000.

Notting Hill Electric Lighting Co.—This Bill promoted by the Notting Hill Electric Lighting Company, Limited, under which power is given to the Company to acquire certain lands near Addison-road for storing and distributing electrical energy, has passed the House of Lords Committee. The Bill, as amended in the House of Commons, expressly prohibits the Company from generating electricity on the lands now to be acquired.

Paisley.—A petition is being prepared by several of the leading local firms for presentation to the Town Council, in which the Council is to be asked to withdraw their opposition to the Clyde Valley Electrical Power Bill on the grounds that it would be to the advantage of the large public works in the burgh if electric motive power could be obtained from the Clyde Valley Company. The petitioners do not propose any interference with the burgh electric supply for lighting purposes.

Annual Outing.—The employés of the Robertson Electric Lamp Company had their annual excursion on Saturday, June 29. The party of over 250, accompanied by Messrs. Robertson and Wilson, left Victoria by an early train for Eastbourne, where a most enjoyable time was spent. At the dinner the usual toasts were given. The employés of this firm number now nearly 500, and after the pleasant experience of Saturday last it is expected that a much larger party will take part in the excursion next year.

Insulating Tape.—A new insulating tape, listed as "Dia's Patent Adhesive N. Tape," has just been put on the market by the St. Helens Cable Company, Limited. It is manufactured under a patent whereby a facing of pure Para rubber is applied to a prepared sheet of previously vulcanised rubber. The pure rubber is put on next the wire, and a vulcanised joint is thus formed without going to the trouble of a cure. It is claimed that an extremely high resistance was shown after the tape had been immersed in water for three consecutive days.

Leeds.—The Lighting Committee of the Corporation have decided to recommend the Council to reduce the maximum price of energy to 4d. per unit. The scale of charges for electricity for motive power is to range from 2d. to 1½d. per unit, according to the number of units supplied, a reduction to be granted in the case of large consumers; and the price of electricity for cooking and other heating purposes is fixed at 2d. per unit. A discount of 5 per cent. will be allowed on all accounts if settled within the month. The recommendation to reduce from the 1st October next the prices of electrical energy supplied by the Corporation was passed on Wednesday.

Islington.—Applications having been received for a supply of electricity to premises in Liverpool-road, Carleton-road, and Highbury-grove, the necessary distributing mains will be laid as follows: Liverpool-road, £88; Carleton-road, £785; Highbury-grove, £650—total, £1,523. The London County Council are prepared to accede to the application of the Council for sanction to the borrowing of £3,236 for electric lighting purposes upon an undertaking being given by the Council that during the currency of the loan all replacements of plant and machinery purchased by money raised under the sanction shall be defrayed out of a sinking fund or from maintenance account.

Battersea.—Alterations are to be carried out to the town hall electric installation in order that energy may be supplied from the general distributing mains, and so save the cost of the upkeep of the station at the rear of the town hall buildings, at an estimated cost of £185. 5s. 6d. The lighting mains in Thurleigh-road are to be extended from Montholme-road to Nightingale-lane at a cost of £556, including the provision of arc light leads; and application is to be made to the Local Government Board for sanction to the borrowing of £131. 10s. to defray the cost of electrically wiring the Lurline-gardens and Lammas Hall branch libraries. Application will also be made to the London County Council for the advance of £10,065 further on account of the amount sanctioned in respect of the general electric lighting scheme.

St. Marylebone.—The Council have agreed to notices from the Metropolitan Electric Supply Company to lay a 5in. cast-iron pipe along the south side of Queen's-road from the west side of Woronzow-road to 36, Queen's-road, and a pipe along the north side of Little Portland-street, from 39, Great Portland-street to the east side of Regent-street. With regard to communications from the Central Electric Supply Company respecting a notice as to laying mains through the borough, the mains occupying for the greater length of the route a width of 4ft. 7in., stating their general manager will be glad to discuss the matter with the Council's electric inspector, and stating, after consultation with the inspector, that they can find no possible way of modifying their proposal, it appears that the Lighting Committee fail to see that the company have made out a case justifying their proposal, and that, therefore, there is no alternative but to submit the question to the Board of Trade for arbitration.

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Eastbourne.—We quote from the last report of Mr. R. M. Gloyne, A.M.I.C.E., the borough engineer, as follows: "There are 25 arcs of 2,000 c.p. now on the parade. For 23 of these current was, up to Dec. 31, 1899, supplied by the electric lighting company, who also cleaned, attended to, and renewed the carbons, charging £30 per lamp per annum. This arrangement remains in vogue under the altered ownership of the electricity works. The remaining two are only lit during the season and the Easter and Whitsun holidays. The charge for current, attention, etc., is £7 for three months' lighting."

Telephonic Competition.—Corporations contemplating the establishment of municipal telephones should take heed of the experience of the borough of Tunbridge Wells. There the Corporation spent all the capital subscribed by its ratepayers in providing a service, a speculation that might have been profitable, based as it was on the calculation of subscribers paying £5 a year. Unfortunately, however, the National Telephone Company quietly waited its opportunity and cut the rate down to under £4 per annum, which possibly means that neither the company nor the municipality can hope to make a profit.

Gravesend.—Application is to be made at once for sanction to the raising of a sum not exceeding £35,000, repayable within the maximum period allowed by the Local Government Board, for the purposes of the provision and equipment of electrical works and a dust destructor in the proportions to be indicated by the electrical engineer. Mr. Trentham is preparing specifications and plans for alternative tenders for the work necessary for the supply of electricity and the provision of a dust destructor (*a*) on the basis of the inclusion of the supply of energy to the tramways and (*b*) on the basis of the exclusion of such supply.

Personal.—Mr. W. E. Brandreth has been appointed resident engineer and manager to the Wycombe (Borough) Electric Light and Power Company, Limited.—Mr. A. H. Hunt, manufacturer of electrical plant, has been appointed London agent for the Walsall Electrical Company, Walsall, samples of whose goods are in operation at 59, Gresham-street, E.C. The Walsall Company have been appointed sole agents for the "G.I." enclosed arc and incandescent lamps, Paragon power motors, sewing machines, motors, etc. Mr. Hunt shows many electrical specialities in the way of traction switches, knife switches, iron-cased fuses, switchboards, etc.

Hampstead.—The Hampstead Borough Council have adopted a report of the Lighting Committee stating that the accountant had laid before the committee the accounts of the electric lighting undertaking for the year ended March 31 last, which showed a net profit of £2,017, and they recommended that it be referred to the Finance Committee to consider the question of investing such profit, together with the sum of £365, the interest on the reserve fund, amounting in all to £2,382, in London County Council stock as before, in accordance with the resolution of the late Vestry. A recommendation that 2d. per unit be charged for electric current used for power and heat, with a minimum charge of 13s. 4d. per quarter, has also been adopted.

New Books.—Two new volumes of that elegant series "Scientia" on up-to-date scientific questions, published by C. Naud, in Paris, have just reached us. They are vols. xi. and xii., and thus complete the series II. The first is a treatise entitled "Production et emploi des courants alternatifs," by M. L. Barbillion, while in the latter M. J. Hadamard discusses "La série de Taylor et son prolongement analytique." A large number of formulæ are given in both volumes.—The engineer of postal telegraphs, Mr. T. E. Herbert, A.M.I.E.E., has just brought out a second revised edition of his practical handbook on "The Telephone System of the British Post Office," with 146 illustrations. Messrs. Whittaker and Co. are the publishers at the modest price of 3s. 6d.

Wirral.—Recently the Birkenhead Corporation asked the consent of the Rural District Council to their obtaining a provisional order to supply electric energy to Prenton. A parish meeting was held at Prenton, and having in view the fact that sufficient people in the district would not take the electric supply, they did not seem to think it necessary to enter into negotiations with Birkenhead. The Wirral Council then refused their consent. Lower Bebington also asked for a provisional order to supply Spital. The electricity would be taken by Spital so long as some protection was secured for them in the matter of charges. The Wirral Rural District Council last week decided that consent be given on the understanding that Spital people be charged at the same rate as Lower Bebington.

London Gazette.—The partnership subsisting between W. H. Palmer and Duncan Watson, electrical engineers, 100, Charing Cross-road, W.C. (trading as Palmer and Watson), has been dissolved by mutual consent.—The partnership subsisting between Luis Alwyn and the Hon. R. C. Craven, electrical engineers, 9 to 13, Cowcross-street, Smithfield (trading as Alwyn and Craven), has been dissolved by mutual consent.—The partnership subsisting between J. McDonald and W. G. Titherington, electrical engineers, 23, Canning-place, Liverpool (trading as J. McDonald and Co.), has been dissolved by mutual consent.—The partnership subsisting between G. W. Warner and F. C. Shirley, electrical fitters and engineers, 12, Holbein-place, Sloane-square, S.W. (trading as Warner and Shirley), has been dissolved by mutual consent.

Cheltenham.—The Town Council have only just received the sanction of the Local Government Board to the borrowing of £6,150 for electric light extensions, for which application was made in October of last year, and last week Colonel A. G. Durnford, R.E., held an inquiry into a further application to borrow £25,000 for a similar purpose. Mr. Hall, the borough surveyor, explained the plans for extensions to the buildings, to cost £3,750. Mr. Kilgour gave details of the new machinery required to meet the increased demand for electric light, and the new demand for electric power for the tramway. In 1896 they had 101 customers, using 6,150 lights, in 1901 they had 491 customers, using 30,030 lights, and the demand was rapidly increasing. There were also 275 arc and 17 glow lamps. The present requirements amounted to about 700 kw., and the present capacity of the works was 1,000 kw. They had no reserve plant.

Telephone Patents.—Our New York contemporary, the *Electrical World and Engineer*, states that a decision was rendered on June 7 in favour of the Western Electric Company, in the United States Circuit Court of the Eastern District of Missouri, on Patent No. 438,788, and that in the same court a decision was rendered upholding the Seely patent on the employment of answering spring jacks in multiple switchboards. Both of these suits were brought by the Western Electric Company against the Kinloch Telephone Company, of St. Louis. The apparatus found to infringe Patent No. 438,788 is the carbon plate protector, manufactured by the Sterling Electric Company. The apparatus found to infringe the Seely answering jack patent, is the multiple switchboard built by the Kellogg Switchboard and Supply Company, of Chicago.

New Issue.—The Electric and General Investment Company, Limited, are just issuing at par 10,000 6 per cent. £5 cumulative preference shares and £75,000 5 per cent. debenture stock of the Electric Lighting and Traction Company of Australia, Limited. The company has acquired the undertakings of the New Australian Electric Company, Limited, and the A. U. Alcock Electric Light and Motive Power Company, Limited, together with Orders in Council for a period of 25 years from Nov. 13, 1900, covering all the most important suburbs of Melbourne; an Order in Council for a period of 30 years from Feb. 20, 1899, at Geelong; and the undertaking of the South Australian Electric Light and Motive Power Company, Limited, including an Act granted by the Parliament of South Australia, covering that colony (with certain restrictions), a small central station in operation at Port Adelaide, and the rights for electric lighting in the capital city of Adelaide.

Nelson.—Since last week the electricity question between Nelson and Brierfield has entered upon another stage, says the *Nelson Chronicle*. Mr. Chadwick Horsfall's party, rather than see themselves absorbed by Burnley, have come to Nelson to see what Nelson can do for them. The only obstacle in the way, at present, of a settlement, is only a matter of opinion. The Burnley Corporation maintain that if Brierfield do not go on with their electricity scheme their powers cease, and Burnley have the sole right to supply the electricity for traction purposes. For illuminating purposes, we have already reported that Burnley have offered current at a prohibitive price to Brierfield. In order to see what the powers of Burnley in this matter really are, the Brierfield Electricity Committee approached the Nelson Electricity Committee. The result of these negotiations was that it was decided to send a joint deputation to interview the Board of Trade. This deputation left for London on Thursday week, and the result of it is being awaited with very great interest by Burnley.

Electricity in North London.—In February, it will be remembered, a joint scheme was promoted in the districts of Enfield, Tottenham, Edmonton, Wood Green, and Southgate, for the generation and distribution of electricity in these districts, at an estimated cost of something like £400,000. In consequence of an adverse vote of the ratepayers of Enfield and Edmonton the scheme fell through. On Friday evening a conference, consisting of the members of the District Councils, assembled at Wood Green Town Hall for the purpose of considering the present position of affairs. Mr. J. T. Davies, chairman of the Wood Green District Council, presided. The following resolution was unanimously carried: "That in view of the expressed opinion of this conference that the supply of electricity could be generated much cheaper by a large than by a small undertaking, it is desirable that the joint committee of the District Councils of Edmonton, Enfield, Southgate, Tottenham, and Wood Green be reconstituted, to take into consideration the provision of the proposed electricity for use in their respective districts." It was stated that in all probability Tottenham and Edmonton would apply for provisional orders.

York.—The city electrical engineer, Mr. C. A. Midgley, has presented to the Electric Lighting Committee of the York Corporation his report on the first year's working of the station. After payment of all outgoings, including interest and sinking fund, and also discharging the debt of £310. 19s. 6d. incurred in preliminary expenses, there is left a net profit of £98. 15s. 9d. This is a record which has never been equalled by any provincial station in its first year. Prof. Kennedy installed four engines and dynamos with a total horse-power of 320. With this plant the works were in a position to supply 6,000 lamps of 8 c.p., each burning simultaneously. So great was the demand, however, that a 400-h.p. engine and dynamo was installed for the past winter. This No. 5 set is itself capable of supplying 7,000 8-c.p. lamps, but even with this set the works had not been able to have one of the others laid off, and at the end of the year (March 31, 1901) there was a total lamp connection of 16,400 8-c.p. lamps connected to the mains, and over 5,000 8-c.p. lamps have been applied for, the majority of which will be connected by the end of July. The mains, which were laid to Prof. Kennedy's specification, are overloaded in all the streets, and will be quite unable to cope with the coming winter's demand. The original scheme was based on a total lamp connection of 6,000 8-c.p. lamps, which it was estimated would be reached in about two years from the start, instead of which this figure was reached by the time the committee were ready to supply, and by the end of the first year current was supplied to 16,400 8-c.p. lamps. It is proposed to apply to the Local Government Board for their sanction to borrow the sum of £10,850 for extensions of mains and buildings, etc.

Bedford.—The Town Council have received the following report from the Electric Light and Traction Committee: "The committee report that the electrical engineer has prepared at their request a summary of analysis of costs and revenue of the electricity under taking for the year 1900, together with a detailed analysis of costs etc., of other electricity undertakings with outputs similar to that of Bedford for the year 1899. The committee have ordered the same to

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be printed and copies forwarded to the members of the Council." The summary of analysis as prepared by Mr. Johnstone, the engineer, was as follows: "Private lighting—total capital expenditure, £56,186; costs of laying mains and equipment, labour, and materials, £20,599; gross income, 1900, £6,386; capital charges on distributing mains, 1900, £1,129; *pro rata* capital charges other than cost of distributing mains, 1900, £2,079; total works cost, 1900, £4,473—net loss, £1,295. Sewage pumping—total capital expenditure, £2,503; cost of laying mains, etc., £855; gross income, 1900, £1,327; capital charges, etc., £49; *pro rata* capital charges, etc., £95; total works cost, £840—net profit, £343. Public lighting—total capital expenditure, £16,199; cost of laying mains, etc., £11,130; gross income, 1900, £2,597; capital charges, etc., £640; *pro rata* charges, etc., £292; total works costs, 1900, £1,783—net loss, £118. Attendance, etc.—Gross income, £146; total works cost, £146. Meters—Total capital expenditure, £2,881; cost of laying mains, etc., £2,881; gross income, 1900, £252; capital charges, etc., £166—net profit, £86. Miscellaneous—Gross income, 1900, £72. Totals—Total capital expenditure, £77.769; cost of laying mains and equipment, labour, and materials, £35,465; gross income, 1900, £10,780; capital charges on distributing mains, 1900, £1,984; *pro rata* capital charges other than cost of distributing mains, 1900, £2,466; total works cost, 1900, £7,242—net loss, £912." The analysis of costs, etc., of undertakings with outputs similar to that of Bedford for the year 1899 dealt with five companies and 24 municipal authorities. The undertakings in the hands of the companies each showed a profit. In 10 instances the undertakings in the hands of municipal authorities showed a loss; in the remainder a profit was shown. Tunbridge Wells, with which Bedford has been compared on various occasions, showed a profit of £765.

Gloucester.—The financial result of the first year's operations of the Gloucester electricity supply works, according to the *Gloucester Chronicle*, shows that the amount of the loans authorised for the purpose of the undertaking was £52,875—£43,450 on March 9, 1899, and £9,425 on Sept. 10, 1900—of which £10,000 had been borrowed at 2¾ per cent., and £283. 8s. repaid out of revenue, leaving £42,875 sanctioned but not borrowed. The capital expenditure, which totalled £54,383. 4s. 5d.—£30,772. 7s. 9d. was incurred up to March 31, 1900, and £23,610. 16s. 8d. during the subsequent year—was made up of the following items: buildings, £9,371. 1s. 7d.; machinery, £15,499. 16s. 1d.; accumulators at stations, £1,365. 4s. 6d.; mains and laying, £19,442. 8s. 6d.; meters, £1,892. 11s. 10d.; electrical instruments, etc., £1,914. 17s. 2d.; general stores, cables, mains, etc., £171. 9s. 5d.; public lamps, etc., £1,529. 18s. 1d.; engineer's commission, etc., £2,339. 0s. 5d.; general expenses, £509. 5s. 3d.; law charges, £61. 19s.; and cost of provisional order, £285. 12s. 7d. The revenue account for the 8½ months ending March 31 last showed a total expenditure of £1,691. 1s. 8d.—generation of electricity, £1,008. 18s. 11d.; repairs and maintenance, £272. 11s. 9d.; rates, taxes, etc., £125. 5s. 6d.; management expense, £233. 19s. 8d.—and receipts amounting to £3,050. 16s. 7d.; ordinary consumers, £2,275. 3s. 9d.; street lamps, £681. 4s. 7d.; less discounts, £57. 4s. 5d.; rental of meters and free-wiring rental, £76. 12s. 8d.; and hire of buildings and plant for testing machinery, £75. There was thus a balance on revenue account of £1,359. 14s. 11d., against which had to be placed interest on £10,000 loan, £203. 7s. 1d.; and bank interest, £936. 1s. 7d.; leaving a balance to be carried down of £220. 6s. 3d. Deducting the last-named amount from the one year's repayment of loan, £283. 8s., there remained a balance to be carried forward to the next account of £63. 1s. 9d. The interest on loan and bank interest accrued to the date of the opening of the works, amounting to £627. 1s. 4d. was carried to a suspense account. The quantity of electricity generated in Board of Trade units was 188,334, of which 177,834 were sold—44 public lamps 54,042, and private consumers by meters 123,792—the quantity used on the works being 10,500. Total maximum supply demanded, 223 kw. The resident engineer (Mr. W. J. Bache), in his report for the first financial year, representing the period from the opening of the works on July 19, 1900, to the end of March, 1901, pointed out that the excess expenditure over the amount sanctioned was largely accounted for by the extensions which had been made to the public lighting and additional mains. The revenue expenditure was satisfactory. With regard to the cost of generating, omitting the expenditure on trimming and repairs to the public street lamps, the cost per unit sold was 2·07d., which was a good result for the first year. Since the opening of the works the number of consumers had steadily increased, and if the committee could see their way to make some reduction in the price the increase would be large. Assuming some reduction, it might be reasonably estimated that the output for the current year would be: private lighting, 270,000 units; public lighting, 83,000 units. The cost of generating that number of units would probably be £2,400. To that must be added the sum necessary to provide for interest and repayment charges, which the accountant had stated would amount to £2,400. It would therefore be necessary to earn a revenue of at least £4,800 before the undertaking would yield a profit. Assuming that the committee decided to make a reduction in the price, Mr. Bache felt confident that the total revenue would considerably exceed that sum. He had had the advantage of conferring with Mr. Hawes, Mr. Hammond's chief assistant, on the matter, and after very carefully examining all the details, they had come to the conclusion that the committee would be fully justified in reducing the initial price in the maximum demand scale from 7d. to 6d. per unit, retaining the second price at 2d. per unit. On that basis they estimated the total revenue would be £5,300, taking the generation costs, interest, and repayment charges at £4,800, leaving a net profit on the year's working of £500 to set against the sum of £627 carried to suspense account. At last week's meeting it was decided to reduce the initial charge from 7d. to 6d. per unit as from June 30, and to grant a month's free supply to new consumers who complete their installations and commence to take a supply of electricity before Aug. 31.

PHYSICAL SOCIETY.

At the ordinary meeting held on June 14, Prof. S. P. Thompson president, in the chair, a paper on **"Herr Jahn's Measurements of the E.M.F. of Concentration Cells"** was read by **Dr. Lohfeldt.** Prof. D. Jahn has recently published measurements of E.M.F.'s of concentration cells, from which he has endeavoured to show that the law of dilution is applicable to strong solutions. The author points out that his conclusions are based on argument in a circle, because Ostwald's law is assumed in the formula used by Jahn for calculating degrees of concentration. The formulæ of Nernst and Arrhenius do not yield consistent results, and it is suggested that the former is suitable for calculating concentrations and the latter for calculating osmotic pressures.

A paper on **"The Mechanism of Radiation"** was read by **Mr. J. H. Jeans.** This paper contains an attempt to obtain answers to two questions: (1) what inferences can be drawn as to the mechanism by which radiation is emitted from an examination of the formula of physical optics? and (2) is it possible, with the help of these inferences, to frame any conception of matter which will give a consistent account of the various optical phenomena. Starting with general spectroscopy, the author has written down the radiation due to a single rotating molecule vibrating harmonically. The effect of a number of molecules is deduced, and it is shown that the condition that the continuous banded spectrum shall be absent is that either the period of rotation must be large compared with the period of vibration, or the radiation from a molecule must be spherically symmetrical. Passing on to dispersion, even if the radiation is continuous between collisions, there will be a discontinuity at every collision, and the train of waves will be no longer regular. It is customary to assume that the vibrations of a dispersing medium are sympathetic with the irregular incident light. The author has calculated the ratio between forced and free vibrations in a prism or grating, and finds that if the dispersion is to be regular the vibrations must be only slightly influenced by collisions, and this requires, as in the former case, that either the period of rotation is large compared with the period of vibration or the radiation is spherically symmetrical. As this is not the case with molecules, the author thinks that the line spectrum is emitted by atoms, that these atoms must be dissociated, and that the shape of these atoms is one of spherical symmetry. It is shown that if an atom is an electromagnetic system, similar to a planetary system, then the periods of such an atom would not be fixed, and there would be no reason for a line spectrum. The normal atom is, therefore, regarded as an electrostatic system, with some law of force, other than the inverse square law, holding at interionic distances. Such an atom when at rest would give a pure line spectrum. Rotation of such an atom causes the lines of the spectrum to shift towards the red, and as the rotation is different for different atoms, the lines will not only be shifted but broadened. To calculate the periods of vibration of an atom, the author has assumed it to consist of an infinitely great number of infinitely small ions. The spectrum of this consists of a collection of spectrum series, each possessing a definite head and capable of explaining doublets, triplets, etc. It is shown that under the action of a magnetic field a line may separate out into approximately equidistant lines, the central line maintaining its position. In conclusion, the author points to many other physical phenomena which can be explained by the theory described.

The **Chairman** then exhibited some specimens of Jena glass. In describing these reference was made to a diagram showing the refractive index, dispersion between the C and F lines, and the reciprocal of the dispensive power of any piece of glass. For this latter quantity the symbol "V" is used, and it was suggested to call it the achromatic refractivity of the glass. The introduction of barium increases the deviation, but leaves the dispersion unaltered. It is possible now to get crown glass with a higher refractive index than flint glass, and this makes it possible to construct an achromatic lens which will also give a flat field. It is usual in making achromatic objectives to make them accurately achromatic for the red and violet rays. A better effect can be obtained by having approximate achromatism throughout the length of the spectrum. This is achieved by matching the irrationality of one glass by means of another, and then constructing an achromatic pair with these two glasses. "Telescope crown" and "telescope flint" are two glasses which give similar spectra and approximate achromatism from the red to the violet.

The society then adjourned until June 28.

At the ordinary meeting, held by invitation of Prof. W. G. Adams in the Wheatstone Laboratory, King's College, on June 28, 1901, Prof. Everett, F.R.S. (vice-president), in the chair, a paper on **"The Effect of a High-Frequency Oscillatory Field on Electrical Resistance"** was read by **Mr. S. A. F. White.** The object of this paper is to discover if the action of light upon the electrical resistance of selenium can be imitated by using high-frequency electrical oscillations. It is found that such oscillations permanently increase the resistance of selenium. The effect of a rise of temperature is to increase the resistance of a piece of low resistance and decrease the resistance of a piece of high resistance. The effects of the field in a piece of high resistance can be reversed by exposure to light or by reheating and subsequent cooling. In the case of tellurium, a high-frequency field temporarily decreases the resistance, as also does a rise in temperature. Repeated heating and cooling of a piece of tellurium permanently increases its resistance. It seems probable that all of the effects are due to rise of temperature, caused by minute sparks within the mass. The rise in resistance by alternate heating and cooling may be due to the formation of tellurides with the metal of the electrodes. The large negative temperature effect of tellurium suggests that it might be usefully employed in the detection of heat radiation.

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The **Chairman** expressed his interest in the paper, and drew attention to the very rapid action of light upon selenium.

Prof. Adams said that as the effects here noticed were not so rapid as in the case of light, they were probably due to change in temperature.

Prof. Bose said he had tried the effect of Hertzian radiation upon thin layers of various metals, and found an increase of resistance in the case of selenium, and a decrease in the case of tellurium. The effect of radiation is confined to a few layers on the surface of the conductor, but it appears that it is of the same nature in continuous solids as in coherers.

A paper by **Mr. E. C. C. Baly** and **Dr. H. W. Syers** on **"The Spectrum of Cyanogen"** was read by Mr. Baly. The authors have been able to obtain the spectrum of cyanogen by allowing the pure gas to flow through a vacuum tube and observing from the end of the tube. This is necessary on account of the brown deposit of paracyanogen, which renders observation in the ordinary way impossible. The spectrum obtained differs from the flame spectrum, and consists of a series of equidistant flutings through the whole of the red and yellow, somewhat recalling those of the positive band spectrum of nitrogen. The experiments prove that (1) the Swan spectrum is not produced by a carbon compound which does not contain oxygen; (2) the Swan spectrum is that of an oxide of carbon, as it is only produced by carbon monoxide, and as this spectrum is changed at once into the carbon oxide spectrum by admission of oxygen, or by intense electric discharge, and, further, as the carbon oxide spectrum is invariably given by carbon dioxide, there can be no doubt that (3) the Swan spectrum is that of carbon monoxide, and the carbon oxide spectrum that of carbon dioxide.

Mr. Gaster said that this paper might throw light on the discussion of the arc where cyanogen, carbon monoxide, and carbon dioxide are present. The presence of cyanogen might be able to explain the hissing of the arc.

The society then adjourned until next October.

PROVISIONAL PATENTS, 1901.

JUNE 24.

12815. **A Morse signalling lamp.** George John Boyman, "Aberfoyle," College-avenue, New Brompton, Kent.

12816. **Improvements in wireless telegraphy.** Harry Shoemaker, 111, Hatton-garden, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 22, 1901, being date of application in United States. (Complete specification.)

12835. **Improvements in electric cranes and other electric lifting appliances.** Stothert and Pitt, Limited, and Percy Kendal Stothert, 24, Southampton-buildings, Chancery-lane, London.

12862. **Improvements in connection with electric cables or conductors where branch terminals are used, especially applicable to the wiring of electrically-driven vehicles.** Philip Dawson, 47, Lincoln's-inn-fields, London. (Complete specification.)

JUNE 25.

12870. **Improvements in and relating to trolleys employed in overhead wire systems of electric traction.** Edward May Munro, Henry Brecknell, and Hugh Innes Rogers, Lloyd's Bank-buildings, Bristol.

12896. **A device for use within electric ceiling roses and the like.** William Grimshaw Stones, 55, Market-street, Manchester. (Complete specification.)

12947. **An improved electric telegraph code.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Charles G. Burke, United States.) (Complete specification).

12954. **Improvements in electrical secondary or storage batteries or accumulators.** William Peto, 66, Chancery-lane, London. (Paul Gouin, France.) (Complete specification.)

12974. **Apparatus for making secondary battery plates.** Albert Franklin Madden, 40, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 19, 1901, being date of application in United States.) (Complete specification.)

12975. **Secondary batteries.** Albert Franklin Madden, 40, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 19, 1901, being date of application in United States.) (Complete specification.)

JUNE 26.

12991. **Incandescent electric lamps.** James Swinburne, 82, Victoria-street, Westminster, London.

13010. **An improved telephone and bell set.** Max Byng and F. G. Bell, 69, Queen Victoria-street, London.

13017. **Recording apparatus for electrical measuring instruments.** Alexander Hill, 20, Smith-street, Hillhead, Glasgow.

13021. **The improved combined automatic clutch for electric arc or other lamps and safety hooking devices for ropo suspension gear.** George Joseph Philpott and George Herbert Alderton, 24, Stafford-road, Brighton.

13032. **Improved process for the reduction of ores or compounds by means of the electric current.** Hugh Alexander Irvine, 55, Chancery-lane, London. (Complete specification.)

13033. **A polyphase electric motor.** Siemens Bros. and Co., Limited, and Francis Lydall, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

13044. **A spark-spreading device for lightning arresters of electrical conductors.** Hans Adolf Bertram, 6, Lord-street, Liverpool. (Complete specification.)

13048. **Improvements in electrodes for accumulators.** Alberto Triblehorn, 18, Buckingham-street, Strand, London. (Complete specification.)

JUNE 27.

13078. **Improvements in electric accumulators.** George James Gibbs, 76, Heslington-road, York.

13129. **Improvements relating to electrical ignition devices for gas and similar engines.** James Hutchings, 45, Southampton-buildings, Chancery-lane, London.

13139. **Improvements in electric furnaces.** Edward James Duff and the United Alkali Company, Limited, 47, Lincoln's-inn-fields, London.

JUNE 28.

13159. **Improvements in resistance switches and automatic cut-outs for starting, protecting, and regulating electric motors and their circuits.** Joseph Edmondson, Penny Bank-chambers, Halifax.

13170. **Improvements in the brackets or guides of lightning conductors.** Joseph Nichols, Joseph Henry Nichols, and William Edward Nichols, 24, Temple-row, Birmingham.

13182. **Improvements in the manufacture of ornamental vases, bottles, and other ornamental vessels, electric switch-caps, and other articles.** Honley Deacon, Thomas Birkett, and Frederick George Faulkner, 128, Colmore-row, Birmingham.

13187. **Improvements in solutions to work electric and galvanic batteries.** José Baxeres de Alzugaray, Suffolk House, Laurence Pountney-hill, London.

13207. **An improvement in the manufacture of filaments for electrical glow lamps.** Henry Charles Gover and Augustus Charles Hyde, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

13231. **Apparatus for generating and utilising electric energy.** William Spiers Simpson, 166, Fleet-street, London.

13239. **Improvements in alternating-current motors.** Caspar Wüst-Kunz, 46, Lincoln's-inn-fields, London.

JUNE 29.

13247. **Improvements in and relating to switches for trolley wires or conductors of electric tramways or railways.** Walter Hugh Lamberton, 96, Buchanan-street, Glasgow.

13256. **A new and improved process for transferring several telegrams in both directions by means of a single wire.** Robert Scharf,, 31A, Luisenstrasse, Berlin, Germany.

13300. **Improvements relating to the manufacture of electrode plates of secondary electric batteries.** Albert Nodon, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Dec. 1, 1900, being date of application in France.) (Complete specification.)

13301. **Improvements relating to steam-engine telegraph and similar apparatus.** Edvard Arfelt, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 20.

1900.

5585. **Measurement of electric power and energy in three-phase alternating-current systems.** Arno. (Date applied for under International Convention, Aug. 26, 1899.)

11264. **Switchboards for electric distribution.** Hirst.

11340. **Electric clocks.** Fischer.

11358. **Secondary batteries.** Wollaston and Sherrin.

11519. **Frogs to be used in connection with overhead conductors of electrical tramways and railways.** Nicholson.

11787. **Electrical starting and regulating switches.** Hickley.

11835. **Electro-pneumatic controlling apparatus.** Hill. (Date applied for under International Convention, Jan. 13, 1900.)

11840. **Electric switches, commutators, current-conductor contacts, contact breakers, and other electric devices for preventing sparking.** Sherrin.

12160. **Manufacture of filaments for electric incandescence lamps.** Thomas.

12977. **Electric battery.** Francken.

13020. **Apparatus for generating dynamical electricity by means of the direct influence of steam.** Van Haanen.

13106. **Safety devices for electric interlocking or block signalling apparatus.** Hollins.

13482. **Collectors, conductors, and conduits for electric traction.** Bede.

13656. **Electrodes of accumulators and the manufacture thereof.** James. (Heilmann).

14906. **Sectional conductor street or road electric railways.** Milnes.

15473. **Process for the forming of electrodes.** Boult. (Andreas.)

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1901.

3823. Conduits for electric wires and cables. Ames.

8598. Accumulators or secondary batteries. Kloth, Bünning, and Kunhardt.

10733. High-potential electric switches. British Thomson-Houston Company, Limited. (Emmet and Hewlett.)

10737. Electric circuit breakers. British Thomson-Houston Company, Limited. (Stewart).

10848. Apparatus for winding coils for continuous-current dynamo and motor-electric machines. Tomkins.

10933. Joint and like boxes for electric cables. Tanner and Fawcus.

10975. Electrodes for electrolytic cells. Justice. (Castner Electrolytic Alkali Company.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	June 29	784	694	+ 90	—	—
Birmingham Tramways	,, 29	4,727	4,453	+ 274	112,828	110,909
Blackburn Corporation	,, 29	473	459	+ 14	12,056	11,000*b*
Blackpool Corporation	,, 27	911	729	+ 182	9,389	7,317
Blackpool-Fleetwood Tramways	,, 30	920	724	+ 196	9,937	10,126
Bolton Corporation	,, 30	1,575	1,363	+ 212	36,328	26,812
Bradford Corporation	,, 30	1,047	463	+ 584	18,092	10,843
Bristol Tramways Company	,, 28	4,743	3,148	+ 1,595	—	—
Carlisle Tramways Company	—	—	—	—	—	—
Central London Railway	,, 29	6,144	—	—	161,176	—
City and South London Railway	,, 30	1,868	1,490	+ 378	50,839	33,725
Cork E. T. and L. Company	,, 27	558	484	+ 74	10,949	9,547
Darwen Corporation	,, 28	198	151	+ 47	4,669	3,847
Dover Corporation	,, 29	239	213	+ 16	4,853	4,501
Dublin & Lucan Electric Railway	,, 29	119	129	- 10	2,460	2,337
Dublin U. T., electric cars	,, 30	†5,499	†4,858	+ 641	—	—
Dublin S. District, Electric	,, 30	†1,420	†1,344	+ 76	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 29	11,988	9,132	+ 2,856	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	,, 29	951	683	+ 267	11,561	8,562
Hull Corporation, E. S.	,, 29	1,645	1,239	+ 405	77,956	41,258
Liverpool Corporation	,, 22	9,166	8,248	+ 918	212,005	182,278
Liverpool Overhead Railway	,, 30	1,696	1,682	+ 14	40,981	37,502
Oldham-Ashton-Hyde Tramways	,, 21	504	494	+ 10	11,942	11,509
Portsmouth Corporation	,, 29	903	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 30	3,672	—	—	—	—
Southampton Corporation	,, 27	848	580	+ 263	—	—
Southport Corporation	—	—	—	—	—	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. † Nine days. *b* Since April 1 1900.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £363 increase.
Barcelona Ensanche y Gracia, £32 decrease. Barcelona, £464 decrease.
Brisbane, £204 increase.
Buenos Ayres and Belgrano Electric, £1,041 increase.
Calcutta, £155 increase.
Cape Town (month of May), receipts, £18,500; expenditure, £6,070.
Mexico Electric (month of May), receipts, £18,500; expenditure, £10,600.
Perth Electric, £262 increase.
Port Elizabeth (month of May), receipts, £3,299; expenditure, £1,818.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅞-⅞
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¾-⅞
—— Ordinary, 1-125,000	1 ..	⅝-¾
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	6-6¼
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4⅜-5¼
British Electrical Engineering, Ordinary	2 ..	1⅛-1⅜
—— Non. Cum., 6 per cent. Pref.	2 ..	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100 ..	103-108
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102 xd
Callender's Cable, Debentures	100 ..	107-111
—— Ordinary	5 ..	14-15
—— 5 per cent. Pref.	5 ..	5¼-6 xd
Crompton and Co.	3 ..	3¼-4
—— 5 per cent. Debentures	— ..	100-105 xd
Edison and Swan United, Ordinary	3 ..	1-1½
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	83-88 xd
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	94-98
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	100-103
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	15½-16½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	107-111
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	101-104
Telegraph Construction and Maintenance	12 ..	36-40
—— 5 per cent. Bonds	100 ..	101-104 xd
Telegraph Manufacturing, Ordinary	5 ..	10-11
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	10½-11½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6½-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-⅝
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	95-100
Bournemouth and Poole, Ordinary	10 ..	11½-12½
—— 4½ per cent. Cum. Pref.	10 ..	11-10
—— Debenture Stock, Red.	100 ..	101-104 xd
Brompton and Kensington, Ordinary	5 ..	7⅜-8¼
—— 7 per cent. Preference	5 ..	8½-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7½-7⅜
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5½-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	102-104 xd
helsea Electricity Supply	5 ..	5⅜-6½ xd
—— 4½ per cent. Debentures	100 ..	107-111 xd
ity of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	12½-13½
—— 5 per cent. Debenture Stock	100 ..	120-125 xd
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	100-102 xd
ounty of London and Brush Provincial, Ordinary	10 ..	8½-9½
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	103-106 xd
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5½-6
—— 6 per cent. Cum. Pref.	5 ..	5⅜-5⅝
—— 4½ per cent. First Mort. Deb.	100 ..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4⅜-5½
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5-5½
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7½-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11½-12½
—— 4 per cent. Debenture Stock, Red.	100 ..	102-105
Kensington and Knightsbridge and Notting Hill	100 ..	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10½
London Electric, Ordinary	3 ..	1½-1⅜
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13-14
—— ,, 85,001-98,769	5 ..	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	108-111
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	94-97
Newcastle-upon-Tyne Electric Supply, Ordinary	— ..	9-9½
—— Preference	4 ..	6½-6¾
Notting Hill Electric Lighting	10 ..	15-16 xd
Oriental, 1879	1 ..	1½-1⅜
—— £5 Shares	5 ..	6⅜-7½
—— £4½ Shares, New	4½ ..	5½-6
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5½-6½
River Plate Electric Light and Traction, Deb.	100 ..	65-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2½-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	9-10
—— 3½ per cent. Deb.	100 ..	97-100 xd
Westminster, Ordinary	5 ..	12-13
Electric Railways.—		
Central London, Ordinary	10 ..	9¼-9⅜
—— Pref. Half-Shares	5 ..	4⅜-5¼
—— ,, ,, deferred	5 ..	4⅜-5¼
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
ty and South London, Consolidated Ordinary	100 ..	54-56
—— Ordinary	10 ..	5¼-5⅜
—— 4 per cent. Debenture Stock	100 ..	112-117
—— 5 per cent. Pref. Stock '91	100 ..	132-137
—— ,, ,, ,, '96	100 ..	122-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	93-96
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4⅛-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	122-128 xd
Blackpool and Fleetwood Tramroad	10 ..	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¼-3½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	99-101
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6½-7
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.e.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	15-16
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-13
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1½-1⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5½-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5½
—— 5 per cent. Deb. Stock, Red.	100 ..	102-105
—— Prov. Cert., all paid	100 ..	96-99
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅜-2
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	98-102
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3½-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	104-106 xd
New General Traction, Ordinary	5 ..	3-3½
—— 6 per cent. Cum. Pref.	10 ..	4½-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	12-13
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	105-107
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	6s. ..	5/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	30 p.c. ..	30 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	3¼-3½
—— 6 per cent. Cum. First Pref.	10 ..	11-12
—— 6 per cent. Cum. Second Pref.	10 ..	11-12
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅛-4⅜
—— 4 per cent. Deb. Stock, Red.	100 ..	94-97 xd
—— 3½ per cent. Deb. Stock, Red.	100 ..	87-90 xd
Oriental Telephone and Electric Company	1 ..	½-1

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NOTES.

Artificial Electric Fountains. We understand from an Italian contemporary that one M. G. Trouvé has devised a method of obtaining effects from an ordinary fountain comparable to those of an electric fountain. He uses glass beads, rice, small celluloid balls, etc., and a jet of air blown by a centrifugal pump as a means for keeping them in motion. When these objects are projected through a jet by the stream of air and illuminated, magnificent effects are said to be produced.

Ball-Lightning.—A novel explanation of ball-lightning, a phenomenon familiar in the tropics, is offered by Mr. Hesechus, a German electrician, who has recently been interesting himself in the subject. He has come to the conclusion that this electrical display is due to the combustion of masses of nitrogen, and he has devised an apparatus by which, with the aid of an alternating 1,000-volt current and a vessel of water, he can give a fair reproduction of the phenomenon.

British Patents in the Colonies.—In the House of Commons a few days ago Sir John Leng asked the President of the Board of Trade whether he had been informed that measures were in preparation for the placing of patents and inventions under one uniform administration throughout the Australian Commonwealth, and whether he would consider the practicability of co-ordinating the law and regulations respecting patents and trade marks in Australia, New Zealand, and Canada with those of the United Kingdom, so that British patents might run throughout the Empire. Mr. Gerald Balfour's reply was to the effect that he had no information on the points mentioned. It rested with the Governments of the self-governing Colonies named to frame their laws and regulations. It would be difficult to make the patent laws uniform throughout the Empire.

Reciprocating Electric Pump.—A patent was recently granted to one L. J. Le Pontais, of Pittsburg, Pa,. in respect of a unique apparatus for obtaining a reciprocating motion with an electric current for direct operation of an ordinary pump. This is accomplished by causing an electrical conductor to be reciprocated in an unipolar magnetic field by the action exerted on the flux surrounding the conductor by the flux of the stationary field, the reciprocating motion of the conductor being obtained by reversing the current passing through the conductor. A standard, after the style of that of the steam pump, engages with tappets at the end of a stroke in either direction, and so moves a rod to which is attached a contact mechanism which makes the necessary reversals of current. In order to avoid sparking during the breaking of contact, the box in which the contact mechanism is placed is filled with glycerine.

Velocity of Waves along Wires.—The digest of the *Electrical World* for the 22nd ult. contains an abstract of a paper by Barkla, giving an account of experiments in which the Rutherford detector was used in measurements of the velocities along wires of various diameters and materials. The author first made experiments with copper wires of different diameters, and found that the wave-length decreases very slightly with decreasing diameter; further, that the diminution of velocity in the finer wires is greater with higher frequency. The effect of increasing the specific resistance of the material of the wire was shown by comparing the wave-lengths, corresponding with the same frequency, along wires of the same diameter but of different material. The comparison was made between platinum and copper, the specific resistances of which are in the ratio of 7 : 1 approximately. The velocity of electric waves along platinum wire of diameter ·0158cm. was less than the velocity along copper wire of the same diameter by about 0·4 per cent.

Prof. Lodge's Induction Telegraphy.—We recently gave publicity in these columns to a report that a private company would be formed to work the patents granted to Prof. Oliver Lodge relating to induction telegraphy. The rumour turns out to be correct. On the 29th ult. the "Lodge-Muirhead Wireless and General Telegraph Syndicate, Limited," was duly registered with a capital of £50,000 in £1 shares, with the object, among other things, "to acquire from Oliver J. Lodge, F.R.S., and A. Muirhead, D.Sc., the benefit of existing inventions relating to telegraphy and telephony, and to carry on the business of telegraph, mechanical, and electrical engineers," etc. The number of directors is to be not less than three nor more than seven. The first are Messrs. Alexander Muirhead, Henry J. Muirhead, and F. Lander Muirhead.

Subterranean Wireless Telegraphy.—The possibilities of using the earth's strata instead of air for transmitting messages by wireless telegraphy are, we learn, now being enquired into by a specially appointed commission on behalf of the French Government. The head of the commission is M. Villot, Inspector General of Posts and Telegraphs in France, who is responsible for the statement that aerial wireless telegraphy cannot give entirely satisfactory results, as experiments have been proved to vary with the atmospheric conditions. Again, the horizon remains an insurmountable barrier for long-distance messages, even with relays. On the contrary, certainty can be obtained in pouring into some known subterranean layers sufficient power to reach a desired spot, where perfected apparatus will receive the message. It is understood that the first duty of the commission will be a thorough study of the earth's strata, which, according to the latest geological researches, are at present imperfectly understood.

Refraction of Electric Waves.—The issue of *Science Abstracts* for June contains an abstract of a paper by Mr. G. Pierce on this subject. By means of a modification of Boys' radio-micrometer the author has measured the refractive indices of paraffin, ebonite, and various specimens of wood. The movable coil of the apparatus is traversed by thermo-electric currents produced by electric waves impinging upon a knot of fine platinum and platinum-nickel wire and heating up the junction. The measurements of refractive indices were made by observing the distance by which the interposition of a known thickness of the dielectric displaces the nodes of a stationary wave in air. The arrangement of apparatus for obtaining the stationary wave is essentially that of Lloyd's mirror for perpendicular incidence, the succession being radio-micrometer, oscillation, dielectric, and metallic mirror. The refractive indices of paraffin and ebonite for waves 4·4cm. long were found to be 1·56 and 1·75 respectively. All the woods examined showed double refraction, black walnut, with indices 1·70 and 1·49 respectively, showing the largest divergence. The author shows from theoretical considerations that it is a case of true double refraction, and not an appearance due to differences of absorption.

Traffic Comparisons.—The peculiarly similar conditions existing between the Paris Metropolitan Railway and the Central London Railway conveniently lend themselves to a comparison of the results of the operation of the two lines. The latest published reports show that at first the "twopenny tube" took the lead in daily passenger traffic, the figures being about 80,000 for London and 45,000 for Paris. During the Paris Exhibition, however, things were reversed, the figures standing at 85,000 for London and 105,000 for

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Paris. By December last, however, the London traffic had increased to a daily total of about 100,000, but was still surpassed by the Paris Metropolitan, which at the close of that month passed as many as 130,000 passengers a day. The mean daily totals of passengers from the beginning of August to the close of December, 1900, were for London 92,910, and for Paris 103,930, while taking the months since the close of the exposition, the corresponding averages were 97,440 for London and 115,232 for Paris. In round numbers it is estimated that there will be 40,000,000 passengers per year in Paris, and 33,000,000 in London. While, however, Paris greatly excelled London in passenger totals, the daily receipts of the Central London Railway have kept steadily ahead of the Paris line. In London the daily receipts have averaged £844, as against £817 in Paris. No doubt this difference in the receipts is due to the fact that on the London "tube" the fare is 2d. for any distance, while in Paris the price varies from 1d. to 2½d., according to class.

German Electric Tramways. — Statistics have recently been published showing the position of the various cities and towns in Germany on Sept. 1 last year in regard to electric tramways and light railways. Altogether, on this date no less than 99 German cities had electric tramways in existence, and it is estimated that on Jan. 1 this year there were 107 cities in this position. As showing the rapid growth which has been made in this direction in Germany in the last decade, we may mention that the number of cities having an electric tramway system in 1891 was three; in 1895, 32; and in 1899, 88. The last year, besides bringing this total up to over 100, has also witnessed a very large extension of existing systems. The length of track on Sept. 1, 1900, was 1,793 miles, against 1,280 miles in 1899. The number of motorcars was 5,994, as compared with 4,504 the year before; and of trailers 3,962 against 3,138. The aggregate power of the electrical plant was 75,608 kw., as against 52,509 kw. in 1899. Whereas the power of the accumulators in 1899 was 13,532 kw., this figure stood at 16,890 kw. on Sept. 1 last year. The system of overhead trolleys is used almost universally, the combined system of trolleys and accumulators not proving satisfactory. There are, however, three cities in Germany which have some short lines with underground conduits—viz., Berlin, Dresden, and Dusseldorf—while only three lines use accumulators exclusively.

Electric Tramway Enterprise in New Zealand. While to Dunedin belongs the honour of being first in the field in the introduction of electric tramways into New Zealand, the town of Auckland is not far behind, and the work has already been commenced of converting the existing lines and constructing large authorised extensions for electric traction. Although for years past the communication between the different parts of the town has more or less been successfully maintained, partly by horse tramways and partly by an omnibus service, the advantages of electric traction were so apparent, especially on account of the climatic conditions and the hilly nature of the district, that some two years ago a company was formed for the purpose of carrying out the change. The length of the lines and extensions will, it is stated, be just upon 19 miles, including some miles of line outside the city. The conditions of purchase are that in 32 years' time from June, 1900, the Corporation may buy the tramways as a going concern, without, however, any allowance for goodwill; while purchase before that date can only be effected upon terms to be mutually agreed. The population of the city of Auckland, including the suburban districts, is about 70,000 (exclusive of Maoris), and no fear as regards the profit-making qualities of the concern is entertained. An estimate puts the net revenue from the whole undertaking per annum at £36,000, and after paying the Corporation its legal share of the profit and providing for depreciation and debenture interest, this will leave £22,000. The authorised capital of the company is £300,000. The lines within the city and the most important extensions outside are expected to be in electrical operation early next summer.

Advantages of Electric Traction.—An instructive article on the experiences of six French tramway systems which have lately changed over from animal to electric traction appeared in a recent issue of *Le Genie Civil*. The most prominent feature of the substitution of electric traction for animal traction would appear to be the large increase in the number of passengers carried. In the cases in point this varied from 37 to 209 per cent. The frequency of traffic is one of the most telling causes for the popularity of the electric roads. When a line is overloaded with passengers the receipts increase in proportion to the number of cars in service, but after reaching a certain point the increase in receipts grows less than the increased frequency of service. Nevertheless, when the operating expenses are small, it is profitable for the road to pass this point and increase the service so long as the extra receipts exceed the extra expenses. With electric traction in particular, says the article, a railway is not being worked to the best advantage until the activity of circulation is such that each car carries only a few passengers. The increase in gross receipts on the French lines varied from 49 to 158 per cent. The receipts per car mile showed a decrease varying between 9 and 24 per cent. The decrease in operating expense sper car mile carried, was between 15 and 35 per cent. But owing to the much greater number of car miles with electric traction, the total operating expenses increased. This increase varied between 36 and 90 per cent., but was in every case less than the increase in gross receipts, so that there was a gain in the net receipts varying between 136 and 1,035 per cent.

Transmitting Pictures by Wireless Telegraphy.—The issue of *Electricity* for the 26th ult. records some successful experiments which have recently been made in New York in transmitting pictures by wireless telegraphy. The tests were carried out with a system devised by Mr. E. A. Hummel, which consists in first tracing through a carbon paper upon a metal plate the picture to be reproduced. The lines thus obtained are then brought out prominently by means of some non-conducting solution, as, for instance, shellac. This prepared picture is then wrapped around a cylinder, against which lightly rests a platinum point connected in circuit. The receiver differs little from the transmitter, except that in place of the picture the cylinder contains a sheet of carbon paper between two sheets of blank paper. In the case in question the transmitter was located at a distance of 15ft. from the receiver with an 8in. brick wall between. As the transmitting cylinder revolved whenever the styles touched the shellac it caused the closing of the induction coil circuit, with the result that an electric wave travelled to the receiving apparatus, causing it to respond. The greatest difficulties which had to be contended with were in overcoming vibration in the registering styles, and in regulating the coherer to the precise degree of sensitiveness necessary to secure good results. Further experiments were also made in the lighting of incandescent lamps at a distance, which, according to our contemporary, was successfully accomplished by means of a mechanical motor used in conjunction with the receiver of the wireless apparatus. With regard to the practical application of this device some encouraging experiments have already been conducted at

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Tompkinsville, on a larger scale, in connection with the offshore lights and beacons in the coast lighthouse service.

Electrolytic Ore Smelting.—A report has recently been issued by the British Consul at Milan on a new process of electrical smelting, which has lately been experimented with in Italy. The report states that the process—known as Captain Hassano's—is claimed to be economic. The tests were begun in Rome, but lately have been carried on under Captain Hassano's personal superintendence by a company formed for the purpose at Darfo, in the province of Brescia, where a valuable water power is available. In the first place, the ore is reduced to powder and then mixed with a certain proportion of powdered coal or charcoal, which is necessary for the production of carbonic acid gas. For binding purposes from 5 to 10 per cent. of vegetable tar is added, and by subjecting the mixture to hydraulic pressure it is said to be effectually caked together. This is then cut into pieces of from 1½in. to 2in. square, which are put into the furnace. The smelting is brought about by intense heat produced by a voltaic arc. The consul further reports that at the end of last January a commission, composed of five well-known scientific men, witnessed a series of experiments with this process, and that they have reported that they consider the Hassano process to be industrially practical. The opinion is held in other quarters, however, that, as yet, no adequate proof has been furnished that the new system will not cost more, rather than less, than the one actually in use. Moreover, its application with any prospect of success appears to be dependent on the possession of a very abundant water power at very low price for the production of the electrical energy, the consumption of which is said to be enormous. All things considered, concludes the consul, it would appear to be unadvisable to adopt Captain Hassano's process until the possession of the advantages claimed for it have been much more clearly demonstrated.

An Electrically-Operated Dry Dock.—New York is now in possession of what is claimed to be the largest and most efficient electrically-operated floating dry dock in the world. From an illustrated description of this floating dry dock in our contemporary the *Electrical World*, we gather that it at present consists of five sections or pontoons, and has a total length of 500ft. Eventually, however, the dry dock will be between 700ft. and 800ft. in length. The operating power throughout is electricity, the motors being of the induction type, and the pump of the centrifugal pattern. Each pontoon, which has the shape of a V, is 80ft. long by 120ft. wide, and has a depth of 15½ft. at the centre. The two wings at each side measure 56ft. from the bottom of the pontoon to the top platform, and on the floor of each wing is situated a centrifugal pump with three suction pipes, two extending towards the two end chambers and one to draw the water out of the central one. The pumps, which were especially manufactured for this dock by the Prindle Pump Company, have a capacity of 5,000 to 6,000 gallons of water per minute. Each pump is connected by means of a vertical shaft to a 75-h.p. General Electric induction motor, housed in at the top of the pontoon about 50ft. above the pump. Three-phase current at 6,600 volts and 25 cycles to operate these motors is supplied by the Edison Electric Illuminating Company, of Brooklyn. It is led to three 300-kw. General Electric air-blast transformers connected up in delta and located in a transformer house, where it is transformed down to 240 volts. From the transformers the current is led to the switchboard, consisting of six panels. The motors on the pontoons are controlled entirely from this board, and drive the pumps at a speed of 250 revolutions per minute. The lighting of the dock is effected by arc lamps located on the top platforms, and for this purpose two-phase 60-cycle 2,500-volt current is furnished by the Edison Company. The electrical method employed for operating this dock is said to be extremely efficient, and one which has never before been used.

Plans—Post Office Requirements.—At the St. Pancras Town Hall, on Monday, a conference of representatives of the London municipalities was held concerning the recent requirements made by the Postmaster-General with regard to being supplied with plans to a scale of not less than 10ft. to the mile, showing the exact position of the electricity mains, etc., laid or proposed to be laid in the public thoroughfares. The Mayor of St. Pancras, having been elected to the chair, welcomed the conference to St. Pancras on this very important occasion. Mr. Sydney W. Baynes, the borough electrical engineer, then explained the nature of the requirements of the Postmaster-General. At the present time, the scale on which the Post Office was being furnished with plans of electricity mains in the streets was 5ft. to the mile. Now the request was made not only that plans should be prepared to a scale of not less than 10ft. to the mile, but that they should show the "exact" position of the mains. As the conference would see, it was a practical impossibility to comply with this last condition on a 10ft. plan, which would, therefore, be no more serviceable than a 5ft. plan. Mr. R. Hammond agreed that even with the extended scale the exact locality of the mains could not be defined. From the point of view of expense alone plans to a scale of 10ft. to the mile would cost the borough councils which have their own electricity undertakings on an average close upon £100 a year, and he thought the requirements of the Postmaster-General were unreasonable, and would serve no useful end. Similar views were expressed by other members of the conference, Mr. Baynes stating that the only reason given by the Post Office for the proposed change was that some of the electric light companies were supplying plans to the extended scale. A long discussion ensued as to the nature of the action to be taken in the matter, and ultimately nine members of the conference and the chairman were appointed to wait upon the Post master-General with a view to obtaining a modification of his requirements.

A Light Electric Automobile.—In a recent issue of the *Scientific American* there appeared a good description of a new two-phase electromobile of the Krieger type. In this system the front wheels turn at the end of a fixed shaft, and each is driven by a separate motor with reduction gearing, thus doing away with the differential, and making a less complicated arrangement. The great feature about this machine, however, is that it has been made to overcome the objection that an electromobile must necessarily be heavy on account of the weight of the accumulators. Another point which is of the utmost importance is that the vehicle in question will, it is claimed, cover a considerable distance without recharging, and its average speed is somewhere near that of a petroleum automobile. The front axle is fixed, and supports near the wheel an electric motor of 3 h.p., which is entirely enclosed by its circular casting and end pieces. Each wheel is turned independently by its own motor. The accumulators are contained in a box which is fixed in the truck below the carriage body, and so arranged that it may be easily slid out from the rear. The batteries are of the Fulmen type, and have a total weight of 800lb., allowing a run of at least 65 miles on a single charge. The two motors, each of 3 h.p., give a total of 6 h.p. for the machine, which enables it to climb heavy grades without injuring the motors. The total weight of the machine, including 800lb. of accumulators, is only

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1,700lb., of which the motors represent 220lb. The mean speed on a level grade is 21 miles an hour, or 12 to 15 miles over an average road. The controller of the Krieger type has the advantage that the steering wheel and controller are mounted in a single device, and the whole direction of the machine is brought to one point. The electric braking action is effected by placing the motors in short-circuit, thus giving a powerful brake upon the front wheels. In addition to this, the rear wheels carry a band-brake. Mr. Krieger claims to have solved the problem of a light electric automobile, and the present vehicle is the result.

Dielectric Losses in Condensers.—Mr. Charles Proteus Steinmetz contributes to the *Electrical World* of New York an article in which some highly interesting conclusions on this subject are given. The experiments were carried out with condensers, which are said to be among the most efficient electric storage devices known, wasting only about the $\frac{1}{200}$th part of the power which they temporarily store, as measured in volt-amperes. The power factor, also, is practically independent of the frequency, from which it follows that the power expended increases directly with the frequency, and in the same proportion as the apparent power. The power per cycle is, therefore, constant for a given constant sinusoidal impressed voltage. And just as the hysteretic loss of iron is known to be constant per cycle for a given range of magnetic induction, whereby the hysteresis loss is in direct proportion to the frequency, so the dielectric hysteresis appears to be a definite quantity per cycle and to increase in proportion to the frequency. Moreover, the loss of power increases as the square of the E.M.F. applied to the condenser, just as in the case of power thermally lost in a resistance. This is different from the case of magnetic hysteresis, which varies approximately with the ·6 power of the flux density, indicating that the physical natures of magnetic electrostatic hysteresis are probably fundamentally dissimilar. The subject of the virtual dielectric resistance or virtual dielectric conductance is of great practical importance in subterranean cables for the transmission of power. It is quite possible that a cable having a relatively large virtual dielectric resistance or relatively large power factor might have a relatively low conductor resistance, and yet waste a comparatively large amount of power in the course of a year in its dielectric, just as though it had a greatly reduced cross-section of conductor, and expended the heat under load in the metal. In other words, the author's conclusion is that a small-conductor cable with a low power factor, in connection with a high-tension alternating-current system, might be as expensive in power and coal as a large-conductor cable with a large power factor.

London County Council Tramways.—The Highways Committee presented an interesting report at this week's meeting of the London County Council on the subject of the extensive tramway schemes which the Council have in hand south of the Thames. As announced in our last issue, the work of reconstructing the tramways for electric traction, when once commenced, will occupy considerably less time than the erection of the electricity generating station, and under these circumstances, and especially having regard to the saving in the cost of working which will be effected by the substitution of electrical for horse traction, it is proposed to make temporary arrangements for the supply of the electrical energy necessary for working the tramways after their reconstruction. The South London Electric Supply Corporation have a generating station near Loughborough Junction railway station, and the committee's proposal is that an agreement should be entered into with the company for the erection of a temporary generating station on the company's land to serve the tramways. In this building would be installed two 2,500-h.p. continuous-current sets of generating plant and auxiliaries, while two of the Stirling boilers, for the supply of which the Council have already entered into a contract, would be temporarily placed in the company's boiler-house. By this arrangement it is estimated that the cost to the Council over and above the prime cost of the engines, boilers, etc., would be about £10,000, but that this sum would be more than met by the profit derived from the electrical working of the tramways being accelerated. The company is willing that the generating plant referred to should be worked by a staff in the employ of the Council, the company supplying steam power and being paid at the rate of 1·4d. per unit of current generated. It is estimated that the cost of working the lines under this temporary arrangement would be ¼d. per mile more than if the Council were in a position to commence the working of the tramways from its own generating station as soon as they were reconstructed. But even taking this into account, it is estimated that the extra profits arising from the substitution of electrical power would probably be £25,000 a year. We may, therefore, expect to see the Council's tramways south of the Thames in electrical operation in about 18 months' time.

The Ganz System.—In view of the attention which has of late been directed to the Ganz system of electric traction, both in this country and on the Continent, an illustrated description in the *Scientific American* for the 29th ult. of the electric line which has just been completed by Messrs. Ganz and Co. at Valtellina has especial interest. Starting from Milan, the Valtellina line runs to Chiavenna and Sondrio, and is some 38 miles in length. The high-tension lines deliver the primary current of 20,000 volts to nine stationary transformers, which feed the current to the trolley wires and earth-rail as three-phase current at 3,000 volts. Current is generated at Morbegno between the Colico-Sondrio branch, hydraulic power being used to develop electrical energy. Three turbines, each of 2,000 h.p., are directly coupled with three-phase generators, which supply the primary current of 20,000 volts Without passengers a car weighs 50 tons, including the motors. The freight locomotive motor weighs 3·8 tons; its rotor about 1½ tons. The car motors weigh 3½ tons approimately Each cascade pair of these motors develops a full-load horse-power of 150, while the high-tension motor itself, when running at full speed with the low-tension motor cut out, yields about the same horse-power. The current generated at the central station has a frequency of 15 per second. When running synchronously the high-tension motors make 300 revolutions per minute. In the rotor of the same motor the periodicity of the induced currents varies according to the slip. During the start, when the high-tension is switched into cascade connection with the low-tension motor, after the speed has risen to half speed, or 150 revolutions per minute, above which speed the cascade connection ceases, the periodicity of the currents in the rotor of the high tension and in the stator of the low tension is about 7½ per second. The speed of the locomotive motors is 125 revolutions per minute. The Valtellina locomotive motors are not geared in cascade; they are all high tension. The passenger trains are intended to make a speed of about 37½ miles an hour, while the electric locomotives, which will be exclusively used for hauling freight trains, will attain a speed of about 18½ miles an hour. The line will very shortly be opened for the public service, and it will be most interesting to watch the results obtained both as regards the electrical and commercial merits of the system.

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More Wireless Telegraphy.—Saturday evening last witnessed the official installation of a wireless telegraphy station which has been erected in the grounds of the Earl's Court Exhibition by the Bouverie-street Engineering and Electrical Works Company. The system which is being experimented with here is the invention of Mr. Arthur T. M. Johnson, the novelty claimed being that it dispenses with the poles which play an important part in the Marconi system. In this device, a disc fitted with reeds of different vibrations is attached to a coil, and a message sent from the transmitter in vibrations of a given reed can only be turned to account by a receiver tuned to the like rate of vibration. The number of reeds can be varied at will to an almost indefinite extent. But with every change the receiver must be properly regulated so as to harmonise. It is said that the new system has been tested successfully over a distance of two or three miles, but that much longer distances will shortly be obtained. Another point claimed for the invention is that messages are capable of transmission by the system through the earth as well as through air and water. Again, in wartime the inventor states it would be impossible for the enemy to tap the messages, as each ship or station, as the case might be, would have a different reed vibration allotted to it, and the reeds might be changed from time to time. We understand that the invention has been brought to the notice of the Admiralty. While on the subject of wireless telegraphy, we may refer to another new system which has just been experimented with at Vésinet on the Saint Germain-en-Laye road, the experimenters being Colonel Pilsoudski, an engineer officer in the Russian army, and Mr. Victor Popp, the French electrician. Again, in this device, no tall masts are required, and it is stated the electric waves follow the surface of the earth. Simplicity would appear to be the great feature of this system, it being claimed that four men can establish anywhere a telegraph station within an hour. The apparatus consists of two electrodes, the distance between them varying according to the distance of the place with which it is desired to communicate. The negative is placed on a sheet of glass on the surface, while the positive is buried some five yards below the surface of the earth. These two electrodes are connected to the transmitting apparatus. The same arrangement followed at the receiving station, it is claimed, ensures the safe dispatch and registration of messages.

Electric Plant Design.—Some useful advice on the design and construction of electric plants was recently given in a paper by Mr. Bion J. Arnold before the Engineering College University of Illinois, U.S.A. The chief points which were brought to the notice of the members on this occasion are set out in the *Street Railway Review* for June, from which it would seem that the first items to which attention must be given in the design and erection of an electric power plant are these: kind and cost of fuel and its accessibility; water, the quality and quantity required; the location so as to have a good water supply; the character of the soil on which the building is to be erected should be good, uniform hard clay or sand; and the kind of building required, which when erected would be a firm and substantial structure. Other features of almost equal vital importance are the cost of the real estate on which the power plant is to be erected, and the character of the electric supply service which it is to render. With regard to the power-house, it should be in general located as near the centre of distribution as possible. In many cases the location of the power-house is a problem of real estate values, and reduces to the question of how to build with the least amount of money. As to the kind of service required, the author states that central stations for electric supply to immediate neighbourhoods are chiefly wanted to supply direct current at 110-220 volts or 250-500 volts for lighting, power, and traction service. An auxiliary storage battery is now almost universally used in the United States for equalising and balancing the direct-current supply by the three-wire system, as well as to carry the load peaks. The question of direct or alternating current distribution from the sub-station is one of great importance. For general supply in the heart of a city the direct current has many advantages. For transmission to outlying districts and interurban work the alternating current has shown itself to be the most suited. But whether for direct or for alternating current supply, the use of direct-connected generating units is to be preferred in plants of considerable magnitude. Another interesting point is that from 15 to 25 per cent. in fuel may be saved by the condensing of the exhaust steam, which is now practicable even with a limited supply of water by the pond and self-cooling condensing systems and cooling towers, and from 8 to 10 per cent. by the use of an economiser for heating the feed water by the escaping chimney gases.

The Induction Motor.—Mr. Ralph D. Mershon has a very interesting article on the induction motor in the *Electrical World* for June 8. As to the misunderstandings concerning the induction motor, which the author regards as surprisingly numerous, most appear to be due to an entire lack of knowledge of its principles, or to a mistaken idea that this piece of apparatus—unlike all other electrical apparatus—admits of little flexibility of design. One of the fallacies with respect to the induction motor is that it is inefficient in starting torque. In point of fact, says Mr. Mershon, the starting torque of this type of motor may be designed for any value within reason, and it is usually several times the full-load torque. As to disturbing effect in starting up, this is also shown to be largely imaginary. When a sudden demand is made upon an energy supply system, a temporary disturbance is necessarily created corresponding to the extent of the momentary demand, but this fact has not influenced the installation of direct-current motors, and can also be dismissed in relation to the induction motor. Another widespread fallacy is that the power factor of the induction motor is necessarily low, whereas this factor can be controlled by the designer within wide limits. Recent requirements of a power factor of ·92 have been met by the manufacturers, and a power factor as high as ·96 has been realised. Mr. Mershon then goes on to discuss the power factor in its bearing on operation. This side of the subject has been particularly clouded, but, as pointed out by the author, the consumer can dismiss the matter as one in which he has little or no concern, the problem being one for the plant engineer, who can always find the necessary solution. The power factor bugbear has doubtless led to the advocacy of the synchronous motor for use in cases where otherwise it would not be considered, but while this type of motor has its field, cogent reasons are given why it is not suitable for general power service. Should the field excitation not be kept at exactly the right point, this type of motor will introduce a disturbing influence which can greatly aggravate the evil which it has been installed to overcome, through giving rise to the equivalent of a power factor. Again, the synchronous motor may possess the equivalent of a power factor in another respect unless its curve of E.M.F. coincides exactly with that of the supply circuit; for should this not be the case, there will be an exchange of idle current between the motor and the line. Moreover, should the synchronous motor have an E.M.F. curve corresponding to that of the line at one excitation, this correspondence may not exist at higher or at lower excitations.

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LUTON ELECTRICITY WORKS.

Another addition to the already long list of municipally-owned electric lighting plants has to be recorded, Luton having successfully inaugurated a regular supply of electricity from its newly-completed works on Wednesday last. The history of the undertaking may be briefly stated as follows

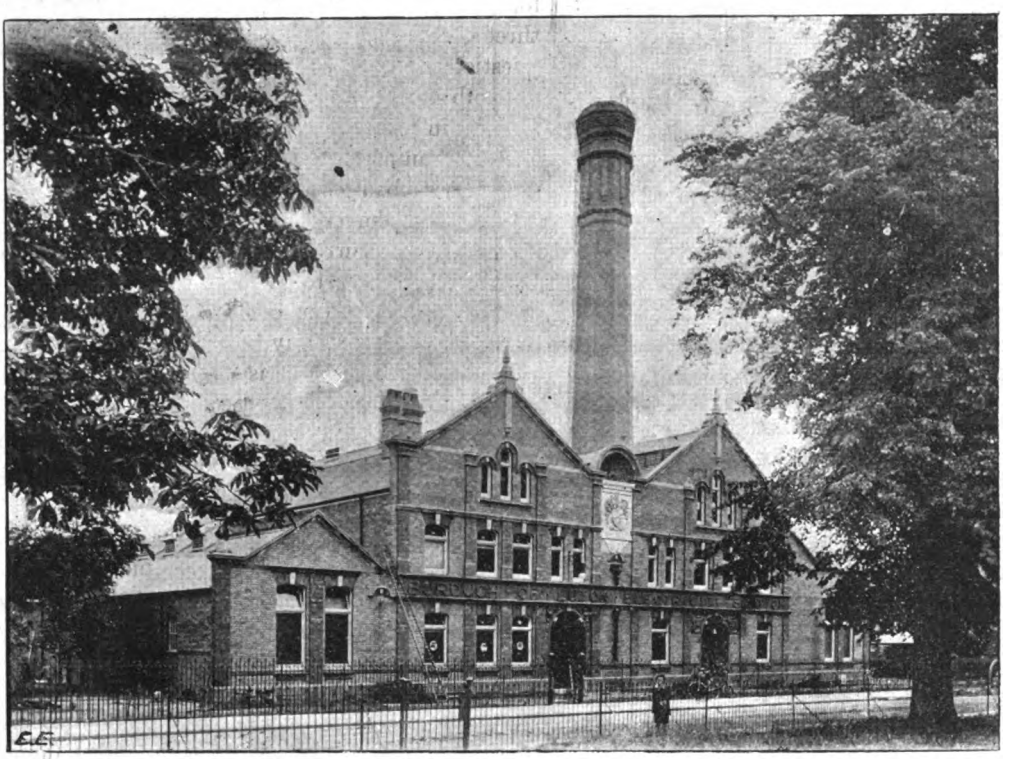

FIG. 1.—Exterior View of the Station Buildings, Luton.

The Borough Council of Luton obtained a provisional order for lighting the town by electricity in 1895. In 1896 the Electric Lighting Committee conferred with Mr. Albion T. Snell, M.I.E.E., A.M.I.C.E., consulting engineer, and a sub-committee was appointed, which visited a number of electricity works. In April, 1897, Mr. Snell was requested to report fully on the lighting of the town, in conjunction with the erection of a dust destructor, and also the introduction of electric tramways at a future date. His report in favour of a low-tension direct-current three-wire system of generation and supply was finally approved by the committee and confirmed by the Town Council in June, 1898, and the following month he was formally instructed to prepare the necessary specifications and plans. Tenders for plant and buildings, amounting to £26,000, were accepted by the Corporation provisionally in 1899, and the

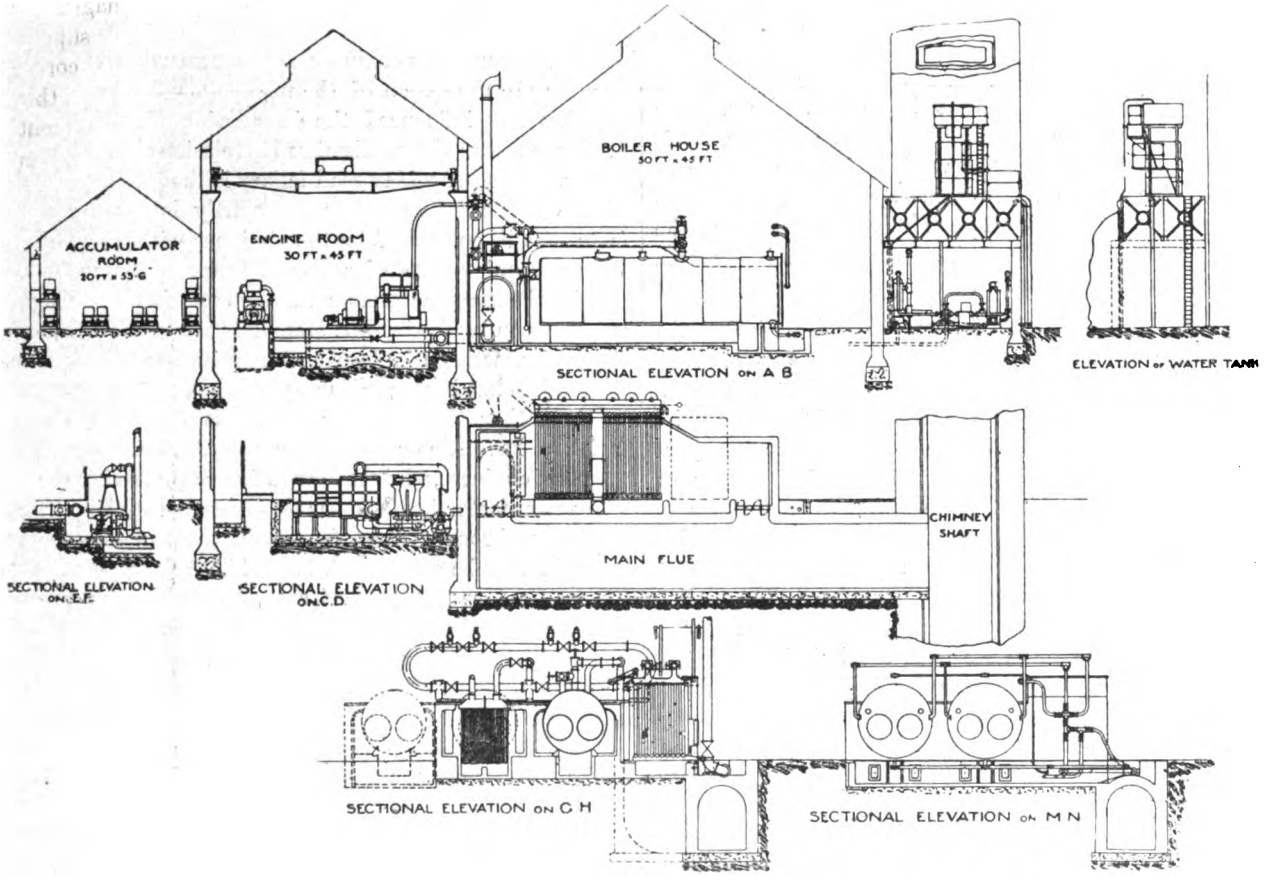

FIG. 2.—Elevations of Station Buildings and Plant, Luton.

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work of erecting the generating station buildings was commenced in the summer of the following year. Application had previously been made to the Local Government Board for sanction to a loan of £27,000, and duly granted.

The station is conveniently situated on the old vicarage site, adjoining St. Mary's Parish Church and near the River Lea. The provisional plans of the buildings were prepared by the consulting engineer, and the buildings were erected by the borough surveyor, Mr. A. J. L. Evans, A.M.I.C.E., who prepared the necessary designs and acted as architect. The elevation which faces St. Mary's Church is in Luton grey brick, with pilasters of Ibstock red facings and Bath stone stringcourses, neckings, and cappings. The front extends 122ft., and is of very pleasing appearance, as shown in Fig. 1. The engine and boiler rooms are parallel to each other, and permit of ample extension towards the river. The first plant is designed so as to be practically self-contained and independent of future extensions, so that in the event of accident from fire or otherwise the first plant of about 1,000½h.p. can be separated from the larger units, which will follow in due course. The floor of the engine-room is laid with slabs of artificial stone, and the walls are lined with glazed brick to the underneath side of the girders supporting a six-ton traveller. Both engine-room and boiler-house have skylights throughout their length, with ventilators on each side. Figs. 2 and 3 show the general arrangement of the buildings and plant. The chimney shaft is octagonal, with a square base. It is 120ft. high above ground line, with a minimum internal area of 60 square feet. The firebrick lining is carried up for about 40ft. The capacity of the shaft with natural draught is fully equal to 2,000 h.p.

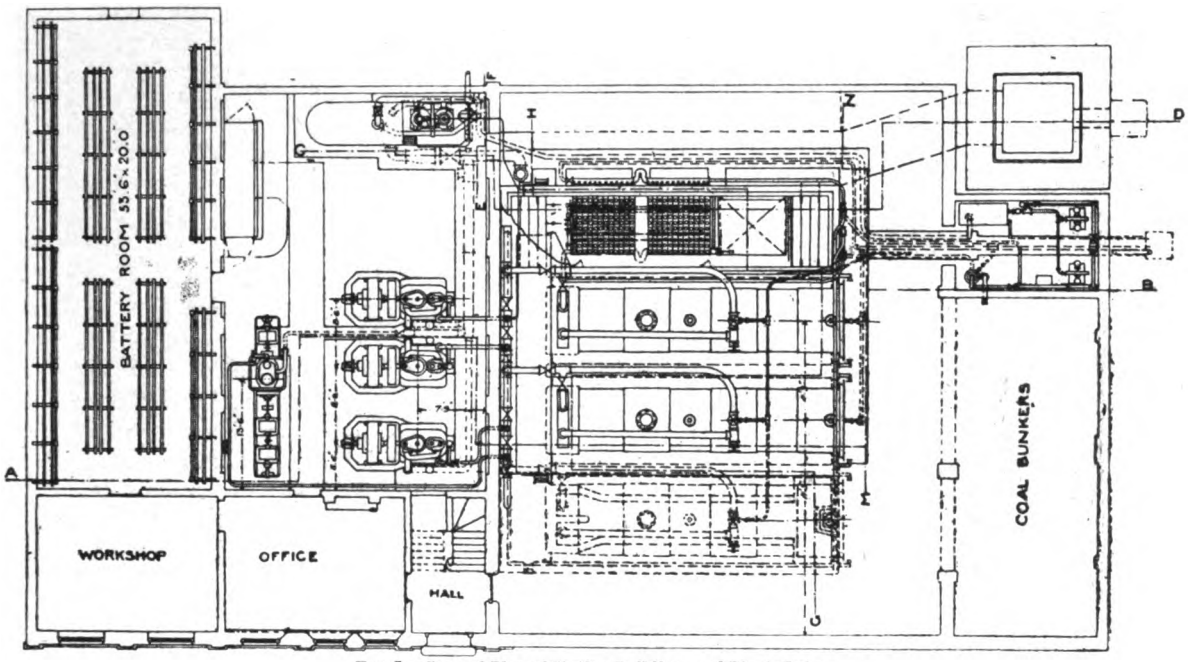

FIG. 3.—General Plan of Station Buildings and Plant, Luton.

Two Lancashire boilers (Fig. 4), by Messrs. Tinkers, Limited, have so far been fixed, each being 8ft. diameter by 30ft. long, fitted with two internal furnaces 3ft. 3in. in diameter, each flue being reduced to 2ft. 9in. at the back of the boiler. There are no cross tubes. The boilers are built for a working pressure of 160lb. per square inch, and have been tested hydraulically to a pressure of 280lb. per square inch. There is a main vertical steam-ring 8in. in diameter, with 7in. branches to the boilers in the lower members, and branch pipes to the engines from

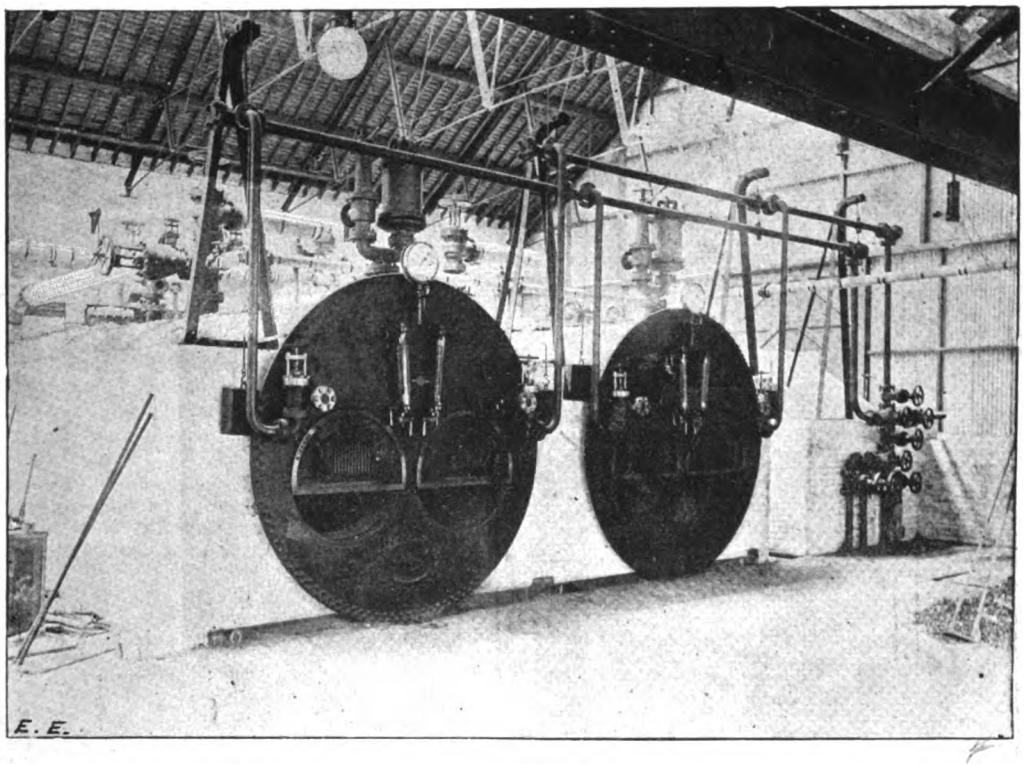

FIG. 4. Boiler-House Plant, Luton.

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the top member. A Musgrave superheater is fitted to each boiler. Space is provided for a third boiler. In the main flue (see Fig. 2) there is a Green's economiser of 240 tubes, capable of raising 15,000lb. of water per hour from 60deg. F. to 212deg. F., space being provided for a further 120 tubes. The scrapers are worked by an electric motor through worm gearing. The coal bunkers are in line with the boilers, and open on to the firing platform. For the time being the boilers will be hand-fired, but provision is to be made for mechanically handling the coal. The main exhaust pipe from the engines is 12in. in diameter, and is laid in a culvert under the engine-room floor. The exhaust steam is passed through a Wright-Berryman's patent surface condenser, capable of condensing 10,000lb. of steam per hour with a vacuum of 25in. of mercury, or it can be taken direct to atmosphere through a Blake and Knowles automatic valve. The air-pump is of Edward's type, with two cylinders coupled to a compound engine. The circulating water is supplied from a concrete-lined cooling pond adjacent to the River Lea, and so designed that part of the river can be deflected through it. The pipes are arranged to allow the circulating water to siphon through a steam-driven centrifugal pump having a maximum capacity of 40,000 gallons per hour. Ultimately it is intended to erect a cooling tower over the pond. The auxiliary steam service is 2in. in diameter.

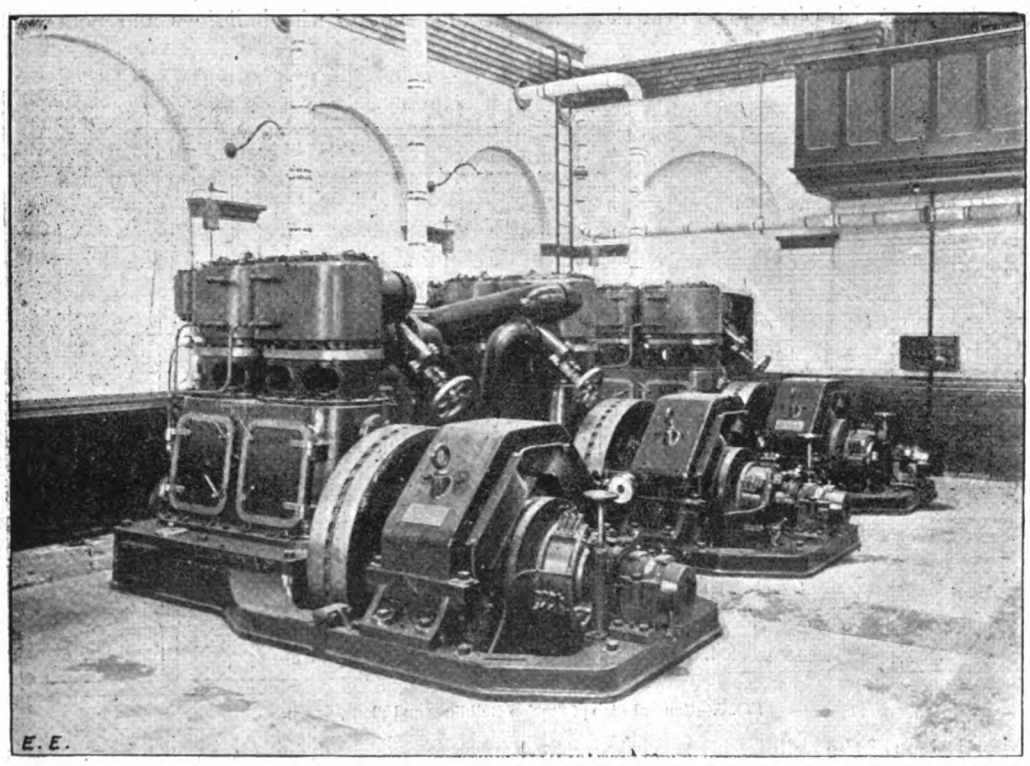

FIG. 5. Generating Sets, Luton.

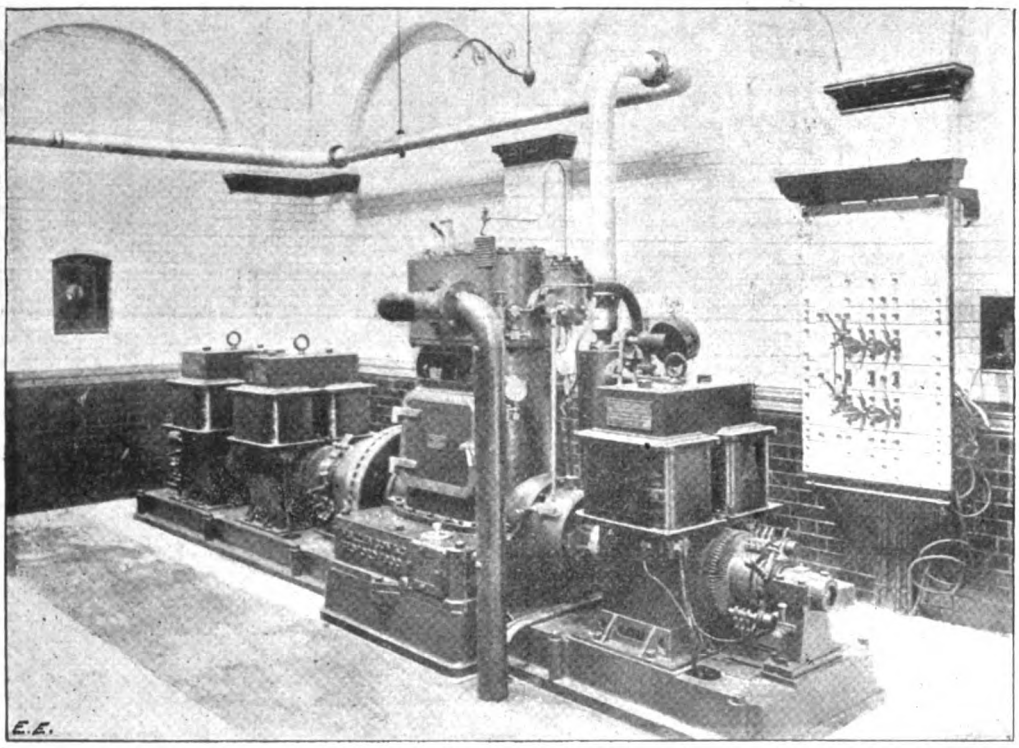

FIG. 6. Steam Balancer, Luton.

The feed-water service comprises two steam Pearn flywheel pumps, each of 10,000lb. capacity per hour and a steam injector of equal capacity. There is a cold storage tank of 6,000 gallons capacity, and a Tyacke water-

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softening plant capable of treating 250 gallons per hour. The usual duplicate services are provided for feeding the boilers with condensed water from the hot-well, cooling pond, or from the cold storage tank, either through the economiser or direct to the boilers through a small feed-water heater. The feed water is measured by a Kennedy meter. The whole of the pipe and feed-water arrangements have been carried out by Messrs. Babcock and Wilcox, Limited.

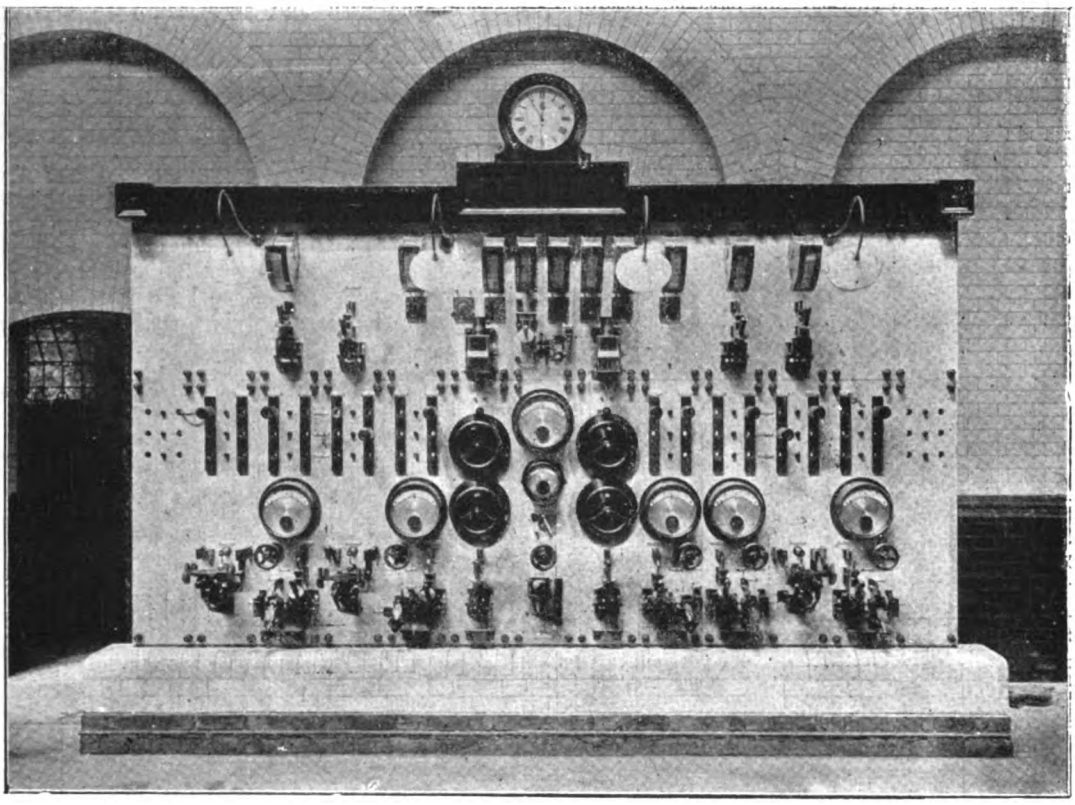

Fig. 7.—Switchboard, Luton.

The generating sets (Fig. 5) comprise three 85-kw. steam dynamos by Messrs. W. H. Allen, Sons, and Co., Limited, running at 390 revolutions per minute, and a 42-kw. steam balancer (Fig. 6) by the same makers, running at 480 revolutions. The two balancing dynamos are connected to a common driving engine through a special coupling, so that they can be disconnected and run as a motor balancer when desired. On the other side of the engine is permanently coupled a 16-kw. dynamo, used for charging the regulating cells. Space is provided for an extension set, having an output of about 250 kw. The large dynamos are of the four-pole type with carbon brushes, and are each designed for an output of 170 amperes at 500 to 550 volts when running at normal speed, and capable of 15 per cent. overload for three hours without undue heating. They are shunt wound, with regulating resistance in the shunts.

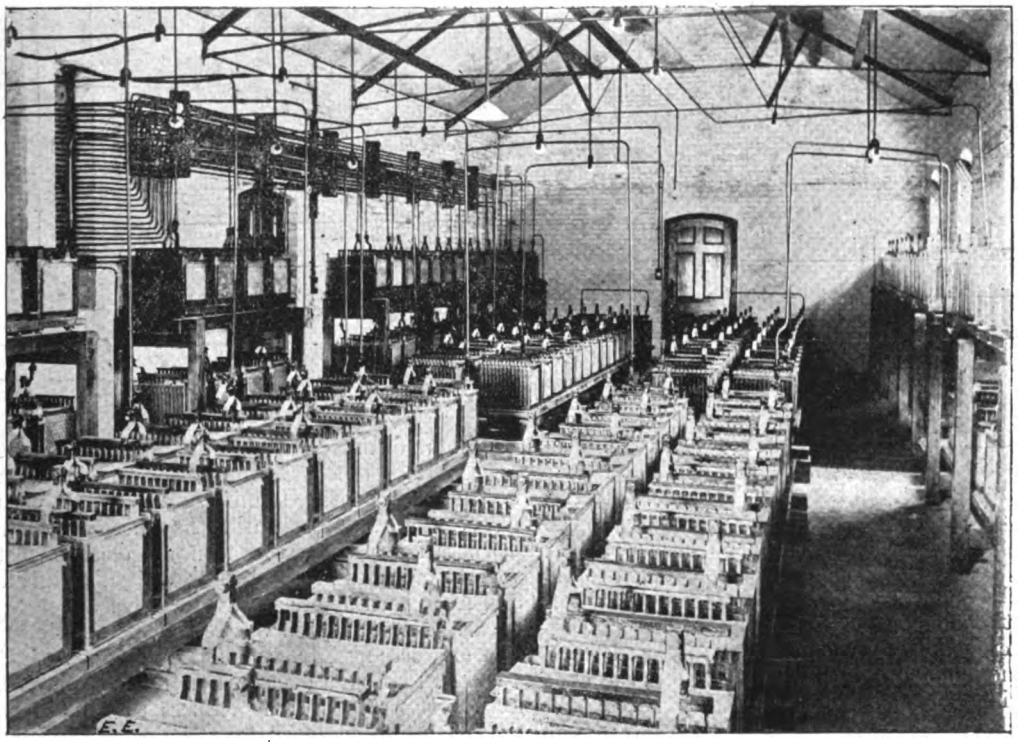

Fig. 9.—Battery Room, Luton.

The switchboard (Fig. 7) was supplied by Messrs. Nalder Bros. and Thompson. It has a base of Sicilian marble supported on an iron frame surmounted by a clock, and

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provides for five dynamos and five feeders, the battery and balancer regulating panels being in the centre. On the lower panel in the centre are mounted the ammeter, automatic cut-out, and resistance for connecting the middle wire to earth. At the back of the board are three horizontal 'bus bars. In the front are vertical 'bus bars so arranged that any machine can be coupled to either of the horizontal 'bus bars. Each dynamo is provided on one pole with an automatic maximum and minimum cut-out, and on the other pole with a main switch interlocking with the field switch. Each main set can be excited separately or off the 'bus bar, but the field circuit cannot be closed or opened until the main switch is opened. The instruments are chiefly of the Weston, Kelvin, and Nalder Bros. and Thompson edgewise permanent-magnet moving-coil type. A diagram of the connections to this board is shown in Fig. 8.

There are two batteries (Fig. 9), each consisting of 140 cells of the Chloride type. Each battery is capable of giving 160 amperes for two hours, 100 amperes for four hours, or 70 amperes for seven hours. The main batteries are charged across the terminals of the 'bus bars, while the regulating cells, which are in the centre on either side of the neutral wire, are charged by the dynamo coupled to the steam balancer already referred to.

The whole of the street cables were supplied and laid by Messrs. Callender and Co. They are insulated with vulcanised bitumen, laid on the solid system in wooden troughs filled with bitumen and covered with tiles. So far two main feeders are laid, one of 0·3 by 0·3 by 0·3 square inch section to the nearest part of the distributing system, and the other 0·2 by 0·20 square inch on the outers only to a point near the town hall. The distributing mains in the heaviest section are 0·15 by 0·1 by 0·15 square inch, but mostly 0·75 by 0·05 by 0·075 square inch. Two pairs of twin pilot wires are brought from each of the feeding points to the station. A large number of street boxes have been laid, in all of which the poles are in separate iron boxes, so that each main can be disconnected without risk of a short-circuit or injury to the workmen.

Ten public arc lamps have so far been erected, and are coupled in series across the outers, a connection being made between the fifth and sixth lamp to the middle wire through a switch, so that five lamps can be switched off without interfering with the other five. The lamps are Crompton's P-20 single-carbon long type, and each post is fitted with Edmundson's automatic cut-out and compensating resistance. They are controlled from the station. The arc lamp-posts were specially designed for Luton, and are of handsome appearance. The centre of the arc is approximately 23ft. from the ground. Two 32-c.p. incandescent lamps are to be used after midnight, when the arcs will be switched off. Approximately 2,000 lamps of 8 c.p. are either connected or about to be connected to the mains The Corporation is supplying current at 6d. for the first

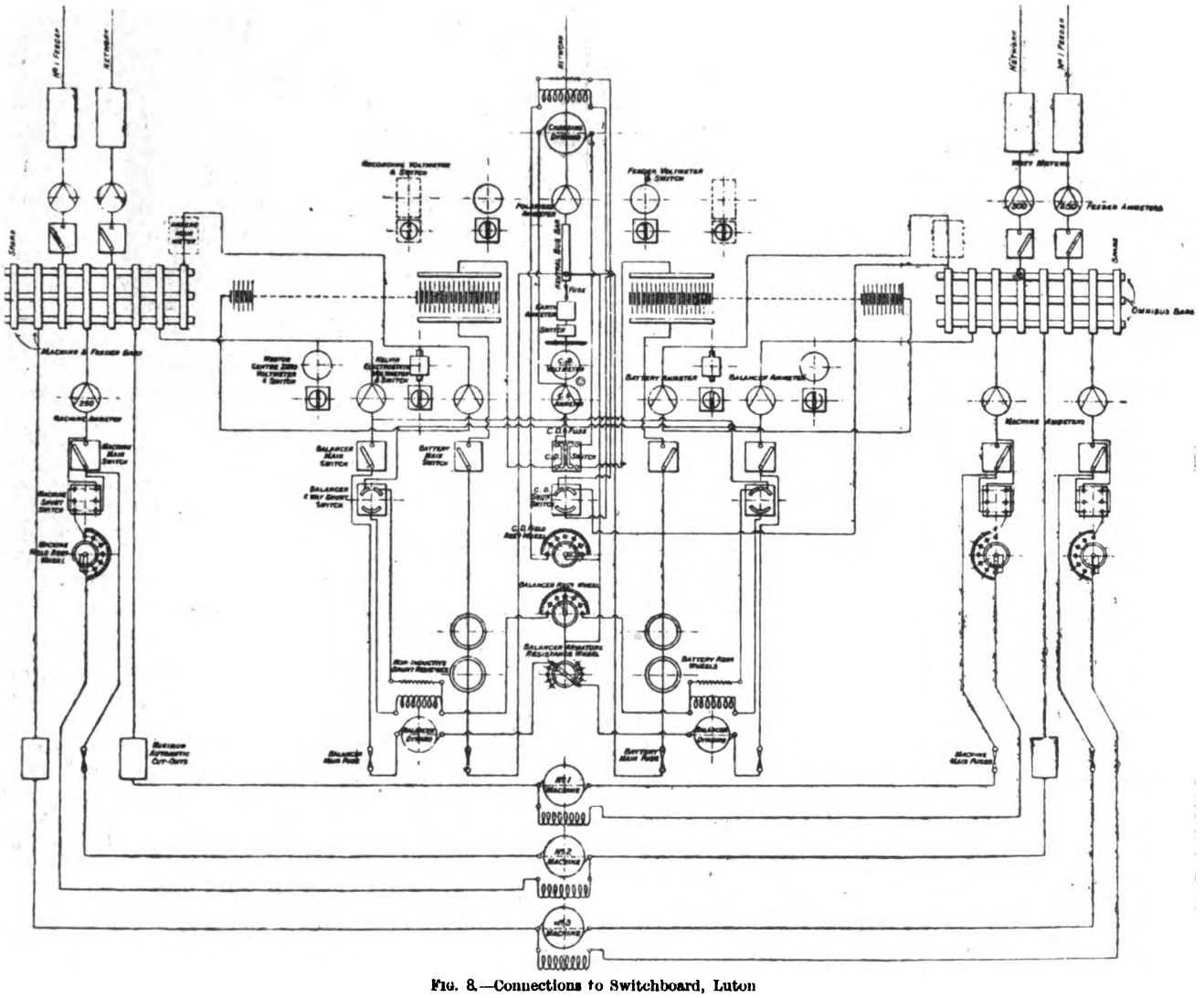

Fig. 8.—Connections to Switchboard, Luton

400 hours of maximum demand and 3d. per unit afterwards for lighting, the price for power being 6d. and 2d. per unit, and for heating a uniform rate of 1½d. per unit. This preferential rate for heating has been decided on by the Corporation in order to encourage electric heating of the various factories in the town. Wright's demand indicators and Aron wattmeters are used at present.

Mr. Albion T. Snell was represented during the progress of the work by Mr. W. H. Cooke, A.M.I.E.E., who was appointed borough electrical engineer on June 1 last. We have to express our indebtedness to Mr. Albion T. Snell, the consulting engineer, for the above particulars.

Opening Ceremony.

The formal opening of the above described works took place on Wednesday, the 10th inst., when the Right Hon. Lord Kelvin, G.C.V.O., F.R.S., L.L.D., started the first engine, and declared the supply inaugurated, in the presence of the members of the Corporation and a number

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of invited guests. The proceedings were in every way satisfactory, delightful weather prevailing, so that the results of the photographic operations to which the party was subjected should prove satisfactory. The visitors congregated at the rear of the station to hear the speeches which were addressed to them from a raised platform. Lord Kelvin was in a particularly bright humour, and spoke at some length, as did also the Mayor of Luton and others. The guests of the Corporation were afterwards entertained by the mayor at lunch.

WIRELESS TELEGRAPHY UP TO DATE.

Experiments between Brussels, Malines, and Antwerp (January to March, 1901).

(Special Article.)

BY LIEUTENANT FERNAND PONCELET (BELGIAN ARTILLERY).

PART I.—THE PRESENT STATE OF WIRELESS TELEGRAPHY.

Wireless electrical telegraphy is at the present moment going through a clearly defined transition period. Arising from the experiments of Heinrich Hertz, who so remarkably confirmed the fruitful electromagnetic theory of Clerk Maxwell, the new telegraphy has not had long to wait before leaving the laboratories to make itself practical in long-distance transmission. The names of Popoff, Schäffer, Tommassina, Slaby, Arco, Tissot, and others mark this first period.

There is now what appears to be a halt in the upward march of experiment, and it is at the moment of passing

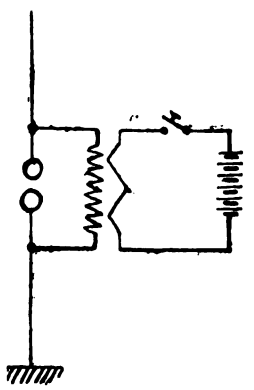

FIG. 1.

from coastline or maritime telegraphy to land telegraphy that experimenters encounter serious difficulties to be overcome. The distances of transmission obtained are relatively small in comparison with the amount of electrical energy employed, and with the cost of the installations.

Wireless telegraphy gives worse results on land than at sea, for the following reasons: A coherer placed underground is not influenced by electric waves—see the experiment of Lagrange (*Comptes-rendus de l'Académie des Sciences des Paris*, meeting of Jan. 28, 1901), which proves that the curvature of the earth constitutes an absolute barrier to wireless telegraphy. Moreover, even if buildings, trees, and generally all irregularities of the ground are pervious to electric waves, it is certain that there is a considerable absorption of energy. While at sea, the experiment of Fleming has shown that electric waves pass through the water with an absorption proportional to the quantity of salt and the thickness of the water: the curvature of the earth does not interfere until the straight line joining the two stations begins to touch the bed of the sea.

To enable wireless telegraphy to communicate on land to any distances, however great, without increasing the cost of installation, some other method than that used at present must be employed. This fact has been grasped by M. Guarini, of Brussels, and the ideas and experiments which he now brings forward appear such as will shortly bring us to the end of the transition period. In order to understand the work of M. Guarini, we will first pass rapidly in review the work of his predecessors, and consider the state of wireless telegraphy at the present moment.

TRANSMITTERS.

As is known, the present systems are all based upon the following principle: to produce at the transmitter a signal, the electric spark, and register it at a distance on a receiver, which utilises the properties of metal filings, powdered carbon, or imperfect contacts. All these systems employ as a transmitter an oscillator inserted in the

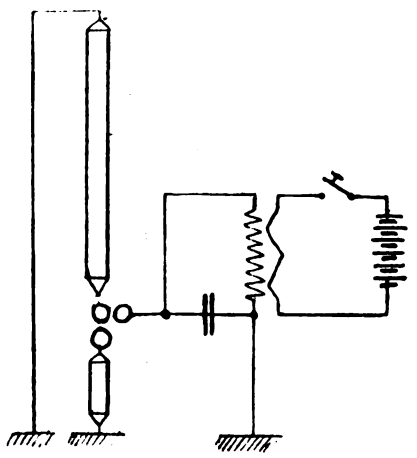

FIG. 2

secondary of a Ruhmkorff coil, the primary including the source of electricity and the Morse key; further, in the systems derived from the Marconi system (Fig. 1), one of the balls of the oscillator is connected to an entirely separated "feeler" upright, and the other is put to earth; in the Slaby-Arco systems (Fig. 2) the feeler is connected to earth.

In either case, we notice that the improvements in similar transmitters consist in the increase of ratio between the power of the signal and that of the source of energy. This necessarily has a limit, since a portion of the energy set in action is transformed into heat and light in the spark. In order to obtain a greater radius of transmission, the power of the source, the size of the Ruhmkorff coil, and the height of the feeders must all be increased. It was by these means, according to the report of Captain Ferrié on the experiments in the Channel, that Marconi has obtained at sea the transmission over 50 km. (30 miles) with an upright of 37m. (120ft.), a coil of 25cm. (10in.) spark, and a battery of 100 cells (of 1·5 volts and of 0·15 ohm interior resistance) and of eight light accumulators, giving at the primary terminals a difference of potential of 16 to 17 volts and a current of six to nine amperes in this circuit. With a coil of 50cm. (20in.) spark and an upright of 50m. (170ft.), Slaby-Arco has obtained on land transmission over 15 km. (9½ miles).

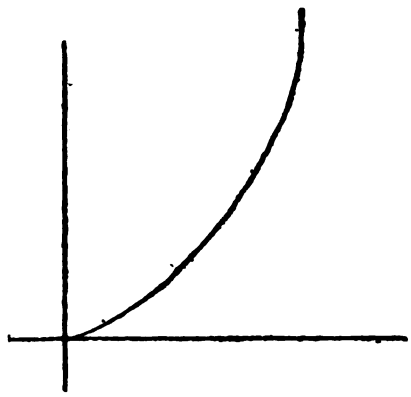

FIG. 3.

The power of the coil and the height of the upright feeler cannot, however, be indefinitely increased. If we plot the cost of maintenance on a diagram (Fig. 3), of which the abscissæ represent either length of spark or height of feeler, we shall notice that the curve bends rapidly, turning its convex side towards the axis of the abscissæ, and that it becomes asymptotic in relation to the ordinates.

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M. Guarini has obviated this difficulty in the following manner: (1) He does away with the oscillator entirely, and substitutes alternate currents only in the transmitter. To obtain this, the upright feeler is connected directly to one end of the secondary of the Ruhmkorff coil, the other end being put to earth (Fig. 4). This arrangement economises

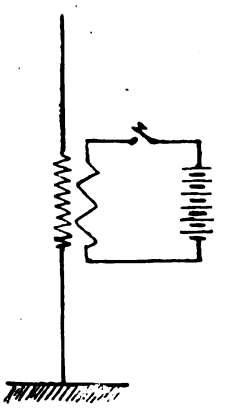

FIG. 4.

that part of the energy transformed uselessly into heat and light in an oscillator. Besides, other things being equal, the range of transmission is greater with an alternate-current transmitter than with a spark transmitter. We shall see the confirmation of this in the Brussels-Malines-Antwerp experiments. (2) When the distance separating

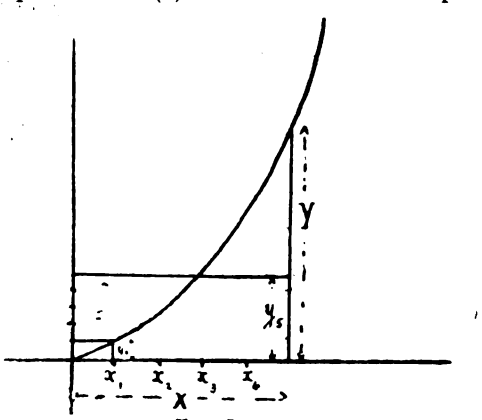

FIG. 5.

the two transmitting and receiving stations is too great for the size of apparatus employed, M. Guarini makes use of the repeater which he has invented. The employment of a suitable number of repeaters placed at intermediary posts or offices enables any distance on land to be overleapt, however great, and there is beside the advantage of some economy in the maintenance of installations. This can be

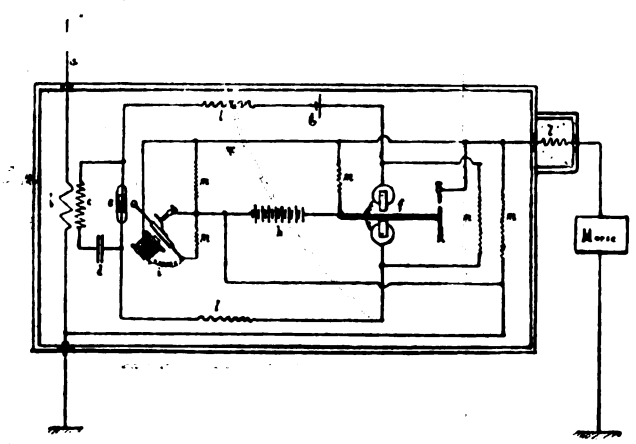

FIG. 6.—*a* upright feeler, *b c* induction coil, *d* condenser, *e* coherer, *f* telegraphic relay, *g h* cells, *i* trembler, *k* metallic box, *l* self-induction coils, *m* non-inductive resistances.

seen on looking at the diagram in Fig. 5, in which the ordinates correspond to the cost of maintenance and the abscissæ to the distances separating the two wireless telegraph posts.

Practice has demonstrated that this curve has the same rise as that of Fig. 3. Let X be the distance separating the two stations. If it is desired to clear this distance direct, this will give a cost of maintenance equal to the ordinate Y; while if this distance is divided, for instance, into five equal portions, by placing repeaters at the intermediate points, x_1, x_2, x_3, x_4, we obtain a cost of maintenance equal to $y_5 = 5\,y_1$. The economy achieved is thus equal to $Y - y_5$, which increases with the distance, X. This reasoning is evidently only exact on condition that the establishment of the five intermediate posts does not cause increase in the cost of staff. As we shall see, M. Guarini has achieved

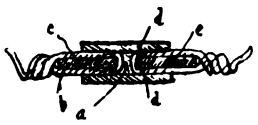

FIG. 7.—*a* carbon, *b* German-silver wire, *c* ebonite plate, *d* mica plates.

this in actual working in long-distance transmission with his automatic repeater, where, thanks to the presence of this apparatus at an intermediate post at Malines, he has been able to establish communication both ways between the two terminal stations of Brussels and Antwerp.

RECEIVERS.

The property of metal filings is the basis of almost all the receivers for wireless telegraphy, of which the Marconi apparatus (Fig. 6) is the most complete type; the coherer.

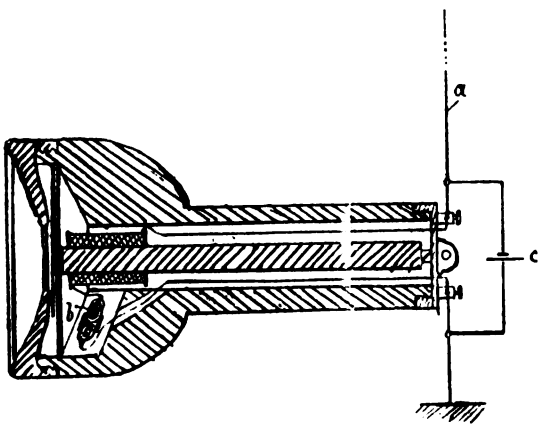

FIG. 8.—*a* feeler, *b* coherer, *c* cell.

connected to upright feeler by means of an induction coil and a condenser (jigger) is inserted, together with a telegraphic relay in the circuit of a battery cell; when under the action of the electric waves the filings become conducting, the exciting circuit of the relay is closed. This latter works a Morse receiver at the same time as the shaking apparatus brings the coherer back to its original resistance. As accessory parts, we find the metal box, the self-induction coils, and the non-inductive resistances,

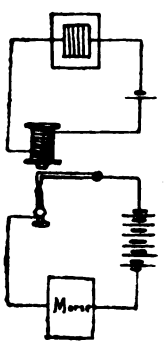

FIG. 9.

which are for the purpose of hindering the extra-current sparks, or the electric waves themselves, acting upon the coherer or the electromagnets at an inopportune moment.

In his receiver, Tommasina uses the auto-decohering property of carbon: his coherer (Fig. 7) is inserted in the circuit of a battery telephone receiver, one of whose poles is connected to the upright feeler and the other to the ground (Fig. 8).

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Schäffer uses an arrangement which has the reverse property to those using metal-filing coherers or carbon coherers. In normal conditions this arrangement (a pellet of silver having numerous fine slits covered with damp felt) allows the current to pass, but its resistance increases under the influence of electric waves, returning to its original weak resistance when the waves cease (Fig. 9).

Secrecy of Telegrams.

Whatever the systems employed, some special arrangement must be introduced to keep the secrecy of the

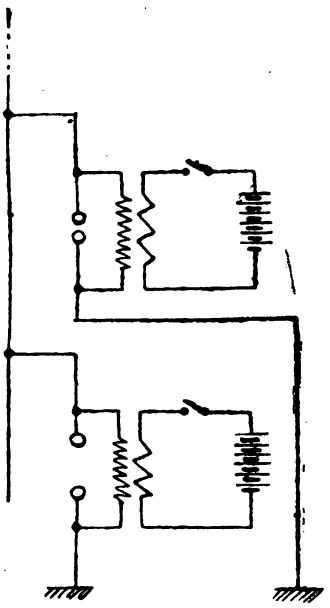

Fig. 10.

telegrams. Tommasi has invented the following arrangement, based on the relationship which he believed he had found between the distance separating the oscillator balls and the range of the Hertzian waves. At the transmitting station two complete transmitting instruments are connected to a single upright feeler, which is thoroughly insulated. One of these (Fig. 10) works in the following manner: The separation of the balls is regulated in such a manner that the distance reached may be a little less than that to the receiving station; all the receiving instruments situated within the zone of action of the first transmitter will therefore be acted upon continuously, and an undefined bar will be registered on their Morse strip. The separation of the balls of the second transmitter is regulated according to the exact distance of the destined receiving station. The working of this second transmitter is regular, but its signals, being intermingled with the continuous signal of the first on all the Morse strips of the intermediate receivers, will be registered alone on the destined receiving instrument. But even if his principle were not verified in actual practice, as M. Guarini has found in his Brussels-Malines-Antwerp experiments, this system is incomplete, as all the stations situated at the same distance as the destined station will intercept the telegram as well as this latter itself.

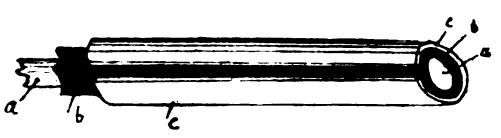

Fig. 11.—*a* metal core, *b* insulation, *c* metallic sheath.

Marconi has solved the question by syntonisation (or tuning), basing his experiments on the formula of Thomson, $T = 2\pi\sqrt{LC}$. He connects the upright feeler (see Fig. 6) to the primary of an induction coil, of which one end is put to earth; in the secondary he inserts the coherer and a condenser. This arrangement, which he calls a "jigger," allows him to vary the capacity, C, and the coefficient of self-induction, L, and thus to make the receiver syntonic or in tune with the transmitter of the same station. He then makes one station in tune with another by modifying the capacity of the feeler by placing strips of metal near it, which strips can be brought near or separated from the upright feeler.

This system is also incomplete, as the formula of Thomson only applies to the principal oscillation, and does not take into account those secondary oscillations analogous to the harmonics of a fundamental note in acoustics. According to the report of Captain Ferrié already mentioned, these secondary oscillations might be felt up to 2½ km. (1½ miles). M. Guarini has found that they may reach 22 km. (14 miles). With this system, multiplex and simultaneous telegraphy is impossible both ways, as the receiving apparatus would have to be at least 2½ km. from one another not to be influenced by the corresponding transmitter.

M. Guarini secures the secrecy of telegrams by an altogether different expedient. The electric waves emitted by the upright feelers of the transmitting station radiate in

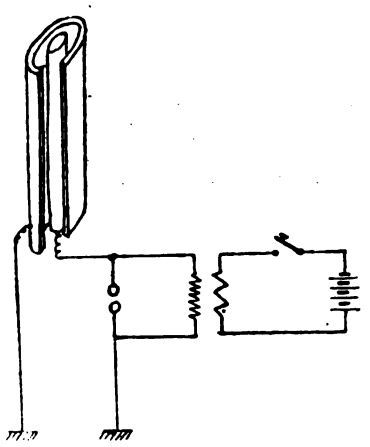

Fig. 12.

a direction normal to the surface of the feeler and in every direction. By a special arrangement of the feelers M. Guarini limits the electric radiations into a narrow sheaf, which he directs towards the receiving feeler: all the regions of space not comprised within this sheaf of rays are not affected by the action of the rays. The receiving feeler itself is arranged in such a way as to receive only the radiations emitted by the feeler of the transmitting stations.

These feelers are constituted in the following manner (Fig. 11): a central core, formed of a wire or of a metallic cable, is carefully covered with insulation and wrapped

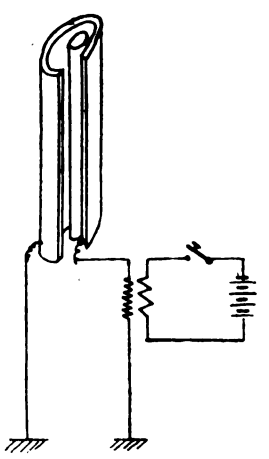

Fig. 13.

in a metallic sheath over the insulation; a longitudinal slit is made in the sheath. This sheath feeler is used by M. Guarini in the following way:

1. The core is connected either to one of the oscillator balls or else direct to one end of the secondary of the Ruhmkorff coil, according to whether Hertzian currents or alternate currents are used for the transmission. The outer sheath is put to earth (Figs. 12 and 13). In this case only that portion of the core opposite the longitudinal slit sends forth its radiations into space. Indeed, the currents given out by the transmitter being at high tension, it is enough

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to recall the following experiment in electrostatics. A pith ball, A, suspended by a silk thread, is violently attracted (Fig. 14) by a metallic screen, B, as long as a neighbouring body, C, is charged with positive electricity, for instance; but the pith ball remains quiescent if the screen is put to earth. If C represents the core of the Guarini feeder and B the metallic sheath, the same electrostatic phenomena are reproduced opposite the open portion of the sheath. All the

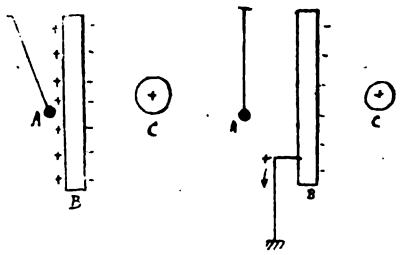

FIG. 14.

space comprised within the sector *a* on *b* is therefore screened from the action of the electrostatic field. The theory which the writer gives, together with M. Guarini, is different (*Compte-rendus de l'Academie des Sciences de Paris*, No. 13, 1900).

2. If the transmitter makes use of alternate currents in closed circuit, the circuit wire is formed by the core and the return wire by the sheath, metallically connected to the core (Fig. 16). In this case, those portions only of the core opposite to the slit give forth radiations into space. Now let us subdivide the cylindrical core into Z elements (cells), traced according to the generators; let Z^1 be the

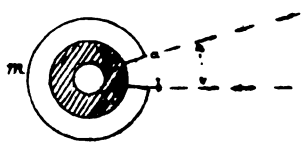

FIG. 15.

number of such elements opposite the sheath; then there are $Z - Z^1$ elements of the core, which correspond to the longitudinal slit. Let us connect together the Z^1 elements of the core, one by one and by their upper parts, with the Z^1 corresponding elements within the sheath. At a given moment, each couple of elements thus formed is traversed by a current in one direction in the inner element and in the contrary direction in the outer element. The resultant of these equal currents is nil, and there is no exterior field. The space corresponding to the open portion of the sheath is therefore deprived of all magnetic field; only the $Z - Z^1$ elements of the core opposite the slit have any exterior field.

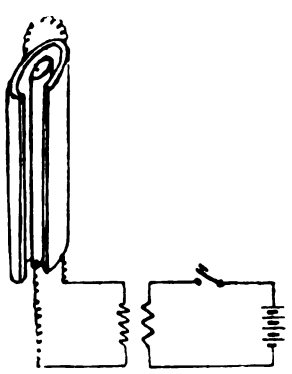

FIG. 16.

3. If the transmitter uses low tension in open circuit, the sheath is insulated from the ground, and the core is connected to one end of the secondary of the induction coil, the other end being put to earth (Fig. 17). In this case the part of the core opposite the slit gives forth into space a concentrated sheaf of radiations. M. Guarini gives the following reason for this: One portion of the current induced in the sheath is transformed into heat, the other portion, not being able to radiate into space, by reason of the peculiar formation of the sheath, nor yet to dissipate into the earth, as the whole system is insulated, must be used up in some way or other, according to the law of conservation of energy. This part is utilised by an induction on the core itself. The latter, at a given moment, is traversed by an inducing current in a certain direction, which induces a current in the contrary direction on the sheath, and this latter current partially, in turn, becomes inducing current for the core. This induced current in the core is added to the inducing current, which is in the same direction. The Ruhmkorff coil will give us a striking example of this phenomenon. If we prevent the energy of the secondary from being dissipated in heat and light in the spark, by putting the two secondary terminals on short circuit, we find an immediate heating effect at the interrupter of the coil: the portion of the energy originally utilised in the spark, is now spent in reacting on the primary.

To sum up, the sheathed feelers invented by M. Guarini enable us to limit the space in which electric radiations

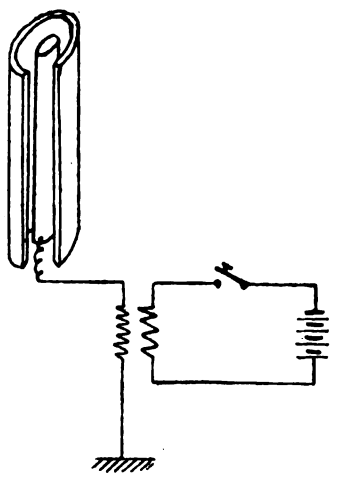

FIG. 17.

are transmitted, and thus to ensure secrecy of telegrams; they may even, in the case of low-tension open circuit, be concentrated into a sheaf or bundle of rays.

(To be continued.)

WEAR OF ROADS BY HORSE HAULAGE AND MOTOR TRAFFIC.*

BY W. WORBY BEAUMONT, M.I.C.E.

W. Worby Beaumont, Esq., M.I.C.E., M.I.Mech.E., F.G.S., etc., is perhaps best known at the present time in connection with the automobile movement, in all matters connected with which he is a leading authority. As will be seen from the following notes, however, he has had an unusually wide experience as a mechanical engineer. Mr. Beaumont was apprenticed in 1864 to the Reading Ironworks Company, who, as successors to Messrs. Barrett, Exall, and Andrews, were makers of steam engines and boilers, winding, pumping and traction engines, and agricultural implements. Here also he was engaged in the construction of biscuit and aerated bread-making machinery, and of the "Lenoir" gas-engines, and thus acquired his first practical knowledge of the modern competitor of the steam-engine in its various forms, as gas, oil, and spirit motor. At the end of this apprenticeship, in 1867, he went as improver to Messrs. Ransomes, Sims, and Jefferies, Limited, of Ipswich, under his grandfather, Mr. Wm. Worby (inventor of the first portable steam thrasher, the self-moving steam-plough anchor, and many other successful things, including the first agricultural locomotive, as exhibited by Messrs. Ransomes and May in 1842). In the Orwell Works he was engaged in erecting steam-engines and machinery, and he also spent a short time in drawing-office work. In 1872 Mr. Beaumont became an assistant, and subsequently chief assistant, to the late Mr. Robert Mallet, M.I.C.E., F.R.S., with whom he was engaged on railway, dock, foundry, and mechanical engineering branches of civil engineering work. He was afterwards engaged in other varied civil and mechanical engineering and expert work. In 1874 he carried out the intensity survey of the area affected by the great gunpowder explosion on the Regent's Canal, and in 1880 conducted an extensive series of experiments in connection with steam condensation in very long steam-pipes, and followed these up by experiments on condensation in condensers, and the now recognised importance of heating boiler feed with live steam. He also made an extensive series of experiments on a large

* Paper read before the annual meeting of the Incorporated Association of Municipal and County Engineers, at Leicester.

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scale on the density of molten metals and rocks and their coefficients of expansion. For over 10 years Mr. Beaumont was joint editor of the *Engineer*, a position which he resigned early in 1896 in consequence of the growth of his private practice as a consulting engineer. The latter he had carried on for several years, and he now devotes himself entirely to it at Outer Temple, Strand, London. In 1893 he designed and carried out the new wood-working machinery department of the great pianoforte works of Messrs. John Broadwood and Sons, for whom he visited the United States in 1898. Numerous other works of similar kind he has carried out elsewhere. Mr. Beaumont has devoted much time to oil and gas engine construction and testing. In 1894 he again turned his attention to mechanically-propelled vehicles, in which his early experience with traction engines on the one end of the scale and tricycles on the other has been of value, and from that time he has been one of the most prominent exponents of the automobile movement. He is the inventor of the "vibromotor," largely used for working large coal screens at collieries, and in flour-mill machinery, and in which is employed his discovery of a mechanical motion new in principle, and by which perfectly automatic balance of reciprocating, gyrating, or rotary machinery is secured. He is also the inventor of the antinertia variable speed gear and electrical clutches, tea machinery, and steam generators, and in quite another field several forms of secondary batteries in association with the editor of this journal. His varied experience gives him frequent occupation in engineering and patent litigation. Mr. Beaumont was president in 1898 of the Society of Engineers, is a member and gold medallist of the Institution of Civil Engineers, member of the Institution of Mechanical Engineers, member of the Institution of Electrical Engineers, and numerous other societies. Mr. Beaumont is the author of a great variety of papers in the *Proceedings* of the societies just mentioned, including papers on the "Cause of Fracture of Railway Tyres," on the "Construction of Thrashing Machines," the "Automatic Balance of Machinery," on "Absorption or Friction Brake Dynamometers," on

W. WORBY BEAUMONT, ESQ., M.I.C.E., ETC.

the "Economic Value of High-Pressure Steam," on Steel as a Structural Material," on the "Prevention of Vibration by Machinery," the Cantor Lectures of the Society of Arts on "Mechanical Road Carriages," and numerous articles, papers, and lectures on the same subject; the "Cause of the Fracture of Railway Rails," and numerous reports on steam, oil, and gas engines. He is also the author of the 'Steam-Engine Indicator and Indicator Diagrams," and of "Motor Vehicles and Motors," the comprehensive book published last October. This, we may add, is admitted to be the standard work on this subject, and, in spite of its high price, a second edition is already called for. Reverting to the subject of the horseless vehicle movement, we may add that Mr. Beaumont was one of the earliest to proclaim his faith in the important nature of this industry. He is one of the pioneer members of the Automobile Club, and has been on its committee from the first. He was chairman of the judges' committee at the Automobile Club Show of 1898, and made the calculations and deductions from the observations made on the vehicles in the 1,000 miles' trials last year, upon which the judges' decisions were based.

The old adage that time is money has always been looked upon as a brief statement of a broad fact, but until comparatively recent times it has not been broadly recognised that time which might be saved by modern expedients and was not saved, was money in sight thrown away. In no matter is this more true than with respect to time lost in the transit of either men or things, and it has not been possible to realise the further truth that the physical fatigue of intelligent men by slow and uncomfortable modes of transport is a waste of money-earning capacity, without any even indirect advantages. To avoid these losses, good roads and ample means of easy and quick transport upon them are among the first of all necessities.

The title given to the short paper the author has the honour of placing before you is "Points as to Wear on Roads Caused respectively by Horse Haulage and Motor Traffic." The author does not, however, intend to occupy much of your time on those questions upon which your personal practical experience is so much more extensive than his own. Since the days when Telford, and MacNeill, his resident engineer (afterwards Sir John MacNeill), and others gave so much attention to the subject, it has been recognised that the wear of roads by horses' shoes was considerably greater than the wear of roads by the wheels the horses hauled. It was shown by the observations of MacNeill that the wear by the horses hauling heavy vehicles and heavy loads was less than that by the horses hauling the lighter loads at the higher speeds. The relative proportions of the wear under these different classes of traffic were fully stated in evidence before the Select Committee on Steam Carriages in 1831, and very little has transpired since to alter the qualitative value of the conclusions then announced, although road and vehicle improvements have added to the number of exceptions to their quantitative value (see report of Select Committee in Gordon's "Elemental Locomotion," p. 131, *et seq.*). The causes of road wear were summarised for a general statement, and may be collated as shown in Table A.

TABLE A.—GENERAL RESULTS OF OBSERVATIONS OF CAUSES OF ROAD WEAR AND DETERIORATION.

Kind of vehicle and load.	Wear due to atmospheric causes.	Wear due to wheels.	Wear due to horses' feet.
	Per cent.	Per cent.	Per cent.
London and Birmingham Coaches — Weight, 16cwt. to 18cwt. empty; loaded, 45cwt. Speed, 8 to 12 miles per hour.	20	20	60
Wagons — Weight, 25cwt.; loaded 92cwt. Speed, 3 miles per hour.	20	35·5	44 5

These figures can only be taken as roughly approximate, because the character of the roads in different places and the gradients make any approach to accuracy impossible. It may, however, be conceded that the relative proportions on average country roads, with some exceptions, remain much the same to-day, as the widths of wheels remain about the same for the lighter vehicles, although on the whole they are narrower for the heavy vehicles generally classed as wagons. Anyone who has observed the effects of the passage of different kinds of vehicles along the road between, say, Southall and Oxford, can, on the Dashwood and Ashton Hills, obtain very good evidence of the nature of the wear due to the different causes which obtain with horse-hauled and motor-propelled vehicles, and it will be seen that the figures and statements of Telford, MacNeill, McAdam, and others are of value to-day.

The great departures from the general applicability of these figures arise where the roads are particularly well made and maintained, but such roads are but a small part of the whole. On the best roads it may be said that the injurious effect of atmospheric changes is less, that the wear due to the wheels is less, and that the wear due to horses' shoes is greater than in the preceding table. Where roads are made with metalling of small size, and with a minimum of binding materials, the irregularities in compactness are less than in roads made with large metalling, the almost regular recurrence of looser and tighter patches due to the method of compacting by rollers is less and the effect of the hammering by horses' feet between the harder or more compacted recurrent spots is less. On most roads the effect of the hammering and scrabbing by horses' shoes is to loosen and remove most where it is most easily moved. The hollows are thus rapidly made more hollow, iron-tyred wheels at high speeds hammer their edges or boundaries, and so enlarge them, and water collects. Once the formation of a saucer hollow has commenced it soon becomes a dish, and every element of wear, tear, and deterioration becomes cumulative. The surface becomes worse and worse, until it is a pain and mortification to have to use them for anything but the heavy slow traffic of three miles an hour. The wear and tear of every vehicle of speeds of eight miles per hour and upwards is enormous, as compared with what it need be. Even with the large wheels of hansom cabs it requires the patience of Job to endure the jolting, and the jobmasters have to keep their best language for expressions of reverence of their repair bills.

Great improvements have been made in the construction and repair of the roads in many parts of the country during the past few years, and much credit is due to a few of the road surveyors, as, for instance, on most of the roads between Coventry and St. Albans and on some of the Cambridgeshire roads, which are also made with metalling broken very small. The great majority of the roads are, however, much in need, not only of improvements in method of making, but in frequent instead of only occasional repairs, and more attention to free drainage from the surface.

To gain anything like a true knowledge of the effect of the average bad road surface in the destruction of vehicles, it is only necessary to take a run in a light motor carriage with, say, 30in. wheels and solid rubber tyres at, say, 12 miles an hour. It may be just possible to retain one's dental integrity at this speed, but at anything like a sufficient speed to avoid a charge of wasting time on the road it would be necessary to have spine and teeth of indiarubber. A motor carriage makes an excellent road surface inspector. It experiences all the badness and says nothing.

Now it is better roads we must have for the higher speeds that modern times demand—more men and for a time more money at the disposal of our engineers and surveyors. Usually very little is done of the nature of effective mending. It is sometimes said that mending and patching are of no use. Mending badly done under incompetent teaching and supervision is of no use, but with roads well made in the first instance, and then kept under inspection by intelligent men

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with sufficient careful workmen under them and suitable tools and materials for making timely corrections and repairs, mending should be of real use. Roads should be under inspection as constant as that of the permanent way of a railway, and each district superintendent should be as responsible for the perfect keeping of his length of road. All this means money, and, in the first instance, rather more money than usual; but the author is quite sure that in a short time such thoroughly kept roads would cost less than the making and remaking of badly-kept roads. Even if it cost a little more, everybody would reap the benefit of it through the lessened wear and tear of every vehicle on the roads and the greater comfort and pleasure.

It would be to no purpose to say that things would be much better were it not for the wear by horses' shoes. Horses on the roads and streets of the kingdom may be reckoned in millions, and it will be a very long time before the seven figures necessary to represent this quantity are reduced to six figures. The growth of the use of motor vehicles will, however, gradually though slowly do this. Meanwhile the indications of modern changes in the type of horse and vehicle used for transport of every-day merchandise should be noted. Time of delivery—in other words, speed—has become the dominant factor, and hence the trotting cart-horse and the light high-speed van with narrow tyres have grown in number more rapidly than any other type, and the heavy slow-speed van for such work is but little used. It is these light vans, carrying from 1 to 1½ tons on 2in. tyres, and with trotting horses, that do more mischief on the roads than any other class, unless it be omnibuses. The same loads at half the speed would do very little damage, except at starting places and on hills. It is the speed that wears the vehicles, and therefore the roads. The speed, however, must be had for all but the very heavy traffic. To make this possible we must have (1) well-made and well-maintained roads; (2) width of tyres (when metal) ample in proportion to load on them. And, as far as practicable, encouragement should be given to (1) the use of rubber tyres generally; (2) the use of light-load motor vehicles, the earning capacity of which is ensured by dispatch in transit, and not by weight of load.

The endurance of materials fixes limits of either speed or load. We may have high speed and light load, or heavy load and low speed. We cannot have both on common roads as made and kept now, but both speed and load may be increased upon really good road surfaces. It is not, however, in this connection necessary to consider continuous heavy traffic on any definite line as between two or more towns. When the quantities of materials to be carried become large and constant, or nearly so, such as from 500 to 1,000 tons per week, then the conditions which require a railway—or, at least, a tramway or plateway—have been reached. Such quantities are best off the macadam or any other kind of highway, however made, and, in fact, could not be carried by them on heavy metal-tyred vehicles. Considering, then, only the lighter class of motor vehicles, such as those which carry from one to two tons, at speeds which may meet modern requirements, it may be confidently expected that the wear of the roads by them will be from 20 to 40 per cent. less than by horse-hauled vehicles, and that it will, therefore, pay to spend more money at first in following out the best possible construction and afterwards in maintaining a trained body of road repairers constantly at work so that these vehicles may be profitably used. The lessened cost of road up-keep will be further reduced by the lessened cost of scavenging. This will be great, even if for the moment the cost of removing the horsedung from our streets is not included, or the hygienic value of its absence not considered. Sir Arthur Arnold recently stated that as much as four tons per mile per day was removed from some of the London streets.

In concluding this brief paper, which, through want of time is only a sketch, the author wishes to repeat that there is nothing on which the county councils of this kingdom can spend money so profitably and economically as on the proper construction and efficient maintenance of good roads. Well-made and well-maintained roads, while being to the advantage and benefit of everybody, cost in the end much less than badly-made and neglected roads.

Discussion.

Mr. R. J. Thomas (Aylesbury) said he was rather interested in the paper because he differed *in toto* with the statements made. If Mr. Beaumont would show him where the wear of horses was greater than the wear of wheels, he would change his views. A wonderful impression prevailed that nothing had been done to improve the roads. He contested that statement entirely. Then the statement was made by Mr. Beaumont that money was not given by the authorities to repair the roads. For the last 11 years his county council had allowed him all the money he required, and if anything was wrong with his roads the fault was his own and not of his county council. Fifty per cent. of his men had been working for him for the last 11 years. They were not loafers and idlers picked up at street corners, but were quite as intelligent as bricklayers, and did their work as well. In response to the President's request, he proposed a vote of thanks to Mr. Beaumont for his paper.

Mr. MacBrair (Lincoln), who seconded, said he would like to call attention to two statements made by the author of the paper: "A motor carriage makes an excellent road surface inspector. It experiences all the badness and says nothing." "Considering, then, only the lighter class of motor vehicles, such as those which carry from one to two tons at speeds which may meet modern requirements, it may be confidently expected that the wear of the roads by them will be from 20 to 40 per cent. less than by horse-hauled vehicles; and that it will therefore pay to spend more money at first in following out the best possible construction, and afterwards in maintaining a trained body of road repairers constantly at work, so that these vehicles may be profitably used." Well, about a year ago they had a private company in Lincoln running motor vehicles with rubber tyres. He carefully noticed some of the roads these went over, and found they were not an unmitigated blessing. The rubber tyres had a peculiar effect upon the roads, giving them a corduroy appearance. Then the cars had an unpleasant habit of swishing the mud and liquid from the roads on to the footpaths. In fact, he would be very glad to see the motor cycles taken off his roads altogether.

Mr. Norrington (Westminster) said although Mr. Beaumont seemed to have been rather unfortunate in referring to a particular road, he would like to say that his experience had been that the general action of local authorities was as described by Mr. Beaumont. He was pleased to hear that Mr. Thomas had full rope given to him as to expenditure on his roads, but it was not so generally (cries of "No, No!"). The authority would repair a road, and then it was allowed to go for four or five years until it got into a shocking condition. In London generally there was not that regular, constant repair of the roads which should take place. Wood paving was allowed to go for six, eight, or ten years before anything was spent on repairs, and then the whole road had to be taken up and relaid.

Mr. E. P. Hooley (Nottingham) said he had pleasure in adding his testimony to what Mr. Thomas had said, and he certainly could not congratulate the author of the paper. He was one of those unfortunate men who had had some slight training in roadwork, and if his knowledge of the work did not take him further than the author of this paper it was a bad look-out for those who were under him. A more ridiculous statement than that the authority cut down the expenditure on the road for the sake of cutting down, without consideration of the condition of the roads, he had never heard. It was simply because they had not the money to waste in the manner in which automobilists wished them to waste it. The criticisms of roadmaking by persons who knew nothing about it actually irritated him—and that was saying a great deal. They read in the newspapers that Mr. Jones, who was a fishmonger in his own country, had actually been upon the roads for 1,000 miles in a motorcar, and that fishmonger proceeded to tell them how they ought to make roads. Why, county surveyors actually travelled 1,000 miles in a week. He thought the author of the paper must have lived in London, and never been out of London. He admitted that the roads were bad in London, but if Mr. Beaumont would come into the country they would show him some good roads.

Mr. J. P. Barber (Islington) said he was unfortunately irritated by his men in London, and he was bound to say that he quite agreed with Mr. Beaumont that in very many cases they were unable to get men who could repair their roads with the same skill and intelligence that the old roadmen in the country exercised to the present day. He had over and over again, when passing over a country road and seen the skilful way in which they repaired the road and trimmed up the bad places, wished that he could have such intelligent men to repair the roads in London. He had the greatest difficulty in selecting six men from 200 who could spread a single load of broken stone efficiently and economically. They seemed to get men in London who had failed at nearly everything else, and who seemed to think that all they had to do was to come and help the borough engineer to do his work. Then it seemed that almost every philanthropic person in London had a great number of persons in whom he was interested, and for whom when they were out of work—and they were nearly always out of work—the borough engineer could provide unlimited work. With this condition of things it was not surprising they were unable to produce the same results as the country districts who had the old country roadmen. It was a most difficult thing to get a workman to take any interest in his work, let alone show any intelligence. Unfortunately, the borough surveyor could not use the language he needed in order to express his annoyance at the stupidity and inability of his men even to carry out his instructions. Only that week he had given the clearest and most specific instructions as to the way in which certain portions of a macadam road were to be repaired, but on going to the road he found the men simply playing the fool. That was a very mild expression. He would have liked to use stronger language, but unfortunately one could not do that. It was exceedingly annoying to find the unskilled men they had to do their work with in London. They could not be overlooking all the men, and unfortunately they could not get the men who could be educated. He wished Mr. Thomas and Mr. Hooley would draft some of the intelligent old roadmen they had in the country into London, because they would not be long in finding situations. He did not find the men employed on the roads in the country were unskilled men. He had noticed some of the old men who were no longer able to pick up a road or spread the material trim up the turf, and make most beautiful curves. If he had the work to do in London, he would have had to send one of his staff with a theodolite to make it out and see it done. He hoped Mr. Beaumont would not go away and think there was no one there who did not lament the decadence of the skill and intelligence of the workman.

Mr. Knight (Mile End) said he regretted very much to hear the sad state Islington was in. He thought Mr. Barber, with his long experience, would have known how to talk to his own workpeople. If he did not, and would go to Mile End, he would give him a few lessons.

Mr. Paton (Plymouth) said he totally disagreed with Mr. Beaumont in his wholesale condemnation of the way in which local authorities kept up macadam roads. He could not help feeling that Mr. Beaumont's experience must be a London experience. The bad condition of the roads in London was due to the very causes for which Mr. Beaumont was asking for better roads. The indiarubber tyres of these vehicles tended to disintegrate the roads. Mr. Beaumont had dealt with generalities all through; he had accused the local authorities of parsimony; and he said the art of roadmaking had been lost—a statement which he totally disagreed with, for if they went to almost any county in England they would find the roads in better order than ever before. In his experience there were very few county councils or borough councils who cut down their estimates to such an extent as to spoil their roads. He had had 20 years' experience of roadmaking, and he could say that the roads were better now than they were even 10 years ago.

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The **President**, in closing the discussion, remarked that the county surveyors who had spoken were model men, and were serving model authorities. They all agreed that the standard of road-making should be advanced as far as possible, in order that the whole country should derive the fullest advantage from automobilism.

The vote of thanks having been accorded,

Mr. Beaumont, in reply, said, while thanking them for the very hearty vote of thanks suggested by Mr. Thomas, he could not help admitting that he was exceedingly pleased at the way in which his paper had been received. If everything he had said had been received as a matter of course, it would have been obvious that it was not necessary to say anything. With regard to Mr. Thomas's remarks, personally he had not said nothing had been done to improve the roads. Even supposing the horses' wear was no more than the wear of the vehicles, the wear by the horses would, at least, be taken away. As to the roads, he admitted he should like nothing better than that he should put his finger on the right spot. He did not mind in the least becoming "homocea" in this particular matter. He was afraid a great many more would be offended if he told them where, in riding thousands of miles, the roads were found to be good, and where found to be bad. Excellent roads had been found in parts of Cambridgeshire, and excellent roads incapable of improvement between Coventry and London. He was the last to say no improvement had been made. The modern methods were infinite improvements on the old methods. Mr. Thomas had said that his council gave him full rope, and he would have pleasure when in Bucks in seeing which of his roads were good and which bad. Where the roads were such that the rubber tyres threw the mud on to the pavements and sucked the moisture out from between the stones, he thought there might be another view expressed with regard to those roads. Mr. Hooley referred to the ridiculous statement he (Mr. Beaumont) made as to money not being placed at the disposal of surveyors, and then he gave the whole case away by saying they had not the money to waste as automobilists wished them to waste it. When Mr. Hooley spoke of his having only a London experience, it was probably known he had travelled all over the country and journeyed many thousands of miles on motor vehicles, and that he had some information as to where roads were good or bad. Mr. Barber, who was known to them all as one who knew all about roadmaking, had spoken about the difficulty of getting good men. As to London roads, it appeared that London was nearly 200 miles in diameter, if he might judge from the condition of the large percentage of the roads outside London. Mr. Paton spoke of his wholesale condemnation of the roads. He had done nothing of the kind. He admitted they were excellent in some parts, but they were execrable in others. He did not wish to point to anyone as being a greater culprit than anyone else. He did not speak of roadmaking as a lost art. If ever it was known how to make a road and how to maintain it, it was to-day as compared with any other time. They might know how to do it, but it required money and men to carry out their knowledge, and that was not what they had got for at least 60 per cent. of the roads of this country. Having said that, he was going to admit that the roads were better now than they were 20 years ago. But these were wanted better everywhere than they were 20 years ago. If anyone challenged what he said he should be pleased to take him on a motor carriage and let him see what would happen when that carriage was going more than a crawl. He would then get an idea of the vileness of the surface. The workmen were wanted just as continuously at the little work on the roads as they were on the permanent way of the railway, and that it could be done there was not the slightest doubt. He would admit that the roads were better, that everybody knew how to make roads, and that only the men and the money were wanted.

THE NEWCASTLE LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The following is the report of the committee to the annual general meeting of the Newcastle Local Section held on June 3, 1901 :

It is with pleasure that the committee beg leave to report that the first session of the Newcastle-on-Tyne Local Section of the Institution of Electrical Engineers has been brought to a successful close.

As the members are aware, this section was founded by your esteemed secretary, Mr. John F. C. Snell, the first meeting for that object being held at the Durham College of Science, Barras Bridge, Newcastle, on Dec. 13, 1899, at which Prof. Silvanus Thompson, D.Sc., F.R.S., then president of the Institution, presided. This meeting was also supported by Mr. A. K. Fawcus, member of council; Mr. W. G. McMillan, secretary to the Institution; the Rev. Principal Gurney, D.L.C., of the Durham College of Science; Prof. Henry Stroud, D.Sc.; Mr. John Holmes, M.I.C.E.; Mr. J. A. Jeckell, borough electrical engineer, South Shields; Mr. C. Burnet, borough electrical engineer, Carlisle; Mr. Alex. Moir, assistant superintending engineer, H.M. Telegraphs; Mr. F. Broadbent, and many other influential local gentlemen and members of the Institution. Letters sympathising with the movement were received from his Grace the Duke of Northumberland, K.G., the Right Hon. the Earl Percy, the late Lord Armstrong, F.R.S., and hon. member, Sir Andrew Noble, K.C.B., Sir Lindsay Wood, Bart., Sir James Joicey, Sir Lowthian Bell, the local members of Parliament, the mayors of Newcastle and of the neighbouring large towns, the Dean of the University of Durham, and others. After a most interesting address by the President of the Institution and by other gentlemen, and a hearty promise of support and welcome from the Rev. Principal Gurney and Dr. Stroud, the meeting unanimously agreed to support a local section, and a numerously signed petition was handed to the secretary, the number of signatures being 69 (members and associates).

At a general meeting held at the Durham College of Science on Jan. 29, 1900, a provisional committee, composed of the following members (with power to add), was formed: the Hon. C. A. Parsons, F.R.S.; A. W. Heaviside; John H. Holmes; W. C. Mountain; J. A. Jeckell; W. D. Hunter; C. Burnet; and John F. C. Snell. At the first meeting of this committee, Mr. A. W. Heaviside was unanimously elected chairman, and Mr. C. D. Hunter vice-chairman. Mr. H. F. Friedrichs was added to the committee. Mr. Snell consented to act as hon. secretary and treasurer for the first year, Messrs. John H. Holmes and Mr. J. A. Jeckell acting as hon. auditors.

The prayer of this petition was duly accepted by the London Council. The local section was formed (the first of its kind), and an allowance of 7s. 6d. per annum per member was granted towards its support. The chairman's presidential address was delivered at the Durham College of Science on May 15, 1900, this, the first meeting, being largely attended. The first annual dinner was held at the County Hotel, Newcastle-upon-Tyne, on Nov. 7, 1900, the President of the Institution (Prof. John Perry, D.Sc., F.R.S.) and the secretary (Mr. W. G. McMillan) honouring the occasion with their presence. There were also present the Mayor of Newcastle (Sir Riley Lord, Kt.), the President of the Local Association of Students of the Institution of Civil Engineers, the President-Elect, the President of the Institute of Mining Engineers, the Rev. Principal Gurney, and 56 members. Later the sphere of influence of the local section was fixed as follows—viz., all the country comprised within the counties of Northumberland, Durham, Cumberland, the town of Middlesbrough, and the Cleveland district. By the kindness of the governors and dean of the Durham College of Science the meetings of the section have been held there, where not only has a lecture theatre been placed at the disposal of the members for their general meetings, but also the secretary of the college has kindly allowed the committee to hold its meetings in his rooms, and a room has been placed at the disposal of the members for refreshment and conversation after the meetings.

At the time of formation the number of local members was as follows: 14 members, 19 associate members, 33 associates, and six students. During this first year many additions have been made: one member, eight associate members, nine associates, and three students, or a total of 97, less removals three associates, one student, the present strength of the local section being, therefore, 92 members of all classes. The following papers were read and discussed: (1) "Credit Systems of Wiring," by Mr. C. Turnbull, borough electrical engineer, Tynemouth; (2) "The Supercession of the Steam by the Electric Locomotive," by Mr. W. E. Langdon, member of council; (3) "Electrically-Driven Machine Tools, etc., in Engineering Workshops and their Advantages," by G. Ralph, member (which earned the Institution's extra premium of £5); (4) "Notes on Wiring Rules," by Mr. Frank Broadbent, member; (5) "South Shields Electricity Works," by Mr. J. A. Jeckell, borough electrical engineer, South Shields, associate. Some of the papers have been accepted by the Council in London for reproduction in the *Journal*.

It is with regret that the committee have to announce Mr. Snell's retirement from the post of hon. secretary, but it is with pleasure that this committee have to ask for the confirmation of his election as chairman during the coming session. The committee feel it both a duty and a pleasure to record their appreciation of the unremitting attention to the duties of his office of the retiring chairman, Mr. A. W. Heaviside, and their indebtedness to him for his constant efforts to further the local section's interests. It is hoped that members will make an effort to send in papers for the next session in time for their remission to headquarters, where selected papers will be printed for circulation and for insertion in the *Journal*. The local section is indebted to the principal and governors of the Durham College of Science for their kindness, and for the arrangements they have made for the reception and comfort of the members. The following are the nominations for the committee for the second year, and the committee have elected Mr. D. H. Kennedy as hon. secretary :

Chairman.—Mr. J. F. C. Snell.

Vice-Chairman.—Mr. John Holmes.

Committee.—Hon. C. A. Parsons, Messrs. H. F. Friedrichs, A. W. Heaviside (*ex-officio*), W. D. Hunter, C. D. Burnet, W. C. Mountain, J. H. Barker, R. S. Dobbie, Alex. Moir, G. W. Money, Dr. Stroud.

Hon. Secretary.—Mr. D. H. Kennedy, A.M., engineer, Post Office Telegraphs, Newcastle-on-Tyne.

Hon. Auditors.—Messrs. W. D. Hunter and Alex. Moir.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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POWER SCHEME PRACTICE.

Whatever may be the future of the numerous power schemes now in hand or projected—a question which, despite sanguine expectations, time alone can prove—their designs should certainly tend to stimulate original thought and healthy endeavour towards the attainment of a degree of perfection hitherto unknown in central-station practice. The cost of an undertaking per kilowatt of plant installed has always been a doubtful comparison of relative economy, and this fact is accentuated in the case of schemes for the supply of electrical energy in bulk, where it becomes a matter of necessity to secure maximum reliability of mechanical and electrical design quite apart from any question of economy in initial outlay. The policy thus dictated, having for its aim the elimination of breakdowns, will tend to weed out plant of weak mechanical design. It should also be remembered that with the success or failure of the pioneer power schemes in this country is involved the future of the electrical industry to an extent hitherto unappreciated—another vital reason why the question of doubtful economy in initial outlay must be avoided A further development, which has hitherto claimed scant attention, is the stimulus which the new schemes are likely to give to the adoption of very large units of plant, a natural consequence of the increased average load obtained per consumer. But whereas until quite recently anything in the shape of an electrical generator having an output of over 500 kw. was looked upon as exceptional in this country, steam-driven sets of 3,000 kw. capacity each have already been installed in many Continental stations. Sets for even larger outputs are now being built in Germany, and the fashion—born of necessity—to adopt these huge sets is bound to spread. How many of our manufacturers possess machine tools capable of tackling such sets? We are afraid that, owing to the want of sufficient foresight, the number is extremely limited at present, and that more orders will consequently go abroad. But in Mr. S. Z. de Ferranti we, at least, have one man whose constant advocacy of large units of plant, coupled with his long practical experience in their design, should help to redeem the situation; and there are indications—as, for instance, the reported new issue of capital of the company with which his name is so intimately associated—which would suggest that our trust is not misplaced.

PETER GUTHRIE TAIT.

With the death of Prof. Tait we have lost one of the pioneers who, by the inculcation and development of correct scientific principles, have helped to render possible the advances of applied science during the latter half of the nineteenth century. In 1856, when Tait's first scientific paper was published, the aspect of scientific opinion was so far different from that of the present day that it is difficult to imagine ourselves in the position of a scientist of that period. It is not alone that experimental knowledge was then so meagre as compared with our heritage at the present day, or that the science of physics was considered to be merely a happy hunting ground for the mathematician in search of recondite (and often ridiculous) problems, but that the air was thick with fallacious principles, survivals from an earlier period. Joule had after many rebuffs obtained a hearing for his classical researches, and Lord Kelvin (then William Thomson) had developed Carnot's principle so far as to include the absolute scale of temperature, and the law of dissipation of energy. These principles were not, however, generally accepted, and Tait's articles on "Thermodynamics," which appeared in the *North British Review* in

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1864, did much to clear the air. In 1867 appeared the first volume of the "Treatise on Natural Philosophy" by W. Thomson and P. G. Tait. Though never carried beyond the second volume, this work forms one of the most valuable text-books ever published, and may only be compared with Clerk Maxwell's "Electricity" and Lord Rayleigh's "Theory of Sound." In it, for the first time, the science of mechanics was based on Newton's laws of motion, combined with the principle of conservation of energy, with the result that mathematical investigations came to have an importance for the engineer, instead of merely providing grounds of dispute between pedants. How much have we gained alone in the simplification of our ideas of force! Where are now the *vis viva*, *vis inertiæ*, and *vis acceleratrix* of the earlier mathematicians? Tait's career opened when the law of the conservation of energy was still disputed. He lived to see energy bought and sold with as much assurance as would apply to any other marketable article. Although he was not actively concerned in the technical application of electrical discoveries, his labours must have had an indirect influence in this direction of no inconsiderable extent. Occupying the chair of physics at the University of Edinburgh from 1860 to 1901, he was brought into contact with large numbers of students who always remembered his influence with respect and gratitude. A keen controversialist, he made some enemies and many friends. As a lecturer he was studiously simple in his methods, using experiments only to illustrate or elucidate his meaning. He objected to mere display, as apt to distract the mind of the student; excessive note-taking on the part of students also met with his disapprobation. He possessed a well-defined personality, and was in some respects unconventional to the verge of eccentricity. He refused the honour of the fellowship of the Royal Society of London, on the grounds that he was satisfied with the fellowship of the Royal Society of Edinburgh. For some time he had been in failing health, having suffered much in the loss of his son Frederick, the famous amateur golfer, who was killed in South Africa shortly after Magersfontein. He died in Edinburgh at the house of his friend and pupil, Sir John Murray, on July 4, at the age of 70 years.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

INDUCTION.

SIR,—A well-known writer on electrical matters has privately communicated some criticisms on my letter which appeared in your columns on Oct. 26 last. His arguments are not satisfactory, but they may have occurred to many of your readers, and I should therefore like to state my case in a manner to which they are not even apparently applicable.

The principle discovered by Faraday may be stated in this way: "Any change in the number of magnetic lines passing round a conductor tends to produce a current that sets up a magnetic field opposing the change in the original field." This we will call the *fluctuation* principle, and I have found it applicable without any difficuly to every case that has come under my notice. But we frequently find, even in works by the most esteemed writers, a statement which we will call the *cutting* principle. For instance, in the fourth edition of his book on "Dynamo-Electric Machinery," p. 22, Dr. S. P. Thompson says: "Faraday's principle may be enunciated as follows: When a conductor is moved in a field of magnetic force in any way so as to cut the lines of force, there is an E.M.F. produced in the conductor, in a direction at right angles to the direction of the motion, and at right angles also to the direction of the lines of force, and to the right of the lines of force as viewed from the point from which the motion originates." I do not wish to lay much stress upon the fact that the induction may take place without any motion of the *conductor*, nor upon the fact that (except where the conductor is at right angles both to the magnetic lines and to the line of motion) the statement regarding the direction of the E.M.F. is incorrect. These inaccuracies are merely a matter of carelessness in expression; what I object to is the fact that in certain cases it is difficult to see how the principle applies, even when worded in the best possible manner. The following instance will show what I mean.

A closed coil of wire is wound round the yoke of a permanent horseshoe magnet with its keeper attached, and the sudden removal of the keeper sends a momentary current through the wire. Now, an elementary student who had been taught the fluctuation principle could account for this current immediately, knowing that the removal of the keeper would cause a diminution in the magnetic flux. But one who had been taught the cutting principle instead would probably doubt that a current would be induced, there being apparently no mutual cutting of conductor and magnetic lines, and finding that there actually was a current, he could only account for it by *supposing* that the lines which had disappeared had first cut across the wire, an unscientific assumption which is wholly unnecessary in the case of the fluctuation principle.

Yours, etc., W. F. DUNTON.

Brixton, S.W., July 7, 1901.

GILBERT'S SELF-DRIVING WEIGHT OSCILLATING MOTOR.

SIR,—In reply to Mr. Gilbert, I am not sceptical, only convinced that his invention cannot involve any principle contrary to natural law. He need not endanger the security of his inventions; let him close with your acceptance of his invitation to visit him. It is evident in his first letter that he claimed to have invented a perpetual-motion machine. In his letter of June 15 he has yielded on the main point, left me nothing to tackle, and coolly referred me to "those engaged in the flying-machine business." This was quite uncalled for. I have given him no ground for imputing to me the opinion that the idea of a successful flying machine is a fallacy. The flying machine is an extremely difficult problem for greater minds than Mr. Gilbert's; a perpetual-motion machine is not merely difficult, but on natural principles impossible. I do not forget that Mr. Gilbert repudiates the idea of perpetual motion, but would like to know what he means by "self-driving." Anyhow, what possible connection is there between the flying machine and the question at issue? Is it a herring across the trail, or something for him to shelter behind?

If this discussion is to continue, will Mr. Gilbert give a straightforward answer to this question: Is the working of his machine the result of energy imparted to the whole or any part of it, or is it accomplished without any energy being so imparted? In other words, will it give out energy without previously or at the same time receiving energy?

With reference to Mr. Gilbert's 1,000-guinea challenge, what I have maintained is not that the principle of his machine is unfavourable, but that his original claim to have invented a perpetual-motion machine is absurd.—

Yours, etc., G. EVANS.

VERBAND DEUTSCHER ELEKTROTECHNIKER AT DRESDEN.

[BY OUR OWN CORRESPONDENT.]

(Continued from page 20.)

Prof. Dr. Budde then read the report of the commission appointed to formulate a set of safety rules for electric railways. It was recommended that the rules provisionally accepted at Kiel last year should now be definitely agreed to subject to certain alterations. This proposition was carried after a brief discussion. The alterations provide, amongst other things, that the sectional area of all conducting wires within the train, with the exception of the

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trolley lines, shall be proportioned as follows, relative to the normal capacity of the protecting fuse, or larger:

Sectional area in square millimetres.	Normal capacity of fuse in amperes.
0·75	4
1	6
1·5	10
2·5	15
4	20
6	30
10	40
16	60
25	80
35	90
50	100
70	130
95	165
120	200
150	235
185	275
200	330

The normal current capacity of the fuses provided to protect the trolley lines may be 50 per cent. higher than in the above table.

Wires serving to carry the braking current must have a capacity at least equal to that of the trolley lines.

The axles of the controllers must be earthed. Each motorcar must have at least one main safety fuse in the motor circuit, while the lighting and heating wires must be separately protected. A short-circuit brake must not be provided with a fuse.

The report of the commission entrusted with the formulation of machine standards was next read by Herr Dettmar, and it was decided by the meeting to provisionally adopt the recommendations contained therein for one year.

A lengthy discussion arose over the standards for rubber-covered wires proposed by the commission on wire and cable, but the report was ultimately adopted. The particulars of one of the standards may be given as an example:

Rubber Tape-Covered Wires (suitable for use in dry rooms with pressure up to 250 volts).

Rubber-covered wires may have single conductors of from 0·75 to 16 square millimetres sectional area, or stranded conductors of from 0·75 to 150 square millimetres sectional area. The copper core must be tinned, then covered with cotton, and over that with commercially pure unvulcanised rubber tape. The rubber covering per 100m. of single-core conductor must possess the following weight:

Sectional area of copper, in square millimetres.	Weight of rubber, in grammes.	Minimum number of wires in stranded conductors.
0·75	120	7
1·0	130	7
1·5	150	7
2·5	180	7
4·0	220	7
6·0	260	7
10·0	320	7
16·0	400	7
25·0	550	7
35·0	650	19
50·0	800	19
70·0	1,000	19
95·0	1,200	19
120·0	1,400	19
150·0	1,550	19

Over the rubber covering cotton tape is wound, a braiding of cotton hemp or similar material being superposed and suitably impregnated. Such wires are not subjected to an insulation test. These wires, when provided with stranded cores, may be employed in twin and triple arrangement, etc., and as such must be subjected in a dry state to an insulation test of half-an-hour's duration with 500 volts alternating current.

(To be continued.)

MUNICIPAL ELECTRICAL ASSOCIATION.

Glasgow Congress.

The following is the annual report of the council which was presented at the business meeting of the above association held during the Glasgow congress:

In presenting the sixth annual report, the council is pleased to be able to record the continued growth and development of the association. During the past year the following 24 Electricity Committees have been elected members: Rochdale, Buxton, Chesterfield, Middleton, Shipley, Long Eaton, Motherwell, Poplar, York, Edinburgh, Wigan, Leeds, Ashton-under-Lyne, Birkenhead, Wakefield, Hoylake and West Kirby, Sunderland Tramways, Bootle, Battersea, Belfast, Leigh, Leyton, Doncaster, Stockport Tramways. One committee has resigned. The number is now 99, an increase of 23. Thirty-seven chief engineers have been elected—viz.: D. F. Adamson, Southend-on-Sea; R. L. Acland, Chesterfield; S. Ashley, Pietermaritzburg; R. Birkett, Burnley; S. E. Britton, Motherwell; C. C. Aitchison, Rochdale; J. Christie, Brighton; J. H. Crowther, Wallasey; A. Day, Bolton; H. Gray, Accrington; R. V. Macrory, Londonderry; H. B. Maxwell, Partick; E. G. Okell, Plymouth; W. J. Proctor, Nuneaton; A. H. Rowe, Bury St. Edmunds (since deceased); L. W. Schofield, Shipley; W. A. Tester, Lancaster; W. C. P. Tapper, Whitechapel; E. Marples, Hoylake; J. T. Marsh, Dudley; A. R. Sillar, Colchester; R. S. Downe, Southport; A. H. Shaw, Ilford; A. H. Forbes Mackay, Battersea; R. Blackmore, Wakefield; J. Vaudrey, Birmingham; W. A. Vignoles, Grimsby; J. Foster, Leigh; J. A. Fraser, Nelson; J. R. P. Lunn, Darlington; J. D. Pember, Farnworth; F. H. Lewis, Leytonstone; H. J. Friedrichs, West Hartlepool; A. G. W. Carter, Stockport; J. C. Gill, Peterborough; E. Calvert, Buxton; H. F. Street, Halifax. Seven members have resigned on leaving municipal service and one has died, there being now 114 members in this class, an increase of 31. Three associate members have been elected as follows: W. J. Poole, Glasgow; J. C. A. Ward, Glasgow; A. H. Toyster, Edinburgh. There are now six associate members on the register. Six associates have been elected—viz.: T. S. Bazzard, Bedminster; R. Cairns, Glasgow; A. Howell, King's Lynn; C. L. E. Stewart, Rochdale; C. E. Heath, York; S. T. Blyth, Great Yarmouth. One has been transferred to the class of associate members, six to full membership, and seven have resigned. There are now 49 associates, as against 53 last year. The total membership in all classes is now 268.

Wiring Rules.—The council has had under consideration the advisability of issuing wiring rules, but in consequence of the Institution of Electrical Engineers having appointed a committee to amend its existing rules and the association being represented on the committee by Mr. C. H. Wordingham, a past-president, it was deemed undesirable to take further action in the matter. Subsequently, however, the Institution of Electrical Engineers invited the association to appoint a representative to sit on the committee, and the council accordingly appointed Mr. H. Faraday Proctor to represent the association.

Board of Trade Regulations.—The council was asked if it would support the London electricity companies' appeal to the Board of Trade for an alteration of the proviso to Clause 6, Section B, of the regulations dated March 4, 1896, relating to change of pressure. The matter was one of great importance to all undertakers, as it was impossible to make any alteration in the pressure of supply if every consumer did not consent; no appeal to the Board of Trade or for arbitration in case of disagreement between the consumer and the undertakers being provided for. A special meeting of the association was held in London in November, when a resolution was passed to support the appeal. A lengthy public enquiry was held in London by the Board of Trade, as the result of which the clause has been altered in the manner desired.

Incorporation of the Association.—A special general meeting of the Municipal Electrical Association was held in London on Nov. 20, 1900, to pass resolutions relating to the incorporation of the association, and to authorise the hon. solicitor (Mr. G. Pearson) to take the necessary steps in applying to the Board of Trade for a license to omit the word "Limited." After negotiations, extending over some months, the association was incorporated, and finally registered on April 15 last. As hon. solicitor Mr. Pearson has rendered the association invaluable services in connection with this matter and on many other occasions, and the association is specially indebted to him for carrying through the incorporation, the result of which is to give the association a legal standing. It will also enable its work to be carried on a manner which would otherwise be impossible, while the fact of its being a corporate body enhances the value and privilege of membership, and adds materially to its influence in many ways.

Benevolent Fund.—In consequence of the treasurer of this fund (Mr. C. H. Wordingham) having resigned his membership and connection with the association on his leaving municipal service, it became necessary to appoint a treasurer, and Mr. J. H. Rider, hon. treasurer of the association, was asked to undertake the duties, and has consented to do so. The council call the earnest attention of members to the benevolent fund, and asks them to give it their hearty support. Its objects are fully set out in the published particulars bound up with the memorandum and articles of association, a copy of which is being sent to every member. Donations and subscriptions to this fund at present only amount to £45. 9s. 6d.

Prize Scheme.—The council regrets that the response to its offer of a prize of five guineas for a paper was so small that it did not feel justified in proceeding with the matter, and considers the associates, to whom it should appeal, do not properly recognise the advantages to be derived from competing, whether successfully or not, but it is hoped that this will be more fully recognised in the future.

Telephone Wires and Overhead Trolley Wires.—Urgent representations having been made to the council that it should invite members and other electrical engineers in charge of the electric tramways to meet and discuss the question of formulating a set of rules for observance by the police in cases of emergency, the opinion of the members was taken, and the matter is to be discussed at the business meeting of the convention at Glasgow.

Repayment of Loans.—The council have under consideration the question of endeavouring to obtain an alteration in the method of repayment of loans so as to relieve local authorities from being compelled to pay the annual instalment on a given loan for the first three years. The matter is still engaging the attention of the council, and a sub-committee has been appointed to deal with it.

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Rucker Defence Fund.—The council have pleasure in reporting that this matter has been satisfactorily terminated. Judgment, with costs, was given for the defendants, and a substantial portion of the contribution of each subscriber has been refunded, the plaintiff agreeing not to bring action against any of the subscribers. The council feels that the hearty thanks of the association are due to the following gentlemen, who formed the sub-committee: Alderman Pearson, Councillor Ellis, A. B. Mountain, and T. P. Wilmshurst.

Generally, it will be seen that while the association has made considerable progress, and its membership has largely increased, totalling now nearly 270, there are numbers of committees and engineers who have not as yet qualified for membership, and it should be the duty and pleasure of members to introduce their committees, members of their staff, and others whom they know to be qualified for the privileges of membership, and in so doing it should be borne in mind that the question of joining an association of this kind is not so much how it will benefit the member personally, but how, by joining, he may assist in forwarding the objects for which it was founded; for while membership in a corporate body, such as this now is, must be of value, it should not be forgotten that it carries with it responsibilities, one of the chief of which is to promote the objects of the association so far as possible, and the most practical way in which this can be done is by increasing the membership, and thereby enabling the association to greatly extend its scope and influence.

No report would be complete without acknowledging the way in which the Electricity Committees of the various municipalities have supported the association, and of its appreciation of many kindnesses received from municipal authorities and others when holding the conventions.

The report was adopted, and it was agreed that the next annual meeting should be held in London. The following were elected officers for the forthcoming year:

President.—J. H. Rider, London County Council tramways.

Vice-Presidents.—J. F. C. Snell, Sunderland; T. P. Wilmshurst, Derby.

Past-Presidents.—H. Faraday Proctor, Bristol; W. A. Chamen, Glasgow; A. B. Mountain, Huddersfield.

Council.—L. Andrews, Hastings; A. S. Barnard, Hull; J. E. Edgcome, Kingston-on-Thames; A. Ellis, Cardiff; J. S. Highfield, St. Helens; Bailie A. D. Mackenzie, Edinburgh; F. A. Newington, Edinburgh; Dr. Panton, Bolton; R. C. Quin, Blackpool; Councillor J. P. Smith, Barrow-in-Furness; C. D. Taite, Pendleton; Councillor Worthington, Wigan.

Hon. Solicitor.—Alderman G. Pearson, Bristol.

Hon. Treasurer.—J. H. Rider, chief engineer, London County Council tramways.

Hon. Secretary.—E. T. Ruthven Murray, Public Offices, Dyne-road, Kilburn, N.W.

Secretary.—C. McArthur Butler, St. James's Hall, Piccadilly, W.

An extraordinary general meeting was afterwards held, at which the following resolution was passed: "That the assets and liabilities of this association be transferred to and accepted by the Incorporated Municipal Electrical Association as from the present date."

The tabulated results of brake tests given below should have accompanied Mr. A. L. C. Fell's paper on "Braking Apparatus for Electric Cars," reprinted in our last issue:

BRAKE TESTS.

Date.	Time, secs.	Speed, miles per hour.	Distance travelled before braking.	Distance travelled after braking.	Remarks.
1901.		*Hand Brake Only.*			
March 12.....	24⅘	12·88	461ft.	61ft. 02in.	
,, ...	27⅖	11·47	461ft.	63ft. 0in.	
,, ...	30	10·48	461ft.	43ft. 0in.	
,, ...	21⅖	14·68	461ft.	77ft. 0in.	
,, ...	32	9·83	461ft.	41ft. 0in.	Rail greasy.
,, ...	21⅗	14·68	461ft.	120ft. 0in.	
,, ...	21	11·16	344ft.	57ft. 0in.	
,, ...	22	14·29	461ft.	35ft. 0in.	
,, ...	22	14·29	461ft.	69ft. 0in.	
,, ...	25	12·57	461ft.	32ft. 0in.	
,, ...	28	11·22	461ft.	31ft. 0in.	
April 19	20	14·42	423ft.	49ft. 6in.	Rail dry, no sand.
,, ...	20	8·26	243ft.	59ft. 0in.	
,, ...	19⅗	14·86	423ft.	54ft. 6in.	
		Slipper Brake Only.			
March 26.....	27	11·64	461ft.	74ft. 6in.	
,, ...	27	11·64	461ft.	96ft. 10in.	
,, ...	25½	12·32	461ft.	102ft. 6in.	Rail dry, no sand.
April 19	20	14·42	423ft.	132ft. 0in.	
,, ...	20	14·42	423ft.	102ft. 9in.	
,, ...	15	10·04	243ft.	125ft. 0in.	
		Electric Brake Only.			
March 26.....	25	12·57	461ft.	88ft. 0in.	
,, ...	25	12·57	461ft.	46ft. 0in.	
,, ...	18⅗	12·6	344ft.	55ft. 9in.	
,, ...	26	12·08	461ft.	73ft. 6in.	Rail dry, no sand.
*April 19.....	22	13·10	423ft.	147ft. 0in.	
† ,, ...	20	14·42	423ft.	105ft. 0in.	
† ,, ...	12	13·80	243ft.	120ft. 0in.	

* Electric full. † Electric varying.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

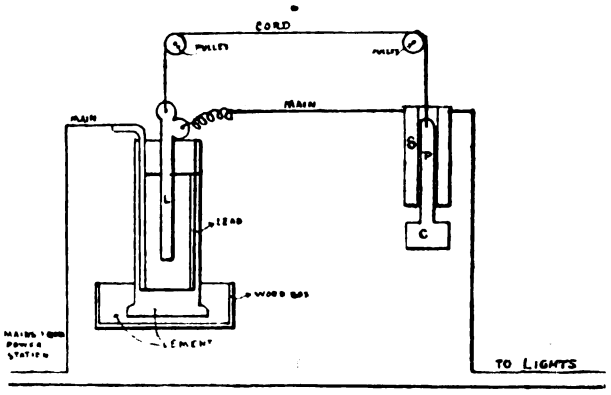
393. What arrangement with three assistants working eight-hour shifts, plus a day-shift assistant, is best adapted to give to each the least possible Sunday labour?—A. G.

394. Describe fully some method of testing the qualities of two samples of carbons sent for use with an open arc lamp.—J. C. R.

ANSWERS.

***Question No. 385.*—In a house-lighting installation with three-quarter mile distance between the power-house and the house, would it be feasible to regulate the voltage on the lamps automatically by means of an adjustable resistance placed at the house and regulated by an electromagnetic device, and if so, what would be the best and most reliable arrangement? Has a similar arrangement been used at any existing installation which you know of, and with what success? The voltage at the power-house is assumed to be kept constant, but the lamp load is assumed to vary from 5 to, say, 100 16-c.p. lamps.**

Best Answer to No. 385 (*awarded* 10*s.*).—There is no doubt but that it would be feasible to devise an adjustable resistance actuated by an auto-electromagnetic device for compensating for the voltage drop in the mains. As the voltage of supply is not stated, nor the size of the mains, exact figures cannot be given for the dimensions of the resistance. One of the best, and certainly the cheapest and easiest to make, would be a water resistance, which can be made as follows: Get an ordinary earthenware drain pipe, fit the end in a box as shown and fill with cement; this will be perfectly watertight. Curve a sheet of lead similar to the zinc of a primary battery, with a lug to connect one of the mains. The other main is connected to a round rod of lead by a flexible cable, which also has an eye cast on the



end to secure a cord. The diagram will make the rest understood. S is a solenoid round which the main current flows; P, a soft-iron plunger; C, a counterweight which is so arranged that when no current is flowing C will fall and lift the rod, L, partly out of the liquid, thus putting in resistance. As the current rises the solenoid sucks the plunger, P, up and lets the rod, L, down, taking out resistance. Acid will be found to be the most suitable substance to mix with the water, as the resistance must be small. The writer devised this arrangement after a good deal of experiment for a similar installation, and found it to be the only reliable device. He found that wire resistances with sliding contact were apt to stick, and were

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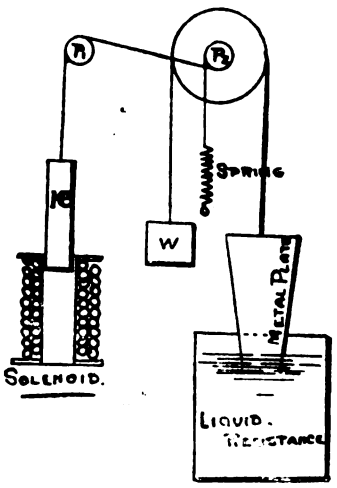
very costly. The above arrangement has been working for years and has given every satisfaction.—C. L. E. S.

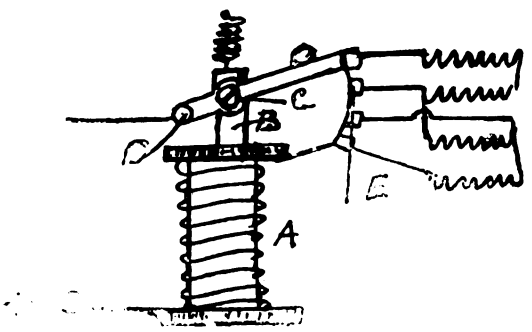
Answer to No. 385 (*awarded* 5*s.*).—Such a piece of apparatus as "R. M. W." wishes would be very convenient in installations similar to that in which he is concerned, and I do not see any difficulty in designing such as would automatically regulate the voltage, and thereby increase the light and life of the lamps. Now, as the volts lost in the mains are proportioned to their resistance, R, and to the current, C, C R = V = volts lost. Then to keep V constant with variations of C, it stands to reason that R must be inversely varied with C. Perhaps the best way to do this would be by the aid of a liquid resistance, worked by a sliding core inside a solenoid connected in series with the lamps. A glance at the diagram will show more clearly what is meant. Make a solenoid, S, with wire heavy enough to carry the full current required by the total number of lights and fix a pulley above it so that the soft-iron core, I C, will hang centrally above the coil. After taking a turn round pulley, P, attach the end to an adjustable spring, as shown.



Now fasten the plate of the liquid resistance to another cord and give it a complete turn round a pulley of larger diameter (but fixed on the same shaft as P_1) to give it the requisite lift. To the other end of the cord fasten a weight, W, to balance the system. The resistance plate must not be allowed to come entirely out of the liquid, and care must be taken to prevent evaporation from doing this. When a current flows it magnetises the solenoid, drawing down the core against the action of the spring, thus allowing the plate to dip deeper into the liquid, and thereby lessening the resistance. When switched off, the spring draws the plate back to its original position. I have never seen any apparatus exactly similar to this, but I feel confident that such an arrangement would work, and as it is quite inexpensive to make I think the experiment worth a trial.—McC.

Answer to No. 385 (*awarded* 5*s.*).—I once knew a similar case to this, and a pupil was put to adjust the E.M.F. to requirements during the time of fluctuation of the current, which he had to watch by means of an ammeter. He had to book the current every five minutes to keep him alert. This plan answered very well. As far as my experience goes no automatic arrangement has ever been made to give satisfaction under these circumstances, although many attempts have been made and considerable ingenuity displayed. All such instruments "hunt"—*i.e.*, they overcorrect an error, and then they set to work to correct the error they themselves make. It is easy to design an instrument to make the adjustment, but in practice it does not answer its purpose. The great difficulty is to make them sufficiently sensitive and at the same time quick and decided enough in action. I have made several, and have thought a solenoid a much better device than an electromagnet, because it gives greater movement, and I have found the action of gravity preferable to that of springs. According to the requirements of the case in the question, the current would vary from three to sixty amperes, and the E.M.F. at the lamps would require readjustment for every variation of two volts. The resistance of the line, supposing it to carry current at a maximum density of 1,000 amperes per square inch of sectional area, would be about one ohm, and this resistance with a current of three amperes (enough for five lamps) would entail a loss of three volts in the line (lead and return), and again assuming all the lamps to be alight and the current required 60 amperes, the loss in the line would be 60 volts, therefore the readjustment would have to be made for every increase of two amperes, and for every decrease of two amperes, or 30 times during the increase from minimum to maximum, and 30 times again during the decrease. No automatic electromagnet or solenoid could deal with such a wide fluctuation of current as this successfully, but, say, 30 solenoids might be arranged to pull up counterweights when the current reached a certain value, and to let these weights down again as soon as the current fell below the desired amount, and each of these movements of the counterweight might be made to make contact in a local bell circuit, and so call an attendant to make the necessary adjustment in the power-house to the lamp circuit. The difficulty might be somewhat lessened by the use of high-efficiency lamps, which would not take so much current as that estimated above—viz., ·6 ampere each. If a battery is used, it would be more economical to increase or diminish the number of cells than to use a resistance according to requirements.—F. G. A.

Answer to No. 385 (*awarded* 5*s.*).—Everyone who has had any experience with lighting when the power-house is at a distance away from the centre to be lighted, has met with the difficulty of keeping the voltage at the lamp terminals constant, and thus avoid unpleasant lighting effects To get over the difficulty, larger mains might be used, and thus the fall of potential kept low; but this is not always economical, for in house lighting sometimes a great demand is made on the mains, going up to twice the normal load, but this only happens a few times in a year, so it would be expensive to put in larger mains. The voltage might be regulated from the engine-house, by switching in more cells or increasing the voltage of the machine, the man in charge being guided by a lamp, which is connected to the house-board. I have seen an ingenious device for regulating the voltage at a distance, and this is accomplished by switching in, or out, resistances in series with the line. A voltmeter was coupled up to a bell and battery in such a manner that when the voltage rose above a certain point, the dynamo attendant's attention was called by the continuous ringing of the bell. The attendant would then switch in resistance until the proper voltage was again reached. I was told that this simple apparatus saved an enormous quantity of lamps in a year. From the question it appears that a resistance like the one mentioned must be automatically regulated at the house. Such an apparatus is shown in the sketch.



The main current passes round a solenoid, A, which exerts a pull on the iron core, B, in proportion to the current passing round A. On B a contact arm is screwed at C. This arm is fast at D, but the other end passes over the resistance contacts, E When the maximum current is passing round A, all the resistance is cut out, the current travelling down the arm to the lamp contact, D. This method will be found very successful if the voltage is kept constant, the voltage supplied to the lamps being varied as more lamps are switched in or out. The arm, C, should never break contact at E, for obvious reasons. F. M. M.

***Question No.* 386.**—Describe and illustrate the method of distribution adopted in three-phase currents, the high-tension

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current being transformed down to 220 volts. Arc and incandescent lamps are to be used, and, if possible, on the same circuits or phases. Explain the method of dividing the load amongst the three phases.

Best Answer to No. 386 (*awarded* 10*s.*).—Before answering "R.'s" question, I should like to remind him that three-phase currents have no advantage over single-phase where power is not used, and the lamps supplied with alternating-current single-phase currents owe their success to the ease by which their pressure may be raised to a voltage far in excess of anything continuous, and the easy way they may be transformed down again to the voltage allowed by the Board of Trade to enter a house. Three-phase currents owe their success to their ability to generate a revolving magnetic field, and this is only useful in motors. A converter may be one, two, three, etc., phase to continuous, and would be used oftener for single-phase but for the difficulty on the motor side (inability to start themselves). There are two types of windings commonly used for three-phase work—"star" and "triangle." In the "star" winding one end of each three windings are connected

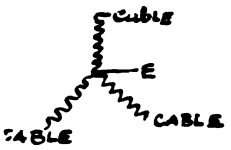

Fig. 1.

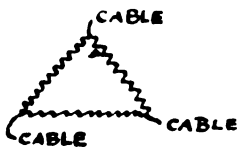

Fig. 2.

together and usually earthed; the three wires of the cable of the overhead conductor are connected to the other ends (Fig. 1). In the "triangle" winding the three conductors are connected together so as to form a triangle to each corner of the triangle the cable is connected (Fig. 2).

In answering this question, we had better start at the central station. We have two windings to choose from. If we connect our alternator "triangular," then our voltage will be smaller than if we had it star connected. A look at Figs. 1 and 2 will explain this. The difference is 1 to 1·73. The current is taken out of the machine by collecting rings and brushes if the armature revolves; if the field revolves—this is usual—by terminals, usually at the bottom of the armature, and well insulated. Our wire then passes through fuses or magnetic breaks and switches; the three levers are coupled to one handle, and if very high tension is employed the contacts are covered with oil. In cases where, say, 20,000 to 30,000 volts are employed, the generator will generate at 5,000, say, and a transformer will insert the rest. The primary of the transformer is sometimes made to regulate by having coils capable of being cut out by a suitable switch.

The conductors are of copper or phosphor bronze, if an aluminium company has not shares in your station. In England, unless the wires run over private property, underground cables for this high tension must be employed. In America they are usually overhead (when it is fine). The insulators are of porcelain. The white ware seems to be in favour at present. Oil insulators had better be used, unless you can get oil of greater specific weight than water. Our sub-station ought to be placed near the work or in the centre of it, because of the now (low-tension) great cost of feeders. If we use the "star," we are able to get two voltages and if our load is not constant and impossible to balance, then a wire had better be run from the centre of the "star" of our generator to the transformer and so on, so that if there is only load on one phase our generator acts as a single-phase alternator. The winding is shown in Fig. 5. A, B, and C are connected together, and, as above, either connected to earth or to a fourth wire. If this fourth wire was not employed, with an out-of-balance load the generator armature would not have the load equally distributed over its surface. The connections of the "star" winding is shown in Fig. 3. The fourth wire is connected to D from the generator to transformer, and so on. It will be seen that if A is placed on one phase only, or is sometimes used alone, the cross-section of D must equal A, B, or C. For motor work, A, B, and C are only used. For the triangle winding, A B, C D, and E F are connected together, and the cable is connected to each of these three points (Fig. 5)

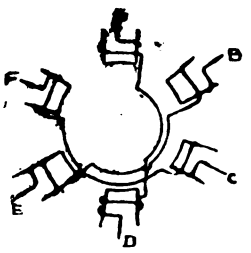

Fig. 5.

Fig. 4 shows the method of distribution; lamp and motor are connected up the same way. In conclusion, I should advise "R." to employ rotary converters or motor-generators for his lighting. We all know alternating-current arc lamps are good, but continuous are better.—T. W. S. H

Answer to No. 386 (*awarded* 5*s.*).—The general arrangement of a three-phase system of distribution such as is employed in central-station work is indicated in the accompanying sketch. A, B, and C represent the three phases of a 220-volt secondary system, and O the fourth or middle wire. With a mixed lighting and motor load, it is advisable to include the fourth wire, as better regulation of the lamp voltage is obtained, and it is also possible to effect a saving of about 40 per cent. in the amount of copper required, such as would be necessary with a similar load, and the utilisation of only three phases, A, B, and C. Further, there are also two voltages available: first, between any of the three phases, A, B, and C, we have a voltage of, say, E volts—

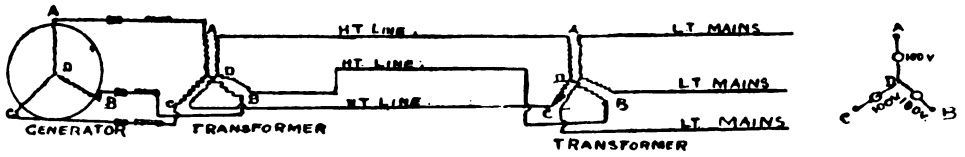

Fig. 3.

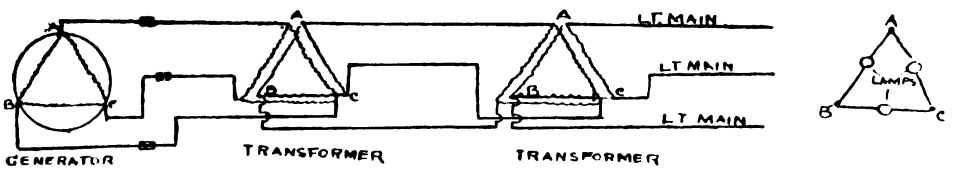

Fig. 4.

220 in the present instance; and, secondly, between any of the three phases, A, B, and C, and the fourth wire, O, we have a voltage equivalent to $\frac{E}{\sqrt{3}} = \frac{220}{\sqrt{3}} = 127$ volts. Hence we can have 220 volts for a motor load and 127 volts for lighting. An examination of the above sketch will make it evident that, so far as the wiring arrangements are concerned, no greater difficulties are to be encountered than with a continuous-current installation. It is only necessary to take two wires from any of the phases and connect the incandescents across these. Of course, the same precautions must be taken as regards the number of lights connected on to any circuit as is usual when wiring on the continuous-current systems. In the circuit of lamps, marked L on the

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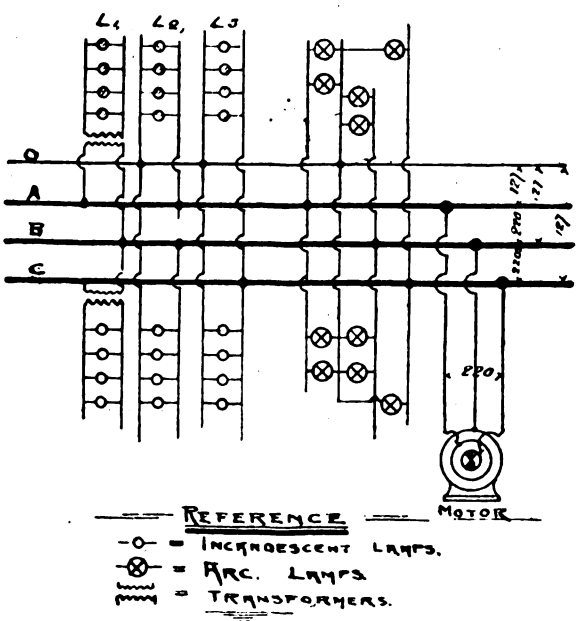
sketch, I have shown transformers for the purpose of illustrating the method of reducing the lamp voltage to any desired figure. This is the method usually adopted when feeding an isolated installation of the high-tension feeders. In the present instance, where the secondary voltage is only 220, the wires would be directly connected to phases A and B, or to B and C. If the four-wire system of distribution be adopted, the circuits would be arranged across the middle or fourth wire, and any of the phases A, B, and C, the voltage across the lamp being 127 volts. Arc lamps can also be connected across any two phases in precisely the same way as the incandescent circuits are arranged, and, if necessary, in series to suit the line voltage. If the arc lamp



load is sufficiently large to admit of the installation of a rectifier, do so by all means, for not only will the lighting effect be greater and better, but steadier burning of the arc lamps will be obtained from the rectified currents. As is well known, an ordinary arc lamp consumes 12 amperes, and to produce the same lighting effect 20 amperes is required if alternating current be employed. The improved lighting effect obtained will more than pay for the initial cost of the apparatus and the conversional losses. Regarding the dividing of the lighting load (or, in other words, the balancing of the load between the phases), this can only be determined by taking local considerations into account. For instance, in town lighting we would balance similar institutions together, such as theatres, warehouses, shops, and factories. This is the nearest and most exact way of obtaining, as far as possible, an equal load on each of the phases, as the demand for lighting in the above instances is likely to occur at about the same time. Of course, there will be a variation of load due to different customers switching in and out of lights at any time, and the distributor can only rely on one customer balancing another.—R. N. FULTON.

Answer to No. 386 (*awarded* 5*s.*).—It is a well-known fact that there is no great advantage in using polyphase currents for an ordinary lighting circuit distribution unless a power service is required off the same network. Three-phase currents feeding into sub-stations are distributed from the secondaries by either the three or four wire systems. The three-wire system is not so much used in practice, because of the greater difficulty in balancing than that of the four-wire system, in which the fourth, or neutral, wire is led from the common centre of the three secondaries. The voltage between this neutral wire and that of any phase wire is $\frac{1}{\sqrt{3}}$ the voltage between the phase wires.

This system is very convenient and economical in the secondary distribution systems. The lamps are connected between the neutral and any phase wire which, with a pressure of 220 volts per phase, will give a pressure of 127 volts between the neutral and the phase wire. The motors are connected between the three-phase wires. The neutral wire of this system carries the out-of-balance lamp current only. Earthing the neutral wire at the station is a point in which many engineers are at variance in this country, but, in the writer's opinion, the neutral should be earthed—provided that the generators are star connected. Triple-concentric mains should not be used, unless they feed the sub-stations direct, or are fed direct into the house transformer. The advantages of using the ordinary three-core cable for purposes of general distribution outweighs that of the triple-concentric cable, on account of the frequent cutting of the two outers for the necessary connection of consumers.

With regard to the unbalancing of three-phase systems, this is made more of than is actually the case, for providing that proper attention be paid to balance the system no troubles whatever need be experienced as to the pressure regulation of the different phases. It may be stated that at Prague, which was the first town to supply current (three phase) for lighting and traction off the same 'bus bars, public lighting by arc lamps are also supplied from the same circuit. The traction current is derived from synchronous motor-generators situated in sub-stations along the line. No trouble whatever has been experienced with the pressure regulation in this town, for anybody who has seen the public lighting can testify as to the present regulation. For consumers using more than 12 8-c.p. lamps all three wires are run into the building. Three-core three-phase transformers are used on the system, which in themselves tend to balance any inequality which may arise. Where the four-wire distribution is in use with a general power and lighting service, besides the motors and transformers tending to equalise any unbalancing, a three-core transformer, but wound only with a single coil on each limb, can be inserted at any convenient point in the network. The coils are connected in star, the neutral point being carried to the fourth wire of the system. These choking coils exert a great influence in keeping the balance. But, as previously stated, provided due attention be paid to the balancing of the system, and a fair quantity of transformers and motors used, no troubles as to pressure regulation will be experienced.—JUNO.

Answer to No. 386 (*awarded* 5*s.*).—The method of distribution that should be used on three-phase work depends largely on the nature of the load. If the amperes taken by each of the circuits shown in Fig. 1 are always equal this three-wire arrangement suffices, but if the load is unevenly distributed among the circuits the voltage diminishes on the overloaded circuit, and it is preferable to use a fourth conductor to act as a common return (as in Fig. 2). It will be noticed that the transformer windings are different for each case, the three-wire being arranged in what is termed "mesh," and the four-wire in Y-shape, the neutral being connected to the neutral point of the three windings in the latter. The size of the neutral wire as in continuous-current work, depends upon the amount of balancing current it would have to carry. Arc and incandescent lamps may be run on the same circuits, but arc lamps preferably singly through a step-down transformer, as is specified for in the Erith scheme.

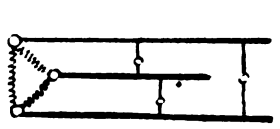


FIG. 1.

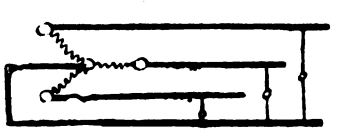


FIG. 2.

The low-tension circuits there are four-wire, and are carefully arranged so that a minimum of current is out of balance, the public incandescent lighting being divided up into several districts, which are fed from switch pillars, and each district is divided into three sections, to each of which a single-phase main and neutral are run. It may be mentioned that in practice the size of the distributing main neutral wire is, as a rule, smaller than the usual continuous-current neutral wire, being as 10 (total section of "outers") to 1, instead of 4 to 1. In two-wire branches the main and neutral are, of course, the same size. Further particulars regarding this question, including methods of calculating sizes of mains, were given in the *Electrical Engineer* for March 1 last.—B. C. H. J.

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LEIGH ELECTRICITY WORKS.

The first annual report of Mr. John Foster, engineer and manager of the Corporation electricity works, on the working of the electricity works for the year ending March 31, 1901, has just been published. The total length of mains laid is as follows: ·3in., 18 yards; ·25in., 465 yards; ·15in., 275 yards; ·1in., 830 yards; ·05in., 2,321 yards, making in all 2 miles 589 yards, the number of services laid during the year being 52. The following table shows the comparative statement of annual progress, the figure for 1900 being for three months only, and the load factor for 1901 being 10·21 per cent.:

Year.	Number of consumers.	Number of 8-c.p. lamps	Number of motors.	Number of units sold.	Maximum load in kilowatts.
1900	38	1,973	1	11,520	33
1901	82	4,847	8	76,988	86

The following table shows the current consumed, etc.:

—	Units sold.	Revenue derived.	Average price obtained.	Max. load in kilowatts	Load factor.
		£ s. d.	Pence.		Per cent.
Private lighting ...	53,989	1,064 15 0	4·73	80	7·69
Power.....	22,999	119 9 5	1·25	13	20·19

Mr. Foster says that the units consumed at 7d. and 2½d. are practically equal, thus showing that the nature of the business in Leigh only calls for a bare average lighting load of two hours a day, hence the low load factor of 7·69 per cent. Should the prices for the supply of electricity for lighting purposes be revised at any time, it will be necessary to take note of this result to enable you to fix the most equitable price between the maximum and minimum rate for all consumers. He also gives a table setting out the analysis of accounts for the year ending March 31, 1901, as follows:

	£ s. d.
Capital expenditure to March 31	10,917 7 7
Revenue from electricity supply	1,184 4 5
Revenue from meter and motor rents and other sources	3 1 6
Total revenue	1,187 5 11
Total costs	572 8 8
Gross profit before providing for interest charges and sinking fund.....	614 17 3
Percentage of gross profit to capital (outlay during year being averaged)	6·14 per cent.
Interest on loans.....	306 7 5
Sinking fund	410 0 0
Percentage of ditto to capital (outlay during year being averaged)	4·09 per cent.
Financial result after payment of all charges: deficit	101 10 2
Capacity of dynamos, etc., March 31 (kilowatts).....	200
Maximum load reached (kilowatts)	86
Load factor	10·21 per cent.
Number of 8-c.p. lamps connected March 31 (arcs, incandescents, and motors, equivalent in 8 c.p.) ...	6,565
Number of units sold.....	76,988
Units sold per 8-c.p. lamp (connections during year being averaged)	15·8
Price charged { Private lighting	7d. and 2½d. or 5d and 3d.
Price charged { Power	3d. and 1½d.

Average price obtained: private supply, 4·73; power 1·25.

ANALYSIS OF COSTS.

Generation and Distribution Costs.

	£ s. d.	Per unit sold. d.
Coal and other fuel	109 13 1	·34
Oil, waste, water, and engine-room stores	37 0 11	·11
Wages of workmen	207 18 6	·65
Repairs and maintenance of buildings, plant, instruments, tools, accumulators, mains, meters, switches, fuses, etc.	48 3 6	·15
Works cost	£402 16 0	1·25
General Costs.		
Rents, rates, and taxes	30 5 0	·09
Management expenses, salaries, etc.	139 7 8	·44
Total generation and distribution costs.....	£572 8 8	1·78
Capital Charges.		
Interest and sinking fund costs.....	716 7 5	2·23
Total costs.....	£1,288 16 1	4·01

The summary of annual financial results for the past year is as follows: Capital expended, £10,917. 7s. 7d.; average charge per unit, 3·69d.; gross profit, £614. 17s. 3d.; percentage to average capital outlay, 6·14; interest and sinking fund, £716. 7s. 5d.—net result (deficit), £101. 10s. 2d.

Mr. Foster concludes in pointing out that the above gross profit is averaged on the mean of the capital outlay at March 31, 1900 and 1901, which is highly satisfactory considering that this is the first completed year.

COMPANIES' MEETINGS AND REPORTS.

EDMUNDSON'S ELECTRICITY CORPORATION.

The report of the directors for the year ended March 31, 1901, states that including the sum of £4,158. 2s. 7d. brought forward from last year, the net profit, after payment of debenture interest, amounts to £26 699. 5s. 7d. After deducting dividend on the preference shares, paid and accrued, amounting to £1,719. 3s. 6d., and an interim dividend at the rate of 5 per cent. per annum on the ordinary shares, amounting to £4,215. 13s., there remains a balance of £20,764. 9s. 1d., which the directors recommend should be appropriated as follows: a final dividend on the ordinary shares at the rate of 9 per cent. per annum, making 7 per cent. for the year, £7,987. 10s.; dividend on the deferred shares of 7 per cent. for the year, £1,575; in further reduction of goodwill account, £5,000; creating a reserve fund, £4,000; leaving to be carried forward to next account £2,201. 19s. 1d. The profits of the Corporation continue steadily to improve, and the directors wish to call attention especially to the considerable increase in the income from dividends and interest which amount this year to £11,108. 1s. 4d., as against £4,438. 18s. 4d. last year. Profit from electric lighting being, under good management, invariably progressive, this portion of the Corporation's income may be expected to improve from year to year. Since the issue of the last report central stations at Melton Mowbray, Lymington, Montrose, Brechin, and a joint station for Sandown and Shanklin have been opened and are working satisfactorily. Parliamentary powers have been obtained for electric lighting and tramways for a number of towns in the name of the Urban Electric Supply Company, which company has now obtained its capital, and this Corporation has entered into a valuable contract for carrying out the various works required. The private house installation business shows a satisfactory increase. The shares in the local companies in which the Corporation is interested have been taken in the balance-sheet at cost price. During the year 20,000 6 per cent. preference shares and £45,000 additional debenture stock have been issued. One of the directors, Mr. J. W. Edmundson, retires by rotation, and is eligible for re-election. The auditor, Mr. W. H. May, offers himself for re-election.

Dr. NET PROFIT AND LOSS ACCOUNT.	£ s. d.
Rent	500 0 0
Office and sundry expenses, lighting, etc.	501 17 0
Advertising, stationery, and postage	623 8 7
Insurance	93 7 6
Bad debts	76 0 11
Income tax	20 0 7
Depreciation of office furniture.....	40 13 7
Directors' fees	1,000 0 0
Auditor's fee.....	52 10 0
Trustees' fees	100 0 0
Salaries	3,910 6 0
	6,918 4 2
Balance, being net trading profit	17,279 11 7
	£24,197 15 9
Interest on debenture stock (paid and accrued)	4,683 1 1
Interest on temporary loans	413 7 4
Preference share and debenture issues expenses (less premium on preference shares)	774 10 6
	5,870 18 11
Balance, being net profit	22,541 3 0
	£28,412 1 11

Cr.	£ s. d.
Gross trading profit.....	24,197 15 9
Net trading profit	17,279 11 7
Transfer fees.....	24 9 0
Interest on loans and dividends from investments.....	11,108 1 4
	£28,412 1 11

ABSTRACT OF BALANCE-SHEET, MARCH 31, 1901.

Dr. Liabilities.	£ s. d.
Capital issued	279,955 10 0
Calls on preference shares paid in advance	12,517 15 0
4½ per cent. debenture stock.....	120,000 0 0
Interest accrued thereon.....	1,109 11 9
Trade creditors.....	32,137 3 8
Balance from profit and loss account	22,305 8 4
	£468,025 8 9

Cr. Assets.	£ s. d.
Goodwill, leases, etc., less amount written off	40,000 0 0
Sundry debtors.....	52,312 1 9
Investments in subsidiary companies	331,394 1 2
Outlay on works in progress at cost	29,315 0 0
Stock in hand	4,399 12 7
Office furniture, less depreciation	366 2 0
Parliamentary deposits	1,500 0 0
Cash in hand and at bank	2,580 1 3
	£468,025 8 9

At the ordinary general meeting of the proprietors, held at the Company's offices, Broad Sanctuary-chambers, S.W., yesterday,

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Mr. John R. Wigham, the chairman, in moving the above report and statement of accounts, said the steady growth in the profits of the Company amply justified the directors in recommending the increase in the dividends. A much larger proportion of the capital invested in the Company's various undertakings was now producing a return, as would be seen by comparing the amount received this year on account of interest and dividends—viz., £11,108—with the amount received last year—viz., £4,438. Better results, however, might be expected from year to year in that respect. Referring to their interest in the Woolwich Company, in which, out of a total capital of about £50,000 they held about £35,000, he said that undertaking had grown into a very considerable concern, and the Corporation of Woolwich were anxious to take the lighting of the whole borough into their hands, and they had made an offer of £80,000 for the undertaking, which had been accepted, and the necessary agreements were being prepared, and would, in all probability, be completed next week. He gave this as an instance of the way in which the Company's investments in these local companies were increasing in value, and also as an instance of the conservative manner in which the directors had dealt with the valuation of their investments.

Mr. W. R. Davies seconded the motion, which was carried unanimously.

Mr. J. W. Edmundson having been re-elected director, the meeting closed with a vote of thanks to the chairman.

BRITISH ELECTRIC TRACTION.

The ordinary general meeting of the shareholders in this Company was held at the end of last week at Hamilton House, Victoria-embankment.

Sir Chas. Rivers Wilson, the chairman, in moving the adoption of the report (the full text of which appeared in our last issue), said it afforded him pleasure to be able to recommend the payment of an increased dividend. In comparing the figures in the accounts with those of last year, it must be recollected that the present accounts were for 12 months, whereas the previous accounts were for 15 months. Having referred to several items in the report and accounts, the Chairman went on to mention an important matter bearing on the stability of their associated companies. As they were no doubt aware, most tramway or light railway concessions had terminable tenures, and upon the expiration of their tenure the local authorities had the right to purchase the undertakings. Under the old Tramways Act of 1870, tramways which were worked by horses or by steam sometimes suffered heavy loss when the period of concession expired. Although the conditions now were much more favourable, it was expedient for every company to make provision for the future, not merely on the grounds of the expiry of the tenure, but to create a provision for replacement of permanent way, of cars, and of the electrical apparatus. It had been decided to establish, conjointly with the associated companies, a mutual sinking fund to meet this contingency.

Sir Charles W. Fremantle seconded the motion.

The **Chairman,** in reply to questions, said it was necessary to have the issue of preference shares guaranteed. The market price of the shares at that time was the amount at which they were guaranteed—viz., £11. 10s. The option was given to Messrs. J. S. Morgan and Co. and the Electric and General Investment Company, at the price of the day, without any consideration of commission. If the shares since the day of option had largely increased in value, it was due to the fact that the transaction had been taken in hand by the parties mentioned.

The motion was unanimously adopted, and the retiring directors (Lord Rathmore and Mr. C. S. Drummond) having been re-elected, the proceedings terminated.

ELECTRIC CONSTRUCTION.

The annual general meeting of the shareholders in this Company was held at Winchester House, E.C., yesterday, Mr. James Wm. Barclay presiding in the unavoidable absence, through indisposition, of the chairman of the Company, Sir Daniel Cooper, Bart., G.C.M.G.

The **Chairman,** in moving the adoption of the report and accounts (which appeared in our last issue), referred to the item of £15,763, part of the expenditure on the new workshop and plant. He complimented the shareholders on now possessing one of the largest and best-equipped electrical workshops in the United Kingdom. The Company's equipment of the City and South London Railway had proved satisfactory to the public as well as to the railway company. They had heard of no complaints from any quarter, and the best proof of the company's satisfaction was that this Company had obtained a new contract for further extensions. It was satisfactory to know that the relations between the Board and all classes of the Company's employés were thoroughly harmonious. All took a deep interest in the prosperity of the Company, and the directors endeavoured to stimulate that interest by a bonus depending on the net results of the year's business, and also by considering in the administration of the works the comforts and welfare of the employés as fully as possible. With regard to the prospects of the business, the shareholders would, no doubt, have observed that some newspapers continually reiterated assertions that electrical manufacturers in this country were behind the time. The only ground they had to offer in support of this assertion was that the use of electricity for traction and motive purposes was much behind what it was in America. But if this were the case, as no doubt it was, the fault did not lie with the manufacturers, as they would understand when he again reminded them that this Company equipped at Liverpool the first overhead electric railway in the world, and also, 10 years ago, the South Staffordshire electric tramways, both with complete success. The delay in the use of electricity was due to the vexatious restrictions imposed by Parliament through the Board of Trade, and to the reluctance of corporations to allow private enterprise to develop the tramways and lighting of their towns. The newspapers ought, therefore, to put the saddle upon the right horse, for, so far as he knew, the manufacturers of electrical machinery in this country have proved themselves equal to produce any description of plant that may be required. He then formally put the motion to the meeting.

Sir James Pender, Bart., seconded.

In reply to a question as to whether the Company had any overhead trolley tramway contracts in hand—the case of Glasgow being especially mentioned—the **Chairman** said that the Glasgow Corporation employed an engineer who was practically an American engineer, and he naturally recommended American plant, so that practically all the manufacturers in this country were thrown out. The directors would be very anxious to contract for the London tramways if they could get reasonable conditions, but he was very doubtful whether they could accept the conditions imposed by the London County Council, not in respect of the quality of the work, but in regard to the conditions under which they were manufacturing. The Council made prescriptions with respect to the company's workmen which, he believed, would tend to demoralise their establishment. Answering further questions, the Chairman said this Company had tendered for the work to be carried out on the Metropolitan Railway, but financial considerations were mixed up with the contract, and the directors were not prepared to do financial business in conjunction with their manufacturing business.

The motion was then put and carried unanimously.

Messrs. J. Wm. Barclay and John Irving Courtenay having been re-elected directors, Mr. James Gray, the secretary of the Company for the past eight years, was unanimously elected to a seat on the Board.

At an extraordinary general meeting held immediately after a resolution was passed for the alteration and modification of certain of the articles of association.

HARROW ELECTRIC LIGHT.

The report of the directors of the Harrow Electric Light and Power Company, Limited, presented to the shareholders at the fifth annual meeting held at the offices of the Company, Harrow, on the 9th inst., is to the following effect: "During the year 1900 the new steam dynamo mentioned in the report of last year has been supplied and fixed. The provisional order relating to that part of the Harrow urban district transferred to Harrow from Wealdstone has been duly transferred by the Harrow Urban District Council to the Company. A wiring department has been opened, offices being taken at Flambards, in High-street. That the dealings of the department have been extensive will be seen from the accounts appended. Mr. R. C. Gilson, one of the directors, has been appointed headmaster of King Edward's School at Birmingham. The directors being very unwilling to lose his valuable services, Mr. Gilson has so far retained his office, but finding it impossible to attend the meetings regularly, he feels unable to offer himself for re-election. In February, 1901, Mr. A. H. Shaw, the Company's engineer, obtained the appointment of electrical engineer to the Ilford Urban District Council. Mr. E. Rowley Hill, who had been second in a charge of the Bromley electric light station, has been appointed in his place. The value of the Company's premises, which were held from the governors of Harrow School for a term of which 59¼ years had to run from March 25, 1900, at a rent of £40, has been materially increased, the directors having obtained a new lease for 78¼ years at a rent of £44. Various further extensions of the Company's mains have been made, and the increase of the business has steadily kept up, as will be seen from the comparative statement at the foot of the report. It has, however, unfortunately been impossible to keep down the works costs owing to the very high price of coal. The directors, after careful consideration, decided not to follow the example of other electrical undertakings and gas companies, and increase the price of current, and they trust that the shareholders will take their view that the temporary gain in income would have been counterbalanced by the heavy check which the progress of the Company's business would have sustained. The 4½ per cent. preference shares have been well taken up during the year, and the 4 per cent. debentures were increased from £10,000 to £15,000, with the consent of all the debenture holders. Two new cottages were commenced to be built on the Company's premises, and are now both completed and occupied by two of the Company's workmen. The directors opposed a Bill introduced into Parliament by the North Metropolitan Electricity Supply Corporation, who sought for powers to supply electricity in the Company's area, including power to supply electricity in bulk. In the result the Corporation were restricted to supplying electrical energy in bulk, and prevented from supplying private individuals in the Company's area except with the consent of the Company. The directors consider that the Company's interests are now sufficiently protected, and that a serious danger to its property has been averted. The directors regret to inform the shareholders that the battery was recently found to be in such bad order that it has been necessary to order a new one at a cost of some £800 to £900. There are differences of opinion between the late and present engineers as to how this arose, and to guard against the possibility of a similar occurrence in the future the contractors for the new battery are to undertake a maintenance contract for 10 years. The necessity of ordering a new battery and of providing for its cost has decided the directors, after careful consideration, to place a larger sum than they had originally intended to depreciation account. The amount available for distribution is £1,648. 14s. 5d. Of this they propose to place £1,000 to depreciation, and to recommend to the shareholders that only the interest on the preference shares, which will

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amount to £328. 10s. 2d., should be paid, and that the balance of £320. 4s. 3d. should be carried forward to next year. The shareholders are asked to settle the remuneration of the directors for 1901. Messrs. R. R. Bartley Dennis and R. C. Gilson retire from the Board by rotation. Mr. Bartley Dennis, being eligible, offers himself for re-election. Mr. Gilson, as stated above, does not seek re-election. Messrs. Jackson, Pixley, and Co., the Company's auditors, offer themselves for re-election."

ELECTRICAL POWER STORAGE.

Directors: John Irving Courtenay, Esq. (chairman and managing director); Sir Daniel Cooper, Bart., G.C.M.G.; Frederick Green, Esq.; Sir James Pender, Bart. Chief engineer: H. W. Butler. Secretary: David Smith.

The directors in their report for the year ended May 31, 1901, state that the profit for the year is £5,665. 9s. 5d., and the balance brought forward from last year, £258. 7s. 8d., together amounting to £5,923. 17s. 1d. Of this, £1,000 has been carried to contingent fund; and the directors recommend the payment of a dividend of 5 per cent. on the ordinary share capital, which will absorb a further £4,491. 8s., leaving £432. 9s. 1d. to be carried forward. The buildings, plant, tools, etc., have been maintained in thorough repair and condition at a cost of £2,698. 12s. 11d., which sum has been provided out of revenue. The directors have pleasure in stating that a gold medal, the highest class of award given to any secondary battery exhibit, was awarded to the Company at the Paris Exhibition, in recognition of the general excellence of its manufactures. Advantage has been taken of an opportunity for increasing the area of the works at Millwall, and this has enabled substantial fireproof stores to be erected. The amount of work turned out during the year has been in excess of that of any previous year, although the increased cost of raw materials has obliged the Company to charge higher prices for its manufactures. Numerous important contracts for power and lighting stations have been completed, and a number of similar contracts for corporations and lighting companies are in course of execution. The staff has given much attention to the improvement of the traction type of cell for use in electrically-propelled vehicles, and the Company is doing a considerable and increasing business in this class of work. The retiring director is Sir James Pender, Bart., who offers himself for re-election. The auditors, Messrs. James Meston and Co., chartered accountants, also offer themselves for re-election.

ABSTRACT OF BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital authorised	100,500	0	0
Capital issued	90,158	0	0
Debentures issued	28,400	0	0
Sundry creditors	12,135	14	5
Amount at credit of reserve fund	10,000	0	0
Contingent fund	4,000	0	0
Profit and loss account	4,923	17	1
	£149,617	11	6

Cr. Assets.	£	s.	d.
Patents, goodwill, etc.	88,285	0	0
Buildings, plant, tools, fixtures, etc., less depreciation	12,132	18	10
Stock on hand, at cost or under	23,725	6	8
Sundry debtors	14,988	18	11
Bills receivable	118	1	5
Investments in other undertakings	630	0	0
Cash at bankers and in hand	9,737	5	8
	£149,617	11	6

WEST AFRICAN TELEGRAPH.

The directors' report for the year 1900 shows that the revenue amounted to £81,567, against which £20,387 is charged for ordinary expenses, and £9,034 for expenditure relating to repairs of cables, etc. After providing £436 for income tax, there remains a balance of £51,708, to which is added £298 brought from the preceding year, making a total available balance of £52,007. From this balance there has been deducted £7,918 for interest on debentures, and £15,766 for sinking fund, leaving a balance of £28,322, out of which the directors propose to place £28,000 to the general reserve fund, and carry £322 forward to next year. The revenue for the year includes a further sum of £12,000, in respect of subsidy due from the French Government, but which had not yet been paid. This arrear, together with the sums withheld in previous years, now amounts to £68,415. Under these circumstances the directors have entered into provisional negotiations with the French Government for the purpose of surrendering to them the French concession now held by the Company, together with the property now belonging to the Company in connection therewith.

EASTERN TELEGRAPH.

The directors in their report for the six months ended March 31, 1901, state that the revenue for the period amounted to £624,340. 9s., from which are deducted £135,790. 4s. 3d. for the ordinary expenses and £46,055. 10s. for expenditure relating to repairs and renewals of cables, etc., during the half year. After providing £5,248. 5s. 11d. for depreciation of spare cable, £67. 11s. 10d. for sundry differences in exchange, and £11,369. 12s. 11d. for income tax, there remains a balance of £425,809. 4s. 1d., to which is added £30,932. 9s. 11d. brought from the preceding half-year, making a total available balance of £456,741. 14s. From this balance there has been paid interest on mortgage debenture stock, £27,212. 19s. 8d.; dividends on preference stock, £31,302. 14s. 8d.; an interim dividend of 1½ per cent. on the ordinary stock, £50,000, leaving a balance of £348,225. 19s. 8d., out of which the directors have placed £10,000 to the reserve fund for maintenance ships, and £205,000 to the general reserve fund. The directors now recommend the declaration of a final dividend on the ordinary stock for the year ended March 31, 1901, of 1½ per cent. and a bonus of 2 per cent., amounting together to £130,000, both payable on the 17th inst., free of income tax, and making, with the three previous payments on account, a total distribution of 7 per cent. for the year. The balance of £3,225. 19s. 8d. shown at the foot of the revenue account is proposed to be carried forward to the next account. The revenue includes £25,164. 10s. dividends for the half-year upon the Company's investments in other telegraph companies. The cable between the Island of Ascension and Sierra Leone, under a subsidy from his Majesty's Government, was opened for traffic on April 24 last. The Durban-Mauritius section of the Cape-Australian cable was laid on May 28 last, thus completing this Company's portion of the new through route between Great Britain and Australia. It is expected that the Eastern Extension, Australasia, and China Telegraph Company's cable between Mauritius and Western Australia will be laid and opened for traffic in October next.

NEW COMPANIES.

The following new companies have been registered since our last issue:

New Principle Autocar, Limited.—Capital, £100. Object: to carry on the business of motor carriage makers, etc.

Leatherhead and District Electricity Company, Limited.—Capital, £10,000. Object: to acquire from the Urban District Council of Leatherhead the transfer of and all benefit under the Leatherhead Electric Lighting Order, 1898; to carry out the work authorised by such order, etc.

Frinton-on-Sea and District Electric Light and Power Company, Limited.—Capital, £5,000. Object: to apply for and carry out provisional orders and licenses under the Electric Lighting Acts, 1882, 1888, and 1899, or similar statutes, to manufacture and deal in electrical apparatus, etc.

John C. Parkes and Sons, Limited.—Capital, £110,000. Objects: to acquire the business now carried on by John C. Parkes and Son at 110 to 114, Coombe, Dublin, and to carry on the business of iron, steel, metal, and tinplate merchants, ironfounders, mechanical engineers, electrical engineers, etc.

West Riding Tramways and Electrical Supply Company, Limited.—Capital, £275,000. Object: to acquire and work any tramways or light railways within the urban districts of Castleford, Featherstone, Normanton, Whitwood and Knottingley, the town and rural district of Pontefract, and the rural district of Tadcaster, all in the West Riding of Yorkshire, or in any adjoining districts or elsewhere in England; to adopt an agreement with the United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited.

Lodge-Muirhead Wireless and General Telegraph Syndicate, Limited.—Capital, £50,000. Object: to acquire any patents, licenses, concessions, or inventions relating to telegraphy, telephony, and the like, and in particular to acquire from Oliver J. Lodge, F.R.S., and A. Muirhead, D.Sc., the benefit of certain existing inventions relating to telegraphy and telephony, and to carry on the business of telegraph, mechanical, and electrical engineers and contractors, manufacturers of dynamos and telegraphic works, instruments, wires, cables, insulators, and electrical fittings, etc.

APPOINTMENTS VACANT.

Trolley Linesmen, Manchester Corporation Tramways, 9d. per hour. Details in our advertisement columns.

Electrical Engineer, tramways, Council of the city of Wellington, New Zealand, July 20. Details in our advertisement columns.

Assistant Superintendents (three) in the Telegraph Department of the Government of India, salary Rs.4,200, July 31. Details in our advertisement columns.

Assistant, at a country house about 35 miles from London, to work small Crossley oil-engine, dynamo, and battery, and to make himself useful in garden, age 23 to 24. Details in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Glasgow.—The Corporation invite tenders for reconstruction of tramways. Tenders by July 16.

Blackburn.—The Town Council invite tenders for steam dynamos. Tenders by July 29. Tenders in our advertisement columns.

Dartford.—The Council invite tenders for meters (direct-current) and cut-outs. Tenders by July 24. Details in our advertisement columns.

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Poplar.—The Electricity Committee invite tenders for arc lamp carbons. Tenders by July 24. Details in our advertisement columns.

Hammersmith.—The Council invite tenders for transformers and electricity meters. Tenders by July 17. Details in our advertisement columns.

Sunderland.—The Corporation require tenders for erection and completion of proposed electric tramcar sheds, Hylton-road. Tenders by Aug. 2.

Poplar.—The Electricity Committee invite tenders for transforming plant and switchgear, etc. Tenders by July 24. Details in our advertisement columns.

Plymouth.—The Corporation invite tenders for tramcars, trucks, motors, trolley arms, etc. Tenders by July 19. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for feeders, mains, and roadwork and arc lamps. Tenders by July 20. Details in our advertisement colmuns.

Bradford.—The Corporation invite tenders for the supply and delivery of 100 electric tramcars. Tenders by July 31. Details in our advertisement columns.

Kearsley.—The Urban District Council invite tenders for tramway poles, bases, section boxes, overhead line, etc Tenders by Aug. 1. Details in our advertisement columns.

Hapton (near Padiham, Lancs.).—Tenders are required for lighting the Hapton township with electricity from Sept. 1, 1901, to April 30, 1902. Tenders by July 31.

Weston-super-Mare.—The Urban District Council invite tenders for work in connection with the electric lighting of the new pavilion at Knightstone. Tenders by 18th inst.

Amsterdam.—The Corporation invite tenders for tramcars for electric traction with overhead wire (perhaps 140). Tenders by Sept. 2. Details in our advertisement columns.

Stepney.—The Electrical Committee invite tenders for steam and other pipework and paper-insulated cables, earthenware conduits, etc. Tenders by July 18. Details in our advertisement columns.

Bury (Lancs.).—Tenders are invited for the work required in the extension of the engine and boiler houses and other contingent works at the electricity works, Rochdale-road. Tenders by July 30.

Greenock.—The Directors of the Greenock and Port Glasgow Tramways invite tenders for the construction of car-sheds, works and repair shops on a site at Ladyburn, Greenock. Tenders by 22nd inst.

Gravesend.—The Town Council invite tenders for boiler-house and engine-house plant, switchboard, mains, meters, crane, dust destructor, etc. Tenders by July 30. Details in our advertisement columns.

Dundee.—The Gas Commissioners invite tenders for surface condensers, electrically-driven pumps, cooling towers, feed-water heaters, etc. Tenders by August 5. Details in our advertisement columns.

Lancaster.—The Corporation invite tenders for water-tank, electric pumps, ejector, condenser, steam, exhaust, and water piping, with valves. Tenders by July 27. Details in our advertisement columns.

Brecon.—The Committee of the Talgarth Joint Asylum invite tenders for the electric lighting of the asylum. Particulars can be obtained from the architects, Messrs. Giles, Gough, and Trollope, 28, Craven-street, Strand. Tenders by Aug. 5.

Aston Manor.—The Urban District Council invite tenders for supply and fixing of generating and distributing plant for their hospitals at Upper Witton, near Birmingham. Tenders by July 25. Full particulars in our advertisement columns.

Amsterdam.—The Municipality invite tenders for 5,000,000 kilos of tramway rails, with plates, bolts, etc. Specification, 2s. 7d. Tenders by Sept. 2. Information is given at the office of the Director of Municipal Street Railways, Nieuwe Achtergracht, 164.

Epsom (Surrey).—The Asylums Committee of the London County Council invite tenders for steam boilers, pumps, and fittings, cooking apparatus and fittings, and installation of electric lighting (excluding generating plant), at the Epileptic Colony, Horton Estate, Epsom, Surrey. Tenders by July 23. Details in our advertisement columns.

Erith (Kent).—The Urban District Council invite tenders for the construction of (Section L) engine and boiler house; (M) chimney shaft; (N) sanitary work, water and fire services; (O) rain and surface water drains; (P) approach roads at site. Specifications, etc., can be obtained of Mr. W. Egerton, quantity surveyor, 12, Queen's-road, Erith. Tenders by July 15.

RESULTS OF TENDERS.

Dundee.—The Town Council have accepted the tender of Lowdon Bros. and Co. for overhead equipment, at £2,010.

Wigan.—The Electric Light and Tramway Committee have accepted the tender of Dick, Kerr and Co., London, for 12 double-deck single-truck electrical cars.

Branksome.—The Urban District Council have accepted the tender of C. Cooper and Co. for supply of electric fittings for the new offices, at £49. 3s. 4d.

Rotherham.—The Corporation have accepted the tender of Morgan, Mowdey, and Co., College-street, Rotherham, at £49. 7s. 6d., for wiring the police buildings.

Hendon.—The Urban District Council have accepted the tender of the Coley Electric Works, Limited, 4, King-street, Cheapside, at £186. 10s., for the wiring of the new Council offices.

Sutton Coldfield.—The Corporation have accepted the following tenders: British Thomson-Houston Company, Limited, direct-current meters; Keighley Engineering Company, Limited, cut-outs.

Warrington.—The Electric Lighting Committee have accepted the following tenders in connection with the extension scheme: Babcock and Wilcox, Limited, Renfrew, boiler, superheater, brickwork, and pipes, £1,486. 10s.; Dick, Kerr, and Co., Preston, steam-engine and dynamo, £4,413; St. Helens Cable Company, Limited, Warrington and St. Helens, cables and conduits, etc., £6,870.

Battersea.—The Works Committee have accepted the tenders of the Edison and Swan United Electric Light Company, Limited, for the supply and delivery of electric switches, distributing boards, etc., at £85. 3s. 9d.; and W. T. Glover and Co., Limited, for the supply and delivery of electric cables and wires, at £55. 19s. 9d. The borough surveyor has been instructed to order the tubing, special brackets, ceiling roses, and fuse boards required from the Simplex Steel Conduit Company, Limited.

Barking Town.—The following tenders have been received by the Urban District Council. Mr. A. Hugh Seabrook, A.M.I.E.E., A.M.I.M.E., engineer and manager:

A. Koppel, 27, Clements-lane, E.C., natural-draught tower £305, condensing plant £1,080	£1,385
Allen and Son, Bedford, Koppel tower £305, condensing plant, Edwards pump, Baker separator £1,750 (accepted)	2,055
Klein Engineering Company, 94, Market-street, Manchester, natural-draught tower £377, condensing plant £1,688	2,065
Mirrlees, Watson, and Yaryan, Glasgow, condensing plant, £2,148 (afterwards corrected to £1,728), Koppel tower £340	2,068
Wheeler Condenser Company, Queen Victoria-street, E.C., tower £878, condensing plant £1,696	2,574
Worthington Pumping Engine Company, Queen Victoria-street, E.C., tower £920, condensing plant £1,816	2,736
Pulsometer Engineering Company, Nine Elms Ironworks, S.W., condensing plant only	1,744
J. Fraser and Co., Millwall, evaporative condensing plant	2,375
Doherty and Donat, Manchester, tower only	490

Engineer's estimate, £2,000.

Nelson.—The following tenders have been received by the Corporation. Mr. W. Alan Fraser, A.I.E.E., borough electrical engineer:

Steam dynamo.

British Thomson-Houston Company (Willans and Robinson engine)	£2,406
British Thomson-Houston Company (Browett)	2,242
Phœnix Dynamo Company (Willans and Robinson)	2,397
Phœnix Dynamo Company (Belliss three-crank)	2,597
Phœnix Dynamo Company (Alley and Maclellan)	2,197
Bruce Peebles (Willans and Robinson) (accepted)	2,180
Bruce Peebles (Belliss three-crank)	2,436
Bruce Peebles (Browett)	1,895
Johnson and Phillips (Willans and Robinson)	2,170
Greenwood and Batley (Willans and Robinson)	2,102
Greenwood and Batley (Alley and Maclellan)	1,800
Electric Construction Company (Willans and Robinson)	2,102
Electric Construction Company (Belliss two-crank)	2,244
Electric Construction Company (Belliss three-crank)	2,466
Electric Construction Company (Galloway)	1,890
Electric Construction Company (Browett)	1,975
T. Parker, Limited (Willans and Robinson)	2,088
T. Parker, Limited (Galloway)	1,855
T. Parker, Limited (Alley and Maclellan)	1,868
Geipel and Lange (Willans and Robinson)	2,060
Geipel and Lange (Belliss three-crank)	2,505
Geipel and Lange (Reavell)	2,090
Geipel and Lange (Allen and Son)	1,100
Crompton and Co. (Willans and Robinson)	2,003
Crompton and Co. (Galloway)	1,785
Crompton and Co. (Browett)	1,898
Mather and Platt (Willans and Robinson)	2,000
Mather and Platt (Belliss two-crank)	2,170
Mather and Platt (Belliss three-crank)	2,360
Mather and Platt (Galloway)	1,750
Mather and Platt (Browett)	1,820
Siemens Bros. and Co. (Willans and Robinson)	1,970
Siemens Bros. and Co. (Belliss two-crank)	2,085
Siemens Bros. and Co. (Belliss three-crank)	2,300
Siemens Bros. and Co. (Browett)	1,832
International Electrical Company (Willans and Robinson)	1,969
International Electrical Company (Clayton)	1,877
International Electrical Company (Belliss two-crank)	2,161
International Electrical Company (Belliss three-crank)	2,376
International Electrical Company (Galloway)	1,650
International Electrical Company (Browett)	1,785
International Electrical Company (Allen and Son)	1,822
Laurence, Scott, and Co. (Willans and Robinson)	1,943
Laurence, Scott, and Co. (Belliss two-crank)	2,065
Laurence, Scott, and Co. (Bellis three-crank)	2,231
Laurence, Scott, and Co. (Browett)	1,575
Laurence, Scott, and Co. (Alley and Maclellan)	1,685
Laurence, Scott, and Co. (Reavell)	1,905
Laurence, Scott, and Co. (Allen and Son)	1,925
T. Barton (Willans and Robinson)	1,942
T. Barton (Alley and Maclellan)	1,750
Johnson-Lundell Company (Willans and Robinson)	1,874
F. Suter and Co. (Willans and Robinson)	1,835
British Schuckert Company (Willans and Robinson)	1,763
British Schuckert Company (Belliss two-crank)	2,092
British Schuckert Company (Allen and Son)	1,777
Clayton Engineering Company (own engine)	1,904
Lancashire Dynamo Company (Galloway)	1,701
Lancashire Dynamo Company (Browett)	1,811
W. H. Allen and Co. (own engine)	1,737
Brush Electrical Engineering Company (own engine)	2,380

Engineer's estimate, £2,100.

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23-kw. balancer.

F. Suter and Co.	£457	0	0
Crompton and Co.	430	0	0
Siemens Bros.	420	0	0
British Westinghouse Company	362	0	0
Read, Holliday, and Sons	340	0	0
Mather and Platt	324	0	0
British Thomson-Houston Company	323	0	0
Bruce Peebles and Co.	319	0	0
Lancashire Dynamo and Motor Company	309	0	0
Electric Construction Company	290	0	0
T. Parker, Limited	280	0	0
J. Barton	272	0	0
Phœnix Dynamo Company	268	0	0
Laurence, Scott, and Co.	260	0	0
Morley Electrical Engineering Company	225	0	0
Greenwood and Batley	209	10	0
British Schuckert Company	203	10	0

Engineer's estimate, £250. Tenders not yet settled.

Cables (solid system).

W. T. Glover and Co., Limited	9,649	0	0
Callender Cable Company (accepted)	9,560	0	0
Telegraph Manufacturing Company	9,543	0	0
British Insulated Wire Company	9,007	0	0
W. T. Henley's Telegraph Company	8,699	0	0
St. Helens Cable Company	8,681	0	0
Western Electric Company	7,816	0	0

Two 30ft. by 8ft. Lancashire boilers.

	Boilers.	Weir pumps and economisers.
J. Carter and Sons	£1,360	£540
Davey Bros.	1,195	530
Meldrum Bros.	1,163	573
Yates and Thom	1,134	566
Anderton and Sons	1,115	538
Tinkers, Limited	1,040	540
Danks and Co.	1,005	525

Engineer's estimate, £1,066. Contract not yet settled.

Travelling crane.

T. Broadbent and Sons	345	0	0
J. Spencer and Co.	246	0	0
J. Carrick and Sons	215	0	0
Marshall, Fleming, and Jack	215	0	0
Carrick and Ritchie (accepted)	205	0	0
Rushworth Bros.	205	0	0
H. Morris and Bastert	198	0	0

Engineer's estimate, £200.

Brighton.—The Town Council have received the following tenders for the supply and fixing of all the wiring and fittings necessary for the electric lighting of the new floral hall of the market:

M. A. Fileman, 99, Queen's-road (accepted)	£90	10	0
G. Hignett and Co., 2, North-street Quadrant	99	15	0
C. G. Reed and Sons, Limited, 26, North-street	105	0	0
Coley Electric Works, Limited, 4, King-street, Cheapside, E.C.	112	0	0
H. J. Galliers, 21, St. James's-street	114	16	6
Lighting Corporation, Limited, 4, Bloomsbury-street, London	135	1	2
H. B. Robinson and Son, 18, Western-road, Hove	149	0	0
Packham and Son, 144, Western-road	182	0	0

BUSINESS NOTES.

TRACTION.

Blackpool.—The sanction of the Local Government Board has been obtained for the permanent way round Marton.

Southend.—Lieut.-Colonel von Donop visited Southend on behalf of the Board of Trade to inspect the electric tramway, which has just been completed.

Hastings.—The Corporation have concluded an agreement with Mr. W. M. Murphy in regard to the Hastings, Bexhill, and district light railway scheme.

London United Tramways Bill.—In the House of Commons this week the London United Tramways Bill was considered and ordered for third reading.

Croydon.—We understand that the main base line of the new municipal tramways—some six miles in length—will be opened for traffic in September next.

Houghton-le-Spring.—The Urban District Council have resolved not to grant the tramway and light railway company the six months extension of time asked for.

Sheffield.—The Corporation have increased the salary of Mr. A. L. C. Fell, general manager and electrical engineer of the tramways undertaking, to £700 per annum.

Yarmouth.—The Corporation have resolved to invite applications from various companies, asking for terms upon which they would be prepared to lease the Yarmouth tramways undertaking.

Ayr.—The Town Council have passed a resolution that after the tramcars have been running on Sundays for six months, a *plébiscite* of the ratepayers be taken on the question of a Sunday service.

Halifax.—The new electric tram service between Halifax and Mytholmroyd is now open for public service. The official opening of the extension from Northowram to Shelf also took place last week.

Manchester.—The third section of the Corporation tramways which have been converted to electric traction—that between High-street, Queen's Park, and Boggart Hole Clough—has been opened for traffic.

Scarborough.—Communications from several firms offering to put down a complete system of tramways were read at the last meeting of the Tramways Sub-Committee, but no definite decision was arrived at.

Middlesbrough.—The official trial trip of the new ferry line connecting the Linthorpe route, Middlesbrough, of the Middlesbrough, Stockton, and Thornaby Electric Tramway was made on Wednesday last.

Newport (Mon.).—The Tramways Committee's latest report discloses the fact that the Corporation road tramways have been completed at a cost of £13,726. 17s. 6d., which sum is £97. 5s. 5d. less than the contract price.

Ramsgate.—The Town Council have decided to approach the other authorities in the district and see whether pressure cannot be brought to bear upon the Board of Trade in the matter of the vibration of the cars on the light railway.

Cardiff.—The construction of the new tramway track from Clare-road through Tudor-road and Wood-street to St. Mary-street, thus making a new connection between Cathedral-road and St. Mary-street, is to be proceeded with next.

Aston.—The Board of Trade have approved of the service of notice on the Birmingham and Aston Tramways Company, Limited, requiring them to sell so much of the undertaking as is situate within the Aston district to the Council.

Private Bills.—In the House of Commons the London United Tramways Bill and the King's Norton and Northfield Urban District Tramways Bill have been read a third time, and in the Lords the Metropolitan District Railway Bill a second time.

Darlington.—The Town Council have adopted resolutions to serve notice of purchase on the Imperial Tramways Company, and to apply to the Light Railway Commissioners for an order authorising the Corporation to convert the lines to electric traction.

Hyde.—At the monthly meeting of the Town Council the Chairman of the Electricity Committee reported that the Bill before Parliament for a joint scheme of electric tramways for Hyde, Dukinfield, Stalybridge, and Mossley was making satisfactory progress.

London Underground Railways.—The Joint Parliamentary Committee appointed to consider which of the tube railways proposed for London will afford the best public facilities, sat again on Tuesday, when several persons interested were in attendance. The proceedings were private.

Kirkburton.—In connection with the new county asylum which it is proposed to erect at Storthes Hall, near Kirkburton, the authorities are considering the construction of an electric railway from the asylum itself to the nearest railway station. The cost of such a scheme is put at about £17,000.

West Bromwich.—A special meeting of the Town Council is to consider proposals to purchase the Birmingham and Midland Tramways Company's undertaking within the borough for £5,500, and the South Staffordshire Tramways undertaking within the borough for £32,000 plus further sums as compensation.

Stourbridge.—The British Electric Traction Company have completed their line from Lower High-street to a point in the Hagley-road, and Colonel York, R.E., of the Board of Trade, has inspected the section. We understand there is likely to be an early start made with the Lye and Wollaston branch lines.

Aberdeen.—At the end of last week the new electric tramway from Castle-street to the beach was opened for traffic. On the remaining portion of the route, across the Links to the Corporation bathing establishment at the sea beach, an experiment is shortly to be made with the third-rail system of electric traction.

Crewe.—The Corporation have passed a resolution to oppose the granting of an order to the British Electric Traction Company, Limited, for the construction of light railways in Crewe, and a further resolution in favour of the Council renewing their application of November last for power to construct a light railway on behalf of the ratepayers.

Morecambe.—The Urban District Council have decided that Mr. Heape, of Heape and Ledward, London, should be requested to meet the Council at any early date with reference to the proposal made by him to establish a system of electric trams in Morecambe. Mr. Heape intimated that he was to interview the Heysham Council on the subject.

King's Norton.—The District Council have sealed an agreement with the City of Birmingham Tramways Company for the electrification of the company's tramways known as the Moseley and King's Heath routes, situate within the district of the Council, on the same system as should be adopted for those routes within the city of Birmingham.

Keighley.—The formal sanction of the Board of Trade has been received to the borrowing by the Corporation of £8,900 for tramways. The Board, however, required certain modifications to be made in the arrangement between the Keighley Tramways Company, Limited, and the Corporation respecting the tramway undertaking, which modifications the Corporation have agreed to.

Dudley.—The Corporation have confirmed the resolution of the Tramways Committee to consent to the British Electric Traction Company laying a double track from Queen's Cross to Hall-street on condition that all the cars from Old Hill and Kingswinford are brought into the Market-place. A further sum of £20,000 is to be borrowed in connection with the tramway scheme.

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Maidstone.—The Town Council have rejected the Tramways Committee's recommendations that the resolution of the Council passed on May 1 last, that a Bill should be promoted, be now rescinded, and that application be made in due course to the Light Railway Commissioners for a provisional order authorising the construction of tramways by the Corporation under the Light Railways Act, 1896.

Colchester.—A deputation has been appointed to wait on the Board of Trade in reference to a suggestion that the Corporation should obtain power to adopt, if so decided hereafter, a system of cars or omnibuses propelled on the electric trolley principle, but without tramlines, "this system being now in use on the Continent, and being much less costly in construction and maintenance."

Blackburn.—In view of the fact that the Corporation have sustained a loss of nearly £10,000 on the tramways undertaking, it has been decided to abandon 1d. fares and charge 1½d. from the centre of the town to the borough boundary in every direction. The new cemetery route of the Corporation tramways was inspected by Major Druitt, of the Board of Trade, last week, and the service of cars is now in full swing.

Berlin Electric Railway.—Advices from Berlin state that the electric elevated and underground railway, Berlin, running from the Warsaw Bridge, in the east of the city, to the Zoological Gardens in the west, will be ready by the end of this year, and is to be opened next New Year's Day. The next month, however, will see the branch line connecting the Warsaw Bridge with the central cattle yard opened.

London United Tramways.—Last Wednesday saw the formal inauguration of the new extensions of the London United Tramways Company's system in West London, from Acton to Hanwell and Southall and from Kew Bridge to Hounslow. The total length of the new line is eight miles, and an unbroken run of 7½ miles from Shepherd's Bush to Southall or from Kew Bridge to Hounslow is now obtained.

Proposed Manchester-Liverpool Monorail.—The Bill promoted by Mr. Behr to authorise the construction of a high-speed electric railway between Manchester and Liverpool is now being considered by the Select Committee of the House of Commons presided over by Sir Lewis McIver. Practically the only opponents to the scheme remaining are the railway companies. Details of the scheme have already appeared in these columns.

The Paris Metropolitan Railway.—We hear that the proposed extensions of the Paris Underground Railway are to be carried out at once. It is also reported that the Metropolitan Company have decided to order a new type of car, of greater length, and with a wide entrance and exit in the centre. The existing car, with its small doors at each end, has been found to be altogether unpractical. An attempt is also to be made to improve the ventilation of the tunnels.

Metropolitan Railway.—The Select Committee of the House of Lords presided over by Lord Falkland have passed the preamble of the Bill of the Metropolitan Railway Company. The only opponents were the District Railway Company, the point in dispute being the extension of the period for the construction of the Harrow and Uxbridge Railway, which the Metropolitan Company have taken over. It was agreed to bring up a clause for the protection of the District Railway.

Bradford.—The electric tramway extensions both to Idle and Thackley and to Queensbury are now within measurable distance of completion. The opening of these lines will complete the large scheme of tramway extension upon which the Corporation embarked some time ago, but with the Bill just passed by the House of Lords the Corporation obtained powers to construct over 15 additional miles of tramway. The Tramways Committee are about to purchase 100 additional tramcars to enable them to deal with the increasing traffic.

Paddington.—The London County Council have notified the Borough Council of their intention not to proceed at present with the scheme for a tramway between Edgware-road and the Lock Bridge, owing to the expensive character of the street widening which would have to be carried out in connection therewith; also that they are opposing the application of the Middlesex County Council for permission to construct a light railway between the same points, being strongly of opinion that this line when made should be constructed by the London County Council.

City and South London Railway.—The accounts of this Company for the half-year ended June 30 last, after providing for the debenture stock interest and transfer to a renewal fund of £2,000, and also the full dividends on the 5 per cent. preference stocks (1891 and 1896), show a balance sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 1¾ per cent. per annum, carrying forward a balance of £733. The dividend for the corresponding period last year was at the rate of 1¼ per cent. per annum, the balance carried forward being £788.

Exeter.—A memorial from owners and occupiers of the principal business premises in High-street and Queen-street has been presented against the introduction of electric traction in those streets. The Chamber of Commerce have appointed a special committee to prepare a report embodying information concerning the effect of the introduction of electric railways upon the trade of cities and towns similar to Exeter, and that authority be given to send a small deputation to some of those towns, with a view of obtaining any particulars of value relating to tramways and motorcars.

Southport.—At the last meeting of the Tramways Committee, the tramways manager presented his first annual report on the tramways undertaking, which was inaugurated in July last year. The report shows that on March 31 this year there were 2½ miles of double and five miles of single track open. The number of miles run was 208,756, and passengers carried 1,513,354. The total receipts for the year stand at £7,568, and the working expenses at £7,487, leaving a profit of £81 on the year's working. The statement was made at Tuesday's meeting of the Town Council that the earnings of the tramways per car mile were 8·42d. on the incomplete year, but it is hoped in the current year that it will be over 10d.

Middlesex.—At the last meeting of the County Council it was decided that the preparation of the working drawings, specifications, etc., with a view to tenders for the construction of the light railways included in the light railways order, now awaiting confirmation by the Board of Trade, be carried out. The following estimates have already been submitted to the County Council through the Finance Committee: estimate of a sum of £350,000 for the cost of the construction of the light railway lines proposed to be authorised by the joint order of the County Council and the Metropolitan Tramways and Omnibus Company, and the purchase of land for generating stations; and an estimate of a sum of £5,000 for the costs of the Metropolitan Tramways and Omnibus Company in obtaining the order.

West Riding Tramways.—A company, known as the "West Riding Tramways and Electricity Supply Company, Limited," has been registered with a capital of £275,000, in £1 shares (125,000 preference), to acquire any tramways or light railways within the urban districts of Castleford, Featherstone, Normanton, Whitwood, and Knottingley, the town and rural district of Pontefract and the rural district of Tadcaster, or in any adjoining districts or elsewhere in England, to apply for any necessary orders, Acts of Parliament and authorities, to adopt an agreement with the United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited, to equip, maintain, and work by electricity, or by oil, steam, horse, or other power all tramways and light railways belonging to the company, and to carry on the business of tramway, light railway, omnibus and van proprietors, carriers, constructors and makers of tramways, railways, etc.

Bury.—Mr. Arthur W. Bradley, borough engineer and surveyor to the Corporation, has just issued his first report since his appointment on the working of his department. On the question of the proposed tramways, the report states that the length of double line proposed to be laid is 6 miles 1 furlong and 2·78 chains. The length of single line is 5 miles 7 furlongs and 8·86 chains, making a total length of 12¼ miles of route—equal to 18 miles measured as single line. The car-shed is intended to be erected on a site situated at Whitehead Bridge, Rochdale-road, and will include the necessary offices, stores, and repairing shops. The present electricity works will be extended so as to accommodate the additional plant necessary for traction purposes. The estimates for the proposed tramway scheme are as follows: permanent way, cars, and depôt, £132,000; land and buildings for generating station and electrical equipment, £39,000; street improvements, £114,000—making a total of £285,000.

Plymouth.—The sub-committee of the Tramways Committee, having considered the question of extending the tramways from Mutley Plain through Alexandra-road to Lipson Vale, have prepared a report expressing sympathy with the proposed extension. At the same time they thought it impracticable to make application to Parliament this year. The tramway receipts for the quarter ended June 29 amounted to £6,311. The Council have approved a plan submitted by the borough surveyor showing the accommodation proposed to be provided at the Octagon for the tramway service of the Corporation. At the Corporation meeting on Monday the Tramways Committee reported that they had resumed the consideration of G. Shellabear and Son's letter with reference to the laying of tramways in Peverell Park-road, and decided that Messrs. Shellabear be informed that it was not the intention of the Corporation to lay the tramways at present. The minute was referred back.

Wilful Obstruction on the "Twopenny Tube."—At the Bow-street Police Court on Saturday, George Parker, a conductor on the Central London Railway, was charged before Mr. Marsham with wilfully and maliciously obstructing a train on the line. It was stated that Parker was under notice to leave, and before going on duty on Friday he told another conductor that he meant to "have a lark." He assisted in conducting a train from Shepherd's Bush to the Mansion House and back again two or three times, but it was noticed by the driver and other conductors that it was on several occasions nearly brought to a standstill between stations. The Westinghouse brakes with which the cars are provided, to be used in case of emergency, were examined, and it was found that the one in the prisoner's car had been recently applied. Several witnesses were called to show that Parker's hand had been seen close to the emergency brake, and that a delay of about 40 minutes had been caused. On Saturday the prisoner went into the witness box and declared that he was innocent, and alleged that most of the evidence against him had been concocted. Mr. Marsham said he did not believe him, and ordered him to pay a fine of £10, or undergo one month's imprisonment.

Manchester-Salford Dispute.—At the last meeting of the Tramways Committee of the Manchester Corporation letters were read from the town clerk of Salford with regard to the reopening of negotiations for the settlement of the tramways dispute, and it was resolved that the communications from the Salford Corporation should be referred to the Negotiations Sub-Committee for further negotiation with the Salford Corporation. It was further resolved that the town clerk should intimate to the town clerk of Salford that he is instructed to arrange for an interview between the Negotiations Sub-Committee and representatives of the Salford Corporation. It has since been arranged that the representatives of the two corporations should meet to-day (Friday). In the House of Commons on Tuesday Mr. Holland asked the President of the Board of Trade whether he was aware that public inconvenience was being caused by neighbouring local authorities (notably Manchester and Salford and Oldham and Middleton) refusing the user of their tramway lines to each other, and

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whether he could do anything, by the offer of arbitration or otherwise, to bring about arrangements by which the convenience of the public might be secured. In reply, Mr. G. Balfour said he had not received any representations on the subject. He was not aware that the Board of Trade had any statutory authority to intervene, but if the local authorities concerned desired to avail themselves of the good offces of the Department, he should be very happy to consider any application that might be made to him with that object.

Glasgow.—A special sub-committee of the Tramways Committee after considering a petition by the motormen and conductors on the subject of wages, hours, and other matters, have agreed to recommend that, if the men prefer it, they should be paid by the week instead of by the hour, and that a nine hours' day on an average be introduced when the whole system has been converted to electric traction and new time-tables have been prepared. The result of the year's working of the Corporation's tramways (according to the balance-sheet for the year ending May 31 last) shows that the revenue amounted to £489,469. 8s. 7d., and the working expenses to £371,705. 7s. 1d., thus leaving a gross balance of £117,764. 1s. 6d. The revenue of the previous year was £469,965. 10s. 11d. and the working expenses £344,721. 11s. 3d., leaving a gross balance of £125,243. 19s. 8d. The gross balance for the past year is, therefore, £7,479. 18s. 2d. less than for the preceding year, although the revenue shows an increase of £19,503. 17s. 8d. The net balance shows a decrease of £34,570. 15s., as compared with last year. This is due to the increased interest and sinking fund charges on the large amount borrowed for the conversion of the system from horse to electric traction, and which was, until within the last few weeks of the financial year, entirely unproductive. The traffic receipts show a grand total of £489,469. 8s. 7d. The total working expenses were £371,705. 7s. 1d.—leaving, as already stated, a balance of £117,764. 1s. 6d. The total amount borrowed for capital purposes now stands at £1,680,732. 0s. 1d., of which £846,000 has been borrowed during the past year.

LIGHTING AND GENERAL.

Antrim.—It is proposed to establish a Post Office telephone exchange at Antrim.

Widnes.—The electrical provisional order for Widnes has now passed all stages.

Chesterfield.—The Town Council expect to have the electric light in operation in August.

Thornaby.—The Corporation intend to apply for an electric lighting provisional order.

Lower Bebington.—An electric lighting provisional order is to be applied for by the Council.

Yorkshire Electric Power Scheme.—This scheme has now been sanctioned by both Houses.

Macclesfield.—The Town Council's electric lighting provisional order has passed through the House of Lords.

Limerick.—The deed of mortgage to the Board of Works for the loan of £22,000 for electric lighting has been sealed.

Whitby.—The Urban District Council have decided to appoint the whole Council to be the Electric Lighting Committee.

Burgess Hill.—The Urban District Council favour the extension of the Brighton Corporation telephones into their district.

Perth.—The City Chamberlain has been authorised to borrow £5,000 on temporary loan for electric lighting purposes.

Sutton Coldfield.—Both the works at the station and also the laying of the cables are proceeding in a very satisfactory manner.

Kingswinford.—The Midland Electric Corporation will commence laying their mains at several points in the district at an early date.

Bradford.—A proposal to increase the salary of Mr. R. A. Chattock, the city electrical engineer, by £200 per annum, is being discussed.

Edmonton.—The Urban District Council on Tuesday decided to apply for a provisional order for the supply of electricity in the district.

West Bromwich.—The better ventilation of the Law Courts is to be assured by placing in the building an electric fan, at a cost of over £38.

Carnoustie.—The Town Council have remitted the question of applying for an electric lighting provisional order to the Lighting Committee.

Volunteers.—We beg to draw attention to an advertisement appearing in this issue calling for 120 volunteers—E.E. (R.E.)—for South Africa.

Romford.—The Urban District Council are reviving the question of electric lighting, and the ratepayers will soon be asked to express their feeling on the subject.

Barrow.—An enquiry is to be held shortly into the application of the Town Council for sanction to borrow the sum of £12,340 for purposes of electric lighting.

Morpeth.—The Northern Counties Electricity Supply Company intend to apply for an order to enable them to provide electricity for public and private purposes.

Hebden Bridge.—Mr. W. Emmott, Halifax, has been appointed consulting engineer to the Council in connection with the proposed electric lighting installation.

Sale of Plant.—We beg to draw the attention of our readers to a sale of electrical plant by the St. Helen's Corporation, particulars of which appear in another column.

Electric Power Scheme for Ireland.—Lord Welby's Committee of the House of Lords on Wednesday passed the preamble of the Shannon Water and Electric Power Bill.

Leatherhead.—The terms of the electric lighting transfer deed have been settled between the committee and the engineers, subject to the approval of the Urban District Council.

Leicester.—The Corporation have decided to issue £335,000 Leicester Corporation 3 per cent. redeemable stock, which sum includes £97,689 for electric lighting purposes.

Caversham.—The question of the desirability of applying for a provisional order to supply the district with electric light has been referred to the committee of the whole Council.

Lecturer.—Mr. Frederic H. Taylor, A.M.I.E.E., has been appointed lecturer in electric lighting and power transmission under the Middlesex County Council for the Tottenham Polytechnic.

Liverpool.—The clerk has been instructed by the Workhouse Committee to prepare specifications for the lighting of the dining hall and the church of the workhouse with electricity.

Batley.—The plans of the engineer (Mr. Clirehugh) for a generating station proposed to be erected in New Ing Fields have been approved, and tenders for carrying out the work are to be invited.

Sheffield Municipal Telephone.—The City Council propose to appoint a committee to make enquiries and report as to the advisability or otherwise of establishing a municipal telephone exchange in Sheffield.

Brandon and Byshottles.—After consultation with the representatives of the Esh Parish Council, it has been resolved to ask for tenders for the erection of poles and wires for the electric lighting of the West Ward.

Telegraph Construction and Maintenance Co.—An interim dividend of 12s. per share is announced, payable to shareholders on the register on July 8. The transfer books will be closed from July 8 to July 16.

Bermondsey.—The Council have resolved that application be made to the Board of Trade for a provisional order authorising the Council to supply electricity for public and private purposes within the whole af the borough.

Lowestoft.—The Council on Tuesday adopted the Electric Lighting Committee's report, recommending the installation of additional plant, the cost of which will be approximately £6,000. Application for a loan is to be made.

Swansea Harbour Trust.—The executive committee last week, after considering the question as to whether the Trust or the Corporation shall light the docks by electricity, decided to defer a definite decision for a fortnight.

Aberdeen Harbour Board.—An honorarium of 50 guineas has been voted to Mr. J. A. Bell, the Corporation's electrical engineer, in recognition of his services in superintending the erection of the electric light installation at the quays.

Worcester.—The Electricity Committee have recorded with regret the resignation of Mr. Hoadley, chief assistant, on his appointment as borough electrical engineer of Maidstone. Mr. J. D. Morgans has been appointed mains superintendent.

Tiverton.—The Town Council on Tuesday decided that, in view of the probable introduction of electric lighting, they could not see their way to make any change in the public lamps that would involve an outlay which might be unnecessary.

East Barnet.—The Urban District Council have decided to enter a formal protest against the proposed application of the North Metropolitan Electrical Power Distribution Company for an order to supply electric light in the East Barnet district.

Aylesbury.—The Board of Trade have granted the Council's application for a 12 months' extension of their electric lighting provisional order. The Electrical Power Distribution Company intend to make application for a provisional order for the district.

S. Z. de Ferranti, Limited.—It is reported that this business, which was formed in June, 1890, is about to reconstruct, and that mortgage debenture stock and £100,000 6 per cent. cumulative preference shares will be offered for public subscription.

Luton.—The Guardians object to the inclusion of their district in the proposed application by the Dunstable Town Council for a provisional order authorising them to provide electrical energy for Dunstable, Houghton, Regis, Kensworth, Totternhoe, and Caddirgton.

Rochdale.—The Gas and Electricity Committee recently appointed a sub-committee to make enquiries as to Mond gas. Under the present conditions the committee hesitated to recommend its adoption as a motive power for generating electricity at the electricity works.

Walmer.—It is intended to form a company, to be called the East Kent Electricity Supply Company, for the supply of electricity to Deal, Walmer, and St. Margaret's. The Council have informed the promoters of their intention to apply for a provisional order themselves.

Pontypool.—With regard to the proposed electric lighting of the workhouse, we are informed that two non-local firms of electrical engineers offered to supply estimates, but the Guardians throught that the six local firms who had been invited to estimate were quite sufficient.

Durham.—The provisional order for the supply of electrical energy granted to the Corporation of Durham in the year 1899 has been transferred to the Electrical Power Distribution Company, Limited, Durham, who are prepared to supply current to consumers early in November.

Eccles.—The minutes of the Electricity Committee states that the new day load plant is now running, and for the first week the coal supply was 21 tons 9cwt., producing 3,050 units, against the previous week 45 tons producing 2,884 units, so there was a saving of over 50 per cent.

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Govan.—The following rates have been fixed for the current year: ordinary consumers, 6d. for the first hour of maximum demand, and 1d. per hour afterwards; domestic consumers, 3½d. per unit; theatres, halls, etc., 3½d. per unit; churches, 3d. per unit; and motive power, 1½d. per unit.

Walker.—The Electric Lighting Committee have arranged loans amounting to £33,259 with the Ecclesiastical Commissioners at 3⅝ per cent. interest for 25 years. Mr. N. W. Reed, of Newcastle, has been appointed clerk of works in connection with the construction of the refuse destructor.

Camberwell.—The County of London and Brush Provincial Electric Lighting Company have offered to supply current to the public offices and buildings at a uniform rate of 4½d. per unit instead of present charge of 7d. for the first 1½ hours' average daily consumption of the maximum demand, and 3d. thereafter.

Private Bills.—The Midland Electric Power Distribution and Light Extension Order, the Goole Electric Lighting Order, and the Handsworth Electric Lighting Order have been reported for second reading in the House of Commons. These Bills have already passed the requisite stages of the Upper House.

King's Norton.—The Guardians will at their next meeting be asked to consider a scheme to light the extensions of the workhouse with electricity. The cost of the installation is estimated to be £1,478, as compared with £589. 10s. for gas, and the working cost per annum is estimated at £347, against £261 for gas.

Electric Fans.—*Indian Engineering* understands that Mr. Staples, agent and chief engineer of the Bengal Central Railway, will shortly introduce the use of electric fans on his line as an experimental measure. The present intention is to limit the expenditure under this head to a figure not exceeding Rs. 40,000.

Southport.—The engineers have been instructed to fit reverse-current breakers to the three traction circuits, at a cost of £42. 18s. The chairman, vice-chairman, and the engineer are preparing a report as to the desirability of providing a water-softening plant. Working tests are being made of fuel from various collieries.

Chichester.—At the last meeting of the City Council it transpired incidentally that if the Corporation did not go on with the provisional order respecting the electric lighting of the city, two private companies were prepared to apply to the Bord of Trade for the necessary powers to embark upon an electricity scheme for Chichester.

Elland.—The District Council have accepted the tender of Messrs. Meldrum Bros., Limited, of Manchester, for a destructor subject to the approval of the Local Government Board. The scheme for an electric installation for Elland, prepared by Mr. W. Emmott, of Halifax, has been approved, and has been appointed engineer for the same.

Burnley.—At the last Town Council meeting, the Chairman of the Gas and Electricity Committee stated, in reply to a question, that the reason why 5,300 fewer units of electricity were used in the past month than in the corresponding month last year was not because less electricity was used, but because the leakage had been reduced.

Maidstone.—A loan for £10,000, being the second part of the loan of £38,000, has been sealed. Twelve arc lamps are to be erected in High-street, and Bank-street is to be lighted with three sets of incandescent lamps of 64 c.p. each set. A feeder is to be extended in the London-road, from Terrace-road to Buckland-hill, at an estimated cost of £446. 5s.

Keighley.—A reduced scale of charges for electricity for motive power has been adopted, and a scale fixed for the loan of motors. The charge for motors will be 10 per cent. on the cost, and as it takes about 4 per cent. to maintain the motors, this only leaves 6 per cent. for depreciation and sinking fund. The scale is the same as that in operation at Bradford.

Norwich.—In consequence of an application recently made by the Norwich Electricity Company, Limited, for the permission of the Council to alter the standard pressures in their distributing mains from 110 and 220 volts to 220 and 440 volts, the Council have decided to enter into negotiations with the company for the purchase of the company's undertaking.

Wakefield.—At last week's meeting of the Council it was decided that a bonus of 1 per cent. be paid to the electrical engineer on all completed work on capital account, in addition to his salary being increased by £50 per year. On Tuesday that part of the resolution referring to the commission was rescinded, owing to the town clerk's ruling that it was illegal to pay a bonus.

Pontefract.—At the last meeting of the Guardians a statement was read showing that the cost of the electric light for the half-year ending last June was, including interest on loans, £108; while the gas had cost £117. 10s. in the corresponding half-year, 1900, making an apparent saving of £9. 10s. In addition to this there is the saving in cleanliness and the advantage to health generally.

Accident.—A lineman in the tramways department of the Corporation, who was working the overhead equipment in connection with the electric tramcar service, on Tuesday fell to the ground from the ladder on which he was standing and fractured his skull. It seems that the man inadvertently caught hold of a live wire with his bare hand, although he was provided with indiarubber gloves.

Hull Telephones.—Mr. Brown, chairman of the Telephones Committee, stated at the last City Council meeting that so far as the promises went they had met with unbounded success. With 1,500 subscribers on their terms there would be a saving of £6,000 a year. There was every evidence that a municipal telephone would pay; in fact, it was paying well in places not nearly so favourably situated as Hull.

Merton.—Messrs. Start and Co., of the Polytechnic Estate, recently sked the Parochial Committee whether they had any objection to em taking an electric supply from the Wimbledon mains if they could get it. It was thought that in view of a probable electric light installation for Merton some time in the future, it would be unwise to compromise themselves. The matter will be discussed at the next meeting.

Melksham.—The report of Mr. Powley to the Urban District Council states that the cable laid by Messrs. Tilke and Smith, under his supervision, is of proper quality and properly laid and protected. The whole work had been done in a thoroughly satisfactory manner, and in strict accord with the most modern practice. The mains were admitted to be of the best type, and were laid at an average depth of 24in., and almost entirely in the roadway.

Nairn.—Mr. Watson, representing the National Telephone Company, has agreed to recommend his company to place the wires at the Links underground, and, if possible, to give another connection free of charge, the Council to keep their decision over in the meantime. The Electric Supply Association, acting for Messrs. Crompton and Co., intend to apply for a provisional order for powers to introduce electric light within the burgh. A special meeting of the Town Council will be held to discuss the matter.

Swansea.—During June there have been 129 applications for electric energy, equal to 15,111 8-c.p. lamps. The engineer having recommended that the question of the extension of plant should be seriously considered, a special meeting will be held to consider a report Mr. Cawthra has been asked to prepare. The Chief Constable is complaining of the defective state of the police telephone wires, and Mr. J. S. Brown, electrical engineer, will be asked to keep the wires in order, according to his offer by letter.

Fulham.—Since the last report applications equivalent to 464 8-c.p. lamps have been received, making a total in all of 17,140. A test half-ton weight, for use in connection with the automatic coal-weighing machine at the electric light works, is to be obtained from Messrs. Barry, Henry, and Co. at a cost not exceeding £9; also 100 more meters for private consumers as follows: 50 from General Electric Company at £3. 10s., £175; 50 from British Thomson-Houston Company at £4. 3s. 3d., £208. 2s. 6d.—total, £383. 2s. 6d.

Sale of Tramways.—In another column appears full particulars of the sale by the Isle of Man Tramways and Electric Power Company, Limited (in liquidation), through Mr. William Henderson Walker, C.A., of the following undertakings of the company: Douglas and Laxey Electric Tramway, Laxey and Ramsey Electric Tramway, Snaefell Mountain Electric Tramway, Douglas Bay Horse Tramway, Upper Douglas Cable Tramway. Tenders must be sent in before 11 a.m. on Sept. 7, addressed to his Honour the Clerk of the Rolls, Rolls Office, Douglas, Isle of Man.

Birkenhead.—A fire broke out on Wednesday night at the town hall, while the dinner of the British Association of Waterworks Engineers was taking place. It is reported that during the toast list one of the guests went into a cloakroom and switched on the electric light, and immediately the wire became fused at the ceiling, causing a flame to run rapidly along towards the base of the tower and spire. The fire was practically confined to the tower, the whole of the upper portion of which was destroyed, together with some of the rooms underneath. Fortunately no lives were lost.

Stock Exchange.—The Stock Exchange Committee have ordered the Central London Railway Company's £1,969,800 ordinary stock £440,100 4 per cent. preferred stock, and £440,100 deferred stock, in lieu of the shares now quoted, to be quoted in the official list. Applications have been made to the committee to allow the following securities to be quoted in the official list: British Electric Traction Company, Limited, further issue of £250,000 5 per cent. perpetual debenture stock; Johnson-Lundell Electric Traction Company, Limited, 40,000 shares of £5 each, £3 paid, Nos. 1 to 7, and 20,008 to 60,000; London United Tramways, Limited, £350,000 4 per cent. first mortgage debenture stock, in lieu of the provisional certificates now quoted.

Birkbeck Building Society.—We quote from the fiftieth annual report of this society as follows: "The receipts from shareholders on completed and uncompleted shares during the last 12 months amount to £294,150. 2s. 9d., and the amount repaid £277,496. 10s. 1d., showing a balance now due to investors of £963,912. 4s. 3d., being a net increase on the year of £16,653. 12s. 8d. The deposits received during the year amount to £13,938,904. 7s. 4d., and the sum repaid is £13,924,573. 12s. 7d., leaving a balance now due to depositors of £9,015,439. 12s. 3d., being an increase on the year of £14,330. 14s. 9d. The investments, including the cash at bankers, are £9,051,109. 4s.—the amount last year was £9,045,535. 19s. 11d.—showing an increase on the year of £5,573. 4s. 1d. The cash balance at the close of the year is £763,966. 17s. 8d., and the amount at the close of the previous year was £707,691. 9s. 1d., showing an increase of £56,275. 8s. 7d. The amount advanced on mortgage during the year is £120,410. 11s. 8d., and the amount repaid £99,772. 19s. 2d., showing an increase of £20,637. 12s. 6d., thus bringing up the balance due by borrowers to £857,304. 1s. 10d. The estimated value of the property on hand last year was £3,600, upon which a balance of £2,425. 11s. 1d. was due to the society, which property has since been disposed of at a profit. The amount of property on hand at the close of the society's fiftieth year is nil. After writing off all realised losses, there remains a clear surplus profit of £25,459. 10s. 1d. for the year, as shown in the balance-sheet; thus increasing the permanent guarantee and temporary reserve funds to £513,222. 17s. 5d., being the largest sum ever reached, amounting on an average to over £10,000 per year for each of the 50 years of the society's existence. The total receipts, which were from 1851 to 1856 £25,614, rose from 1896 to 1901 to £89,943,572, making the total cash received during the 50 years £290,256,184. In commemoration of its fiftieth anniversary—the jubilee of the society—the directors propose to present to each of the clerks and other employés a bonus. The total sum proposed to be distributed amongst a number of 94 will amount to £3,187."

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Barrow.—An enquiry was held on the 9th inst. into an application of the Corporation to borrow the sum of £12,340 for the extension of the electric lighting system at Vickerstown, Walney Island. There was no opposition. The supply of electricity to Barrow was only commenced in 1899, when there were 43 consumers, and now there are 192, and, exclusive of Vickerstown, there are 945 lamps awaiting connection.

Naval Manœuvres.—A series of experiments in wireless telegraphy are to be made in the English Channel off the Cornish coast in connection with the forthcoming naval manœuvres. For this purpose masts and the necessary apparatus have been specially fixed at Rame Head, the telephonic signal station at the extreme entrance to Plymouth Harbour. The Admiralty has also issued instructions for those cruisers and battleships taking part in the manœuvres not yet fitted with the apparatus to be so fitted immediately, and overtime is being worked in the dockyard for that purpose.

Bray.—The Urban District Council intend to apply for sanction to a loan of £4,000 for electric lighting extensions. Mr. Thomas Tomlinson, in his report on the account of the undertaking, after referring to an expenditure of £200 caused by the abnormal coal prices, says: "Looking at the accounts for last year, the municipal concern, which is growing at the rate of £200 a year, and which, after paying all expense and interest and sinking fund, and £600 capital, out of revenue, in five years—or at the rate of £120 a year—still shows a deficit of only £431, is unquestionably sound."

Cuckfield.—The Brighton Council had suggested the inclusion of Cuckfield in the Brighton municipal telephone scheme, but the Postmaster-General advised that the district of Haywards Heath being in the Horsham exchange area he was not in a position to consent to its being included in the Brighton area, but he would favourably consider any application from the Urban Councils for a license to establish a telephone exchange in the district. The Council being unable to concur with the Brighton application have resolved to apply to the Postmaster-General to grant a telephone exchange for the Cuckfield urban district.

Hereford.—The Electric Lighting Committee have requested the Finance Committee to take the necessary steps for borrowing the sum of £5,000, the amount of the loan recently authorised. They have sent to the Finance Committee an estimate of income and expenditure for the ensuing year as follows: estimated expenditure, £2,719; estimated income, £2,513; balance required, £206. The committee add that the estimate has been carefully prepared, and is believed to be justified, and as the amount includes repayments of principal to the extent of £900, they suggest that it discloses a state of things by no means unsatisfactory.

Cardiff.—A very satisfactory report was presented by Mr. Ellis to the Lighting Committee last Thursday week. Among the subjects considered at that meeting was a list representing something like £100,000, which it would be necessary to borrow during the next 12 months. During the discussion, the Chairman stated that last year they made a loss of £1,700, but this year, after paying £4,187 interest and sinking fund, there was a loss of £75. 19s. 3d. Against this they had paid £97. 10s. on account of repairs to the Ferranti engine, but on this item they still had £1,056 in hand. Balancing up the whole they had a profit of £21. 10s. 9d.

Dundee.—A new industry has been inaugurated on Tees-side by Messrs. Ashmore, Benson, Pease, and Co., who have laid down a plant for the manufacture of electric batteries. They have secured contracts from the Devonport Corporation for a 280-cell battery of the value of £2,600, and the Mexborough Urban District Council for a 250-cell battery, in addition to many other small orders. Workshops have been erected in Bowesfield-lane, and one of the latest orders that has been placed with them is that of a 58-cell battery for Lord Londonderry's seat at Wynyard Park, where it has been erected. The electric battery works at Stockton are the only one of their kind north of York and Manchester.

Fire.—A fire occurred at about 11 o'clock on Friday in Little Newport-street, off the Charing Cross-road. Wooden blocks were being removed from the roadway by some workmen, when one of the latter drove a spike into the electric lighting cables. The cables immediately fused, there was a rumbling sound underground, and the workmen sought shelter just as the coverings of three cable boxes were blown up. Fire-engines and a large number of police had to be brought into action, and workmen pulled up the road in Little Newport-street in order to bare the cable and the ending of the fusing. There was very considerable excitement, but nobody was injured, and no damage was done to the property along the sides of the street.

Aron Electricity Meter, Limited.—We are informed that the directors of this Company intend very shortly to make an issue of 5 per cent. debentures to the extent of £60,000 at 95 per cent. The extension of this Company's operations has made it necessary to have workshops for the manufacture of meters in England, and also to erect new factories in Schweidnitz, Germany, and to fit the same with the latest appliances for the most economical production of meters. The Berlin works have been considerably increased, and the establishment of a branch factory in Budapest is also contemplated, so that the growing business requires additional capital, which we have every reason to believe will be readily subscribed by the Company's strong body of shareholders.

Birkenhead.—Application is to be made for sanction to the borrowing of the sum of £40,000—*i.e.*, £11,270 for additional generating plant at Bentinck-street works, £5,800 for providing plant to the south end, £8,000 for feeder and distribution mains for the Rock Ferry district, £7,500 for distributing mains in other parts of the borough, £3,000 for service mains and connections, meters, and terminal boxes, £2,000 for arc lamp mains, lamp pillars, lamps, and switch pillars, and £2,430 for costs and expenses incurred in excess of amounts already sanctioned. The Council intend to apply to the Board of Trade for powers under the Electric Lighting Act, 1882, for a provisional order to supply electrical energy for public and private purposes within the townships of Higher and Lower Bebington and Prenton.

Kimberley.—The directors of the De Beers Consolidated Mines have practically completed the arrangements for a great extension of their electric light and power system. The Natal Government have voted a further sum of £5,900 to be expended on electric light extension in connection with the Durban harbour works during the current financial year. In addition to the above, the projected new harbour extension scheme at Durban, shortly to be brought before the Natal Parliament, involves the placing of very considerable orders for electric lighting and power plant. An order for an electric tramway water-cart will probably be shortly given out by the Durban Town Council. The directors of the South African Gold-Dredging Company propose to erect a central electric plant on the Mazoe river.—*The British and South African Export Gazette.*

Dover.—The Town Ward Lighting Committee reported to the Town Council last week on the question of the lighting of Folkestone-road, which had been referred to them on March 6, 1900. They recommended that electricity should be utilised, and suggested that two 16-c.p. lamps on separate sockets should be placed on each tramway pole, 40 yards apart, between the Red Cow and the Elms Vale-road. They estimated 850 units per annum would be required for each, and this would be charged for at the same rate as the tramway current, 2½d. per unit. The added consumption would aid to increase the tramway current, so that it would be reduced another farthing for the trams. The cost would be £3. 18s. per pole, and they recommended that the electric light company should commence the lighting on the expiration of the contract with the gas company on Dec. 31 next. The matter was adjourned. The question of municipal telephones will again be considered in two or three weeks' time.

New Issues.—An issue is being made, at the price of £103, of £250,000 4 per cent. guaranteed debenture stock of the Central Electric Supply Company, Limited. The company was formed in 1897, with an authorised share capital of £100,000, and in 1899 obtained compulsory powers to purchase land in St. Marylebone, and to erect thereon a generating station for supplying electrical energy to the St. James's and Pall Mall Electric Light Company, Limited, and the Westminster Electric Supply Corporation, Limited. Contracts have been entered into for the erection of a generating station, and for sufficient plant to give a supply for 250,000 8-c.p. lamps installed, or their equivalent, in the districts of the two companies. The estimated cost of the land and mains and of the plant is £350,000, of which £100,000 is provided by the issue of the shares of the company, and the balance by the present issue of debenture stock. The stock will be secured, both as to principal and interest, by a first charge upon the undertaking of the company, and by the joint and several guarantee of the St. James's and Pall Mall Electric Light Company and the Westminster Electric Supply Corporation.

Battersea.—Mr. J. C. Livesey has been appointed chairman of the Lighting Committee for the next three months. A report has been submitted stating that, pursuant to the authority of the Council, alternative schemes were invited for the wiring and fitting up of consumers' premises for electric lighting, free of all initial cost to the Council or the consumer, and in response thereto four schemes were received, but the committee do not see their way to recommend the Council to accept any one of them, and have adjourned the further consideration of the matter pending the steps which are being taken to endeavour to obtain legislation empowering local authorities to carry out the work themselves. They further recommend that the charge for the supply of electricity by means of prepayment electricity meters be 6½d. per unit, and that no rent be charged for the meter; and that a formal opening of the central electric generating station take place, that no refreshments be provided at such function, and that they be authorised to make the necessary arrangements. The date is not stated, but it appears that the works are not as far advanced as was anticipated at the time of the laying of the foundation stone, when July or the beginning of August was given as the probable time for the commencement of the street-lighting.

Darlington.—Mr. Lunn's last report states that the number of consumers connected during the month were three, making a total of 88. The number of 8-c.p. lamps connected during the month was 128, making a total of 6,850. He had secured application from 21 intending consumers, who would require 1,565 8-c.p. lamps. The number of units generated during the month was 7,264, and 34 tons of coal had been consumed, the cost of coal per unit being ·66d. Application is to be made for sanction to a loan of £12,000 for the extension of the electric lighting plant. The report on the specifications for this plant states that the size specified by Dr. Kennedy, which is practically the same as that recommended by the electrical engineer, is the most useful size to instal at present, even if the tramways should be converted at once. It will be large enough to supply current sufficient to drive from 20 to 30 tramcars, and if more than this number of tramcars should be running one of the present sets could be run in parallel with it. If it is decided to supply electricity for traction purposes, however, another set would be required in addition to the one now proposed, and if the trams are not ready for 12 or 18 months probably two sets would be wanted in addition to the one proposed, as this one would by that time be loaded up with lighting consumers. The engineer considered that the Lancashire boiler was most suitable for their purposes.

Brighton.—According to a recent statement of the borough accountant on the electric light undertaking for the period Jan. 1 to March 31, 1901, there is a balance of revenue, after providing all working expenses and interest and sinking fund charges, of £4,663. 13s. 3d. That this surplus amounted to so considerable a sum is accounted for by the fact that under the present sliding-scale system of charge, very nearly all the units at the higher tariff fell to be charged

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during the earlier part of each half-yearly period. Especially is this the case with the period January to June, and therefore an account for the three months from January to March, which includes all the revenue from sales of current during the said quarter at 7d. per unit, must obviously be very misleading, if regard be had to the balance appearing thereon as profit. The accountant does not consider that it is desirable, under the special circumstances that had necessitated the preparation of this account, to attempt to apportion the revenue between the first and second quarters of the current half-year. Moreover, if this were done now, it followed that a similar apportionment would have to be made each succeeding year; and, in his opinion, it would be bad policy to introduce into future accounts an uncertain element of this nature. He was bound to add, however, that from an accountancy point of view, it would be a decided advantage if it could be arranged that the dates of the commencement of the two half-yearly tariff periods could be altered from Jan. 1 and July 1 respectively to April 1 and Oct. 1, so as to correspond with, and not overlap, the dates newly prescribed for the commencement and close of the accounts year.

Presentation.—Mr. J. A. Jeckell was presented with a handsome gold watch and chain, spade guinea, and sovereign purse, together with an oak timepiece, by the contractors, officials, and employés connected with the electric light works of the South Shields Corporation at the County Hotel, South Shields, on Saturday. Councillor Grey presided, and there were also present Alderman Rennoldson, Messrs. W. E. Moffett, G. Robertson, J. C. Petersen, H. G. Templeton, and Spence. Alderman Rennoldson, who made the presentation, said that it was about eight years since Mr. Jeckell first came among them at the initiation of the Corporation electricity undertaking. From then until now he had succeeded in maintaining the respect and confidence of the Council as well as of those who had been associated with him in the progress of the works. It was exceedingly pleasing to find that the relations which had existed between Mr. Jeckell and the Corporation, and also between himself and the staff, had been of such a pleasing character. That Mr. Jeckell was leaving was to him a matter of personal regret. He was going to a place where he would find ample work and opportunities for showing his ability, and he hoped he would be as successful there as he had been at South Shields. Mr. Jeckell, after speaking of the pleasant relations that had existed between the workmen and himself, said that one great reason for his leaving South Shields was that he was unable to stand the climate. Moreover, he wished to take up the commercial side of electricity supply, and at Coventry he would find scope in this respect. He thanked those present for the exceedingly handsome testimonial, but more for the kindness which it showed.

Aberdeen Subway.—Good progress is being made with the construction of the electrical subway from the new electricity works at Dee Village to the top of Crown-street, in connection with the electrical department of the Aberdeen Corporation. The subway is being built for the purpose of carrying all feeder cables with their pilot leads for supplying energy to the tramways, and for the distributing mains in the west, north, and central districts of the city. The work was planned and is being carried out by the burgh surveyor's department, and is under the special charge of Mr. Conway. Mr. Peter Tawse is contractor, and Mr. William Turner, Brixton, London, who has had large experience of subway construction, is inspector of works. A beginning was made in December, and considering the nature of the ground, which is difficult to handle, the hindrance caused by the house connections with the water and gas mains, and unforeseen obstructions, such as an old sewer, satisfactory progress has been made. The subway up to a point near St. Mary's-place is nearing completion, and is of concrete, 8ft. high by 4ft. 8in. wide, with an inner lining of red brick. Between the concrete walls and the brickwork lining, Callender's bituminous damp-proof sheeting is placed to keep the subway absolutely dry. Where the space between the top of the sewer and the surface of the roadway is limited, a flat roof section has been adopted of rolled-steel beams, with expanded metal and concrete filled in between the flanges. This was rendered necessary in view of the heavy loads that will fall on the subway when the electric cars are running in Crown-street; and it may be mentioned that the rolled-steel beams have been thoroughly tested, and have borne the weight of six tons, to which they were subjected. In the portion between Dee Village-road and St. Mary's-place workmen are busy, and by the aid of the electric light deftly lay the outer wall of bricks, which are all placed on cement and pointed with the same material. Built into the brick lining are cast-iron wall plates for the reception of porcelain insulators for the carrying of the 56 feeder cables it is proposed to carry along to the switchboard chamber in Union-street.

London County Council.—On Tuesday the Highways Committee recommended that, in connection with the electrical working of the London County Council tramways, an agreement be entered into with the South London Electric Supply Corporation, providing that (*a*) the company shall permit the Council to erect a temporary building at the company's electricity generating station near Loughborough Junction, and to place therein two 2,500-h.p. continuous-current sets of electricity generating plant and auxiliaries, and also to place therein temporarily two Stirling boilers; (*b*) that the generating plant referred to shall be worked by a staff in the employ of the Council; and (*c*) that the company shall be paid by the Council at the rate of 1·4d. per unit of electric current used for working the tramways. Notices under Electric Lighting Acts and Orders were granted as follows: Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Order, 1897, to lay low-tension mains (*a*) along a portion of Burnt-ash-road, and (*b*) along a portion of Dorville-road; the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, 1892, to lay high and low tension mains across East-hill and along Herndon-road, Eglantine-road, Geraldine-road, and Allfarthing-lane; the Metropolitan Electric Supply Company, under the West London Order, 1889, to lay high-tension mains across and along South-street, and along Manchester-street; the St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, of intention to lay mains (*a*) along a portion of Albany-street, (*b*) along portions of Herbert-street and Malden-road, and (*c*) along portions of Euston-buildings and Miller-street. Receipt of notices, served under orders granted to local authorities, and under which the Council have no power of approval or disapproval of the works, were reported as follows: from the Hammersmith Borough Council, under the Hammersmith Order, 1893, to lay mains along Dalling-road; and from the Poplar Borough Council, under the Poplar District Order, 1893, of intention to lay mains along Violet-road, Devon's-road, and High-street.

Wolverhampton.—It is proposed to increase the salary of Mr. Shawfield, borough electrical engineer, by £150 per annum. In support of their recommendation the Electrical Committee have prepared the following report, which will be considered at the August meeting of the Town Council: "Mr. Shawfield was provisionally appointed chief engineer to the electric lighting department in July, 1898, at a salary of £200 per annum, which was increased to £300 (being the amount at present paid to him) in July, 1899, when his formal appointment to that office was confirmed. During the three years that have elapsed since he was first appointed the work of the electric lighting department has considerably increased, as the following figures will show: number of consumers 1898, 208; 1891, 461; per cent. increase, 120; units sold, 291,233, 633,508, 118; maximum demand at works in kilowatts, 320, 642, 100; capital expenditure, £41,781, £92,283, 121; kilowatt capacity of station 482, 1,440, 198. The growth of the undertaking, as shown above, has necessitated large extensions of the generating plant and distributing system, all of which Mr. Shawfield has designed and carried out at a capital cost of about £50,000. In addition to his ordinary duties in connection with the electric lighting department, he has also drawn up the whole of the plans and specifications for the complete electrical equipment of the new tramway undertaking, the construction of which has already been commenced, and will be carried out under his supervision. Mr. Shawfield has performed the whole of this extra work in connection with the tramway scheme with great tact and ability, and without any additional assistance. His duties and responsibilities will be greatly increased in the near future by the commencement of the commercial operation of the 11 miles of tramways now under construction, and the extension of the system by the provision of additional routes. Had not these duties been placed in the hands of the electrical engineer, the appointment of a qualified person to undertake this work would have become necessary, involving an extra outlay of probably £400 or £500 per annum. The advantage of securing Mr. Shawfield's services for this work is obvious."

Royal Tour.—The last number of the *Sydney Morning Herald* to hand contains a glowing description of the illuminations in Sydney during the visit of H.R.H. the Duke of York, from which we quote extensively as follows: "The remarkable scene presented shows that electrical engineering skill, at present at all events, knows no limits as regards artistic grouping of coloured lights in order to present effects hitherto undreamed of. Magnificent as were the electrical illuminations during the Commonwealth celebrations, they paled before those which shed a flood of light along some of the principal thoroughfares of the city last evening, and also towered skywards to become beacons for miles around. Myriads of incandescent lamps, glimmering in all the colours of the rainbow, were distributed to outline arches, festoons, pictures, and other devices too numerous to mention. The Railway Commissioners, as usual, scored, and the illuminations at the Redfern railway station were particularly good. A novel element in the decoration there was the introduction between the small bannerets of celluloid balloons, each having inside powerful incandescent lamps. Each mast supporting these balloons was also adorned with rings of multi-coloured lamps." With regard to the electric light installations, we quote from the *Sydney Morning Herald* a description which will give our readers an idea of the plant used in Sydney: "The fact that 22,000 incandescent lamps, over 100,000 c.p. in arc lights, about 20 miles of large stranded electric cable, and half as much again of smaller leading-off branch cables were used by the Government for the purpose of illuminating Macquarie-street, Bridge-street, Pitt-street, Martin-place, Queen's-square, and Government House gates and grounds, will indicate at once that powerful electric light generating establishments had to be erected to supply the necessary current. The marvel is that Mr. Raw, engineer of the Government architect's department, upon whom devolved the task of providing the light, was able to do so well, seeing that there was no uniformity in the type of electrical machines that were placed at his disposal. As a matter of fact they were most varied in character, and the result was they required different treatment as regards the mechanical appliances for driving them. The principal installation was located in the Botanic Gardens, from which a portion of Macquarie-street, the first section of Bridge-street, the large crown on the top of the Chief Secretary's office, Government House gates, the arc lamps in Government House grounds, as well as the new marquee erected therein, were lighted. During the Commonwealth celebrations it was found necessary to erect a temporary station in the Botanic Gardens to supply the current to the Palace Gardens and the arc lamps in the Outer and Inner Domains. The building and a portion of the machinery then erected are being utilised for lighting up portions of Macquarie and Bridge streets, the crown on the Chief Secretary's office, the arch at the entrance to Government House, and the arc lamps in the grounds of Government House. The large Siemens-Willans plant, which was specially procured for the Commonwealth celebrations, has been removed from this station to a temporary station recently erected in Martin-place. Its place has been taken by a direct-coupled Raworth machine made by the Brush Electrical Engineering Company. It was ordered 12 months ago, but was only landed last week. It reached the Botanic Gardens last Tuesday, but by working continuously night and day the engineers succeeded in erecting it, turning on steam, and generating electric light in four days. This engine is a 15-h.p. plant. It is a facsimile of two plants which have been

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in use for three years illuminating the public offices. The whole station embraces four large boilers lent by the Railway Commissioners on the occasion of the Commonwealth celebrations, and an 80-h.p. multitubular boiler. The electric light generating plant comprises the new Esworth machine, two horizontal engines, each of 120 h.p., and another one of 80 h.p. The dynamos consist of six Brush arc machines, each of 25 lamps capacity, one Anglo-American 110-volt dynamo of 250 amperes capacity, one Mather and Platt dynamo of 330 amperes capacity, one Mordey dynamo of 140 amperes capacity, and a machine by the Electric Generating Company of 100 amperes capacity. The greater portion of the magnificent illuminations in Macquarie-street is supplied from the electric light station situated in the Domain, at the rear of Parliament House, and generally used for lighting that building. Only portion of the machinery at this station is used for illuminating Macquarie-street, the other portion being required to supply electric current to Parliament House in connection with the State function, which takes place there to-morrow evening. The station also worked the powerful searchlight which was used to bring out into bold relief the statues of Queen Victoria and Prince Consort. The temporary installation in Chancery-square was used to illuminate that portion of Macquarie-street near Queen's-square, as well as to supply current to the 24 powerful arc lamps that surrounded the latter. The station temporarily located in Martin-place comprised the large Siemens-Willans 2,000-ampere plant formerly located in the Botanic Gardens, one Anglo-British dynamo of 250 amperes capacity, and one Parker dynamo of 200 amperes capacity. The two latter machines are driven respectively by a Brush-Falcon high-speed vertical engine, and an early type of Westinghouse make. Steam is generated in two large multitubular boilers, aggregating 400 h.p. From this station was supplied the whole of the illumination for the Court of the Empire and the magnificent display of canopied lights in Pitt-street, extending from King-street to Bridge-street. The erection of the station was commenced three weeks ago, and worked smoothly, notwithstanding the heavy load that had to be carried. Another temporary station was provided on a vacant piece of land facing Bridge-street and between Philip and Young streets. It embraces one of Ruston and Proctor's portable engines and boiler, and a Ransomes, Sims, and Jefferies portable engine and boiler. The first-mentioned plant drives a Mather and Platt dynamo. It is one of the latest pattern of multipolar machines of 375 amperes capacity: also a Brush dynamo of 200 amperes capacity. These two machines are used in producing the magnificent light enveloping the Lands Office tower. The other engine drives a Mather and Platt 180-ampere dynamo and a Parker machine of 125 amperes capacity. They light up a short section of the Bridge-street electric light arcade, as well as the allegorical figure of commerce surmounting the Merchants' Exchange. The small installation erected during the Commonwealth celebrations near the Treasury buildings in Macquarie-street was brought into operation for the purpose of supplying electric current to the illuminations in front of the Customs House and along Circular Quay."

PROVISIONAL PATENTS, 1901.

JULY 1.

13324. Improvements in electric switches electrically controlled. Charles Salmon and Henry James Creffield, 15, Crusoe-road, Erith, Kent.

13329. A new and improved system of wireless telegraphy by means of stationary electrical waves. Robert Scharf, 31A, Luisen-street, Berlin.

13371. Improvements in method of and means for tandem connecting asynchronous alternating electric current motors. Ernst Danielson, 322, High Holborn, London.

13372. Improvement in alternating electric current induction motors. Ernst Danielson, 322, High Holborn, London.

13402. Improvements in self-exciting alternating-current dynamos. Marius Latour, 47, Lincoln's-inn-fields, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Dec. 13, 1900, being date of application in France.)

JULY 2.

13410. Terminal block or pillar for connecting electrical conductors. John Dugdill, Failsworth, near Manchester.

13411. Improvements in surface contacts for electric traction in streets or roads. Charles Salmon and Henry James Creffield, 15, Crusoe-road, Erith, Kent.

13415. Improved holder for electric incandescent lamps. George Wallace, 151, Upper Rathmines, Dublin.

13431. Improvements in the method of and means for electrically controlling a plurality of actions at a distance through a single conductor. John Gardner, 70, Market-street, Manchester.

13468. Improvements in electrical interlocking apparatus for railway signalling. The Westinghouse Brake Company, Limited, and Ernest de Mérindol Malan, Westinghouse-building, Norfolk-street, Strand, London.

13478. Improvements in electric railways with overhead conductors. Carl Bach and Karl Richard, 221, Allecstrasse, Barmen, Germany. (Complete specification.)

JULY 3.

13510. Electrical workmen's time-checking clock. Charles Tookey Mason and Sam Randall Brown, 82, Rutland-street, Leicester.

13513. Improvements in electrical cut-outs. William Hellier Evans, 8, Lombard-chambers, Bixteth-street, Liverpool.

13563. Improvements in and relating to the transmission of electrical energy. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Nikola Tesla, United States.) (Complete specification.)

13568. Improvements in plates for electric accumulators. Donato Tommasi, 53, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 17, 1901, being date of application in France.)

13577. Improvements in electrical fuses for high tension. Paul Loescher, 322, High Holborn, London. (Complete specification.)

13583. Improvements relating to electro-mechanical regulators. Joseph Louis Routin, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Dec. 22, 1900, being date of application in France.)

JULY 4.

13595. An apparatus for holding paper for use on telephones by means of which calls may be readily recorded. Harald Clegg, 34, Napier-avenue, Southend-on-Sea.

13623. Improvements in push-switches for electric bells. The British Thomson-Houston Company, Limited, and Archibald Stannard Cubitt, Bush-lane House, Cannon-street, London. (Complete specification.)

13624. Improvements in the methods of securing and sealing electricity and other meters. William Charles Bushby, 25, Eastgate-street, Winchester.

13640. Improvements in secondary batteries. Jules Buffaud and Auguste Tavian, 53, Chancery-lane, London.

13644. An improved electrical resistance. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Georges, Gabriel Poncelin, France.)

13655. Improvements in or relating to electric illuminating devices. Alfred Julius Boult, 111, Hatton-garden, London. (Jean Marie Le Gall, France.)

13662. Improvements in electrolytic cells. Julius Raschen and the United Alkali Company, Limited, 47, Lincoln's-inn-fields, London.

13663. Improvements in telephone transmitters. Ernest Benjamin Fahnestock, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13665. Improvements in holders for Nernst lamps. Eustace Graham Sheppard, Gilbert Scott Ram, and Nernst Electric Light, Limited, 18, Southampton-buildings, Chancery-lane, London.

13666. Improvements in lampholders for electrolytic lamps. Bernard Mervyn Drake and Nernst Electric Light, Limited, 18, Southampton-buildings, Chancery-lane, London.

JULY 5.

13723. Improvements in lifeguards for electric cars and other self-propelled vehicles. Arthur Royle, 6, Lord-street, Liverpool.

13732. Method of and apparatus for effecting electric traction on tramways. Charles Denton Abel, Birkbeck Bank-chambers Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la Transmission de la Force par l'Electricité, France.)

13738. Improved means for preventing sparking at the collector of dynamo-electric machines. Alexander Heyland, 47, Lincoln's-inn-fields, London.

13747. Page printing telegraph. Guiseppe Musso, 55, Chancery-lane, London. (Complete specification.)

JULY 6.

13802. An improved trolley for electrically-driven tramcars and the like. Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Léon Chapius et Cie., France.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 27.

1900.

10348. Electromagnetic motor. Van Der Ploeg.

11907. Block or mounting for electrical, gas, and like fittings. Bolton.

11937. Telephone systems. Stafsing and Egnér.

11965. Electric receivers and electric clocks. Barr, Stroud, and Becker.

12331. Blocks for electric and like conduits. Schellbach.

12737. Holders for electric incandescent lamps. Oppenheimer. (Actien-Gesellschaft Mix und Genest.)

12893. Underground wires and accessories for transmitting electric energy. Rosati.

13962. Electric signal registering systems for telephone systems. Jensen. (Yurgae Signalphone Manufacturing Company.)

14558. Transmission and receiving of telegraphic signals. Blochmann.

15748. Electric switches, fuses, and other apparatus in which destructive electric arcs are liable to be formed. Partridge.

16644. Electricity meters. De Ferranti.

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17829 Device for measuring upward pressures, and particularly for enabling the trolley arms of electric tramcars and vehicles being set to exert a certain upward pressure on the wire. Wilkinson.

1901.

9676. Electric smelting process and apparatus to be used therein. British Aluminium Company, Limited. (Cowles.)

9769. Current collectors or contact shoes for electric railways. Lake. (McElroy-Grunow Electric Railway System.)

9883. Controllers for electric motors. Fox.

11280. Electrical reversing switches and mechanism for operating them. De Kandó.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	July 6	842	699	+ 143	—	—
Birmingham Tramways	,, 6	4,889	4,649	+ 240	117,717	115,558*b*
Blackburn Corporation	,, 5	531	486	+ 45	12,588	11,488*b*
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 6	785	801	- 16	785	801
Bolton Corporation	,, 7	1,608	1,420	+ 188	37,937	23,233*b*
Bradford Corporation	—	—	—	—	—	—
Bristol Tramways Company	,, 5	4,873	3,222	+ 1,651	—	—
Carlisle Tramways Company	,, 6	274	284	- 10	4,034*b*	—
Central London Railway	,, 6	6,079	—	—	6,079	—
City and South London Railway	,, 6	1,972	1,447	+ 525	1,972	1,447
Cork E. T. and L. Company	,, 4	644	526	+ 118	11,593	10,073*b*
Darwen Corporation	,, 5	203	152	+ 51	4,881	3,999
Dover Corporation	,, 6	254	235	+ 19	5,108	4,737*b*
Dublin & Lucan Electric Railway	,, 7	143	112	+ 31	143	112
Dublin U. T., electric cars	,, 5	†2,827	†2,442	+ 385	—	—
Dublin S. District, Electric	,, 5	†664	†611	+ 53	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 6	12,353	9,408	+ 2,945	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	,, 6	998	702	+ 296	12,560	9,949
Hull Corporation, E. S.	,, 6	1,726	1,312	+ 414	1,726	1,312
Liverpool Corporation	June 29	9,633	7,750	+ 1,883	221,639	190,028*b*
Liverpool Overhead Railway	July 7	1,732	1,687	+ 45	1,732	1,687
Oldham-Ashton-Hyde Tramways	,, 5	532	516	+ 16	12,972	12,520*b*
Portamouth Corporation	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 6	3,595	—	—	—	—
Southampton Corporation	,, 4	888	648	+ 240	—	—
Southport Corporation	June 29	321	—	—	4,297*d*	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. † Five days. *b* From Jan. 1. *d* From April 1. 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £121 decrease.
Barcelona Ensanche y Gracia, £32 decrease. Barcelona, £464 decrease.
Brisbane, £1,820 increase.
Buenos Ayres and Belgrano Electric, £695 increase.
Calcutta, £155 increase.
Cape Town (month of June), receipts, £13,119; expenditure, £6,380.
Mexico Electric (month of May), receipts, £18,500; expenditure, £10,600.
Perth Electric, £262 increase.
Port Elizabeth (month of June), receipts, £2,983; expenditure, £1,800.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¾-1
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¾-⅞
—— Ordinary, 1-125,000	1 ..	⅝-¾
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	6-6¼
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4¾-5¼
British Electrical Engineering, Ordinary	2 ..	1¼-1⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	103-108
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102 xd
Callender's Cable, Debentures	100 ..	107-111
—— Ordinary	5 ..	14-15
—— 5 per cent. Pref.	5 ..	5¼-6 xd
Crompton and Co.	3 ..	3¼-4
—— 5 per cent. Debentures	— ..	100-105 xd
Edison and Swan United, Ordinary	3 ..	1-1½
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85 xd
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	92-96
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1⅞-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	100-103
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	15½-16½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	107-111
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	101-104
Telegraph Construction and Maintenance	12 ..	36-40
—— 5 per cent. Bonds	100 ..	101-104 xd
Telegraph Manufacturing, Ordinary	5 ..	10-11
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	98-100
Bournemouth and Poole, Ordinary	10 ..	12½-13½
—— 4½ per cent. Cum. Pref.	10 ..	11-10
—— Debenture Stock, Red.	100 ..	101-104 xd
Brompton and Kensington, Ordinary	5 ..	7⅞-8¼
—— 7 per cent. Preference	5 ..	8¼-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7¼-7⅜
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	102-104 xd
Chelsea Electricity Supply	5 ..	5¾-6¼ xd
—— 4½ per cent. Debentures	100 ..	107-110 xd
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	12¼-13¼
—— 5 per cent. Debenture Stock	100 ..	120-125 xd
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	100-102 xd
County of London and Brush Provincial, Ordinary	10 ..	8¼-9½
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	103-106 xd
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¼-6
—— 6 per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4½ per cent. First Mort. Deb.	100 ..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5-5½
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11¼-12¼
—— 4 per cent. Debenture Stock, Red.	100 ..	102-105
Kensington and Knightsbridge and Notting Hill	100 ..	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13¼-14¼
—— ,, 85,001-98,769	5 ..	13¼-14¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	108-111 xd
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	94-97 xd
Newcastle-upon-Tyne Electric Supply, Ordinary	— ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16 xd
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7-7½
—— £4½ Shares, New	4½ ..	6-6½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5¼-6½
River Plate Electric Light and Traction, Deb.	100 ..	65-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14¼-15½
—— 7 per cent. Pref.	5 ..	9-10
—— 3½ per cent. Deb.	100 ..	97-100 xd
Westminster, Ordinary	5 ..	11½-12½
Electric Railways.—		
Central London, Ordinary	10 ..	9¼-9⅜
—— Pref. Half-Shares	5 ..	4⅜-5¼
—— ,, ,, deferred	5 ..	4¼-5
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	54-56
—— Ordinary	10 ..	5¼-5⅜
—— 4 per cent. Debenture Stock	100 ..	112-117
—— 5 per cent. Pref. Stock '91	100 ..	132-137
—— ,, ,, '96	100 ..	122-128
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅜-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4¼-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	123-128 xd
Blackpool and Fleetwood Tramroad	10 ..	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¼-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	100-102
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¼-7
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14¼-15½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-13
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅜-1⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	102-105
—— Prov. Cert., all paid	100 ..	96-99
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅜-2
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5¼-5⅜
—— 4 per cent. 1st Mortgage Debentures	100 ..	100-103
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	98-102
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	104-106 xd
New General Traction, Ordinary	5 ..	3-3¼
—— 6 per cent. Cum. Pref.	10 ..	4¼-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10⅜
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	12-13
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	105-108
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	6s. ..	5/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	30 p.c. ..	30 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	3⅜-3⅝
—— 6 per cent. Cum. First Pref.	10 ..	11-12
—— 6 per cent. Cum. Second Pref.	10 ..	11-12
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-4⅜
—— 4 per cent. Deb. Stock, Red.	100 ..	95-98 xd
—— 3½ per cent. Deb. Stock, Red.	100 ..	89-92 xd
Oriental Telephone and Electric Company	1 ..	⅞-1

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NOTES.

Erratum.—In our note referring to the exhibits at the American Institute of Electrical Engineers' conversazione we described a static dynamo and a Bohrenberger sphere. Both of these machines were exhibited by Prof. Elihu Thomson, and we wrongly credited them in our note to Mr. Nikola Tesla.

Post Office Telephone. — A question put to the Secretary to the Treasury in the House of Commons on Monday, gave rise to the important announcement that the Postmaster-General hopes to be able to begin the connection of subscribers with the central exchange and some others at the beginning of October next.

Automatic Telephones.—We understand that the German Imperial Postmaster-General has finally decided to introduce the Stowager automatic telephone, a system which enables subscribers to connect and disconnect themselves automatically with other subscribers, thereby dispensing with the exchange operator. This decision has only been come to after prolonged investigation and practical tests, which it is said warrant the introduction of the system.

Electric Mail Carriers.—The working of the pneumatic tube systems of carrying mails in United States cities on the present basis of cost has proved too expensive. At least this is the view taken by a specially-appointed committee which, as the result of investigation, recommends a system worked by electricity. It consists of a miniature third-rail trolley road operated in a tube, and we understand the system is now in process of development.

Proposed German Technical Bureau.—We understand that a federal bureau of technics is to be established in Germany. The executive committee having charge of the preliminary steps in the matter consists, it is said, of members of the leading chemical works, the Technical Association of Germany, the Association of German Engineers, the Central Bureau for Scientific Investigation, and others. The scheme is also supported by several well-known electrical firms in Germany.

Electric Lighting Loans.—We notice that the London County Council Finance Committee have again refused an application for deferring the repayment instalments on an electric lighting loan until after three years from the loan being made. We regret that the financial wisdom of this committee cannot be brought more into line with the facts of the case, as it would be a great boon to new electric lighting undertakings if such a deferment of the repayment of principal could be made.

Railway Telephones.—The Missouri-Pacific Railway Company are setting a good example to their *confrères* in other countries. We note that this railway is about to establish a telephone system along its lines for the convenience of its patrons and also for the furtherance of its own business. In our own land the benefit of such a system would be especially felt in the country districts, and the tendency would undoubtedly be to greatly promote business in the outlying places, where at the present time it is necessarily hampered for want of better convenience.

Water-Power Development in Sweden.—From a report which has recently been issued by the Swedish Agricultural Department, attention is drawn to numerous waterfalls in the country which could be successfully utilised for the development of motive power. It is estimated that the available energy of the principal waterfalls in Sweden is from 2,000,000 h.p. to 4,000,000 h.p. The national coal bill for last year amounted to considerably over £3,000,000, and it is pointed out that this sum might be considerably diminished by the employment of the natural motive power possessed by the country.

Progress in India.—Electricity in India is making rapid strides. The most important schemes at present on the *tapis* is the installation of the combined electric punkah pulling and lighting of the barracks and hospitals of the British troops in India. According to the latest reports, the demand for electric ventilators in British India largely exceeds the supply. American manufacturers, it is said, are handicapped by the fact that a preference is shown for ventilators with blades from 4½in. to 6in. long, while those of American make are only about 3in. long. The establishment of a depôt for automobiles in Bombay is also under consideration.

French Visit to the States.—The announcement that *L'Eclairage Electrique*, through its editor, Prof. Blondin, has organised a trip to the United States, so as to arrive in time for the meeting of the American Institute of Electrical Engineers at Buffalo, is welcomed in that country with enthusiasm, and extensive provision, we note, is being made to give the French electricians a very cordial reception. The visit is regarded as affording an excellent opportunity of enabling the American Institute to return the hospitality enjoyed by its members on the occasion of the Electrical Congress of last year. According to present arrangements, the date of departure from Paris is Aug. 3, the sailing date of return being Sept. 13.

Cape-Australia Cable.—Sir Edward Sassoon asked a question in the House of Commons the other day about the Cape-to-Australia cable, to which Mr. Chamberlain replied that no general contract will be signed between his Majesty's Government and the Eastern Telegraph Company in connection with the matter, but the conditions by which the company will be bound will be embodied in landing licenses shortly to be issued for this cable at Mauritius, Rodrigues, and Cocos Islands. The Colonial Secretary further stated that he had received no appeals from Canada, Australia, and the Cape that an expropriation clause, reserving to the State the right of purchase on equitable terms, should be inserted in these licenses.

Smoke Nuisance Preventive. — The smoke nuisance is common to all countries, and many are the devices which have been contrived to keep manufacturers and others out of the clutches of the law. In this connection we notice the interesting announcement in *Electricity* of New York, that, with a view to doing away with the smoke nuisance, an exceedingly tall smoke stack has just been completed at Constable Hook, N.J., for the Oxford Copper Works. The stack is 365ft. high, and is built of brick, the chimney wall at the base being 7ft. thick. The inside diameter is 76ft. at the bottom and 10ft. at the top. The work of construction was carried out from a scaffold inside the chimney. In these days of induced draught apparatus the building of such a high stack is most unusual.

Timber Poles.—The United States Department of Agriculture recently issued a report on telegraph, telephone, and electric power and light poles, from which we gather that the timbers most used for these purposes are tamarack, white cedar, and red juniper. Their life in the ground is about 10 years, so that every decade sees one generation of poles worn out and another cut to replace it. The total, including the poles required for new lines, is therefore very large, the telegraph lines of the country requiring nearly 600,000 poles annually, at a cost of about £250,000, and the telephone and electric car lines and light systems, it is estimated, use as many more. At the present time the price of poles for such uses varies greatly, ranging from

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4s. to £10 each, but with the ever largely increasing demand the natural supply will run low, and then, says report, higher prices will prevail.

Capillary-Electrical Phenomena.—The *Journal* of the Chemical Society for July gives a short abstract of a paper by Mr. W. Palmaer, containing a discussion of the theories of Helmholtz, Warburg, and Nernst regarding electro-capillary phenomena. The author considers that there is no evidence to support Helmholtz's view of the influence of time or to support Warburg's idea of the capability of mercury to cause a condensation of the solution at its surface. Further, the explanation of Warburg would necessitate an inconceivably high concentration of the salt in the layers of solution contiguous to the mercury. The Nernst theory explains most of the facts without the necessity of any new hypothesis, both in regard to the phenomena obtained with pure mercury and with amalgams, whereas Warburg's theory necessitates contradictory suppositions with different amalgams.

Wireless Communication with Lightships.—From the answer to a question put to the President of the Board of Trade in the House of Commons by Sir John Leng a few days ago, we gather that the question of the establishment of electrical communication, including wireless telegraphy, between lighthouses and lightships and the shore is under the consideration of the Departmental Committee appointed in 1899. At present, however, the President of the Board of Trade was unable to say that wireless telegraphy will be selected as the best method of communication in any particular case. A further question to the Secretary to the Treasury elicited the statement that no agreement has yet been arrived at between the Post Office and the Admiralty to facilitate the use of Marconi's wireless telegraphy by British steamships for postal telegraphs and news messages. Negotiations, however, with regard to this matter are still proceeding.

Compensating Measuring Instruments.—A recent communication to the French Academy of Science by Mr. M. P. Weiss describes an ingenious modification of electric measuring instruments. In this device a permanent magnet is utilised to furnish a field of force through which a coil carrying an electric current moves. It is well known that in all such instruments the magnet suffers more or less change with time, and these changes may be either increase or decrease of the magnetic moment of the permanent magnet, according to whether it produces or works against the deflection. The device in question, which is used to compensate the two effects, consists of a small needle of soft iron rigidly connected with a movable coil. In the event of the permanent magnet increasing in strength, the tendency of the coil deflections will also be to increase; but the presence of the needle, if the latter be saturated, it is claimed, will so compensate as to produce the same deflection as before. Both ammeters and voltmeters have been made on this plan, and it is stated that they have operated with great success.

Tramway Sufferers.—The correspondence columns of the *Standard* have of late been made the medium for correspondents to ventilate their grievances consequent on the working of the electric trams in the western suburbs of London. One gentleman, signing himself "Sufferer," complains that "in the whole of the three nights since the service opened on Wednesday last I have not had more than 12 hours' sleep." From this we assume that he resides on one of the new routes of the West London Tramways, and regard it as only natural that he should at first experience something in the nature of a "nerve-destroying din," but, as in other parts of the country, the residents along these routes will sooner or later become accustomed to the new sounds, and, indeed, will hardly notice them after a time. With regard to the writer's statement that "the value of the better-class residential property will be depreciated," this has not been the case in other towns provided with an electric tram service. In fact, the evidence is all one way, that with the introduction of the electric tram there is a decided tendency in favour of house property increasing in value.

Electrolytic Estimation of Bismuth.—A short abstract of a paper by Karl Wimmenauer on this subject appears in the current number of the *Journal* of the Chemical Society. The author has examined the methods for the electrolytic estimation of bismuth and gives details of his results. An accurate and expeditious estimation is best obtained as follows. The electrolyte should contain 0·1 grm. of bismuth oxide to 1 to 0·5 cubic centimetre of concentrated nitric acid, and, if an excess of nitric acid is not employed, 2 to 4 cubic centimetres of glycerol (one part glycerol to two parts water) must be added, and the solution diluted to 150 cubic centimetres. When this solution is subjected to electrolysis, using a current of 0·1 ampere at first, and reducing this to 0·05 ampere as soon as any indication of peroxide is detected, a dense, bright deposit is obtained, which is easily washed without loss. It is essential that the electrolyte should be continuously agitated during the deposition. Quantities up to 0·4 grm. of bismuth are easily deposited in three hours. The temperature of the solution is gradually raised to 50deg. and maintained at this until all the bismuth is deposited. The results are within 0·1 to 0·25 per cent. of the theoretical.

E.M.F. of Clark Cells.—In some recent publications Prof. Henry Carhart discusses at length the various determinations of the E.M.F. of the Clark cell. A short *résumé* of the articles is given in the *Electrical Review* of New York, from which it appears that the value originally obtained by Clark reduced to present units at 15deg. C. is 1·4378 volts, but subsequent research has shown that this is somewhat too high. Prof. Carhart summarises the results of eight other determinations of this constant, in five of which the value was obtained by the use of the silver voltameter, the remaining three values being obtained by absolute methods. The mean value calculated from the whole eight determinations is 1·4335 volts at 15deg. C., and the mean of the three absolute determinations is 1·4333 volts. The conclusion at which the professor arrives is that the true value is nearer 1·433 volts than the generally accepted value of 1·434 volts. This conclusion is borne out by the result of two determinations of the mechanical equivalent of heat by electrical methods, in both of which the values obtained are higher than those given by direct mechanical methods; if the E.M.F. of the Clark cell is taken as 1·433 volts instead of 1·434, the discrepancies almost disappear.

Fenders.—As an outcome of the unusually large number of accidents which have occurred on the Berlin tramways since the introduction of electric traction on that system, a new fender apparatus has been devised which, it is claimed, fully meets all the requirements demanded by the authorities. The new contrivance is the result of extensive tests which have been going on for some time under the direction of some of the highest German authorities, including Dir. Bark and the late Prof. Garbe. The first requirement, that "persons falling in front of the car must be picked up," would appear to be met by the employment of an open framework, which is attached in front of the car and raised slightly above the pavement. In the second place, the buffers and front of the dash are covered with an elastic screen, which disposes of the con

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dition that "persons standing in front of the car, and hit by it, should receive a shove which will not seriously injure them." The third demand is complied with by fastening two handrails along the entire width of the dash at convenient heights, these rails being mounted on springs, and thus the conditions imposed by the authorities have all been successfully treated. We understand that the new device has been adopted in Berlin, and some 50 cars are now being equipped with the fender.

Steam-Engine Specifications.—The question of the lines to be followed in drawing specifications for the installation of steam-engines has been taken up by the United States Engine Builders' Association, which makes several suggestions for the consideration of architects and engineers. In the first place, it is recommended that contracts which provide a penalty to deliver in time or for failure to meet guarantees, ought also to provide equal premiums for earlier delivery; again, that bonds should not be required on installation contracts unless corresponding bonds for similar amounts are given to secure payment, an exception always being made in the case of Government and municipal contracts. It is further suggested that settlements should not extend beyond three months from completion of the contract, and that a guarantee against defective material or workmanship should not be made to cover a period of more than one year from date of shipment. The last suggestion is that purchasers of engines ought not to be furnished with complete drawings, but with this we cannot agree. We doubt whether users of engines would be satisfied with general drawings showing the assembled engine in outline with such principal dimensions as will answer for building foundations, the erection of engines or their care, as the association recommends, and think that engine users are entitled to full and detailed working drawings.

The National Physical Laboratory.—We are informed that the Executive Committee have made the following appointments in connection with the National Physical Laboratory at Teddington: superintendent of the engineering department, Dr. T. E. Stanton; assistants in the physics department, Dr. J. A. Harker, Mr. A. Campbell, B.A., and Dr. H. C. H. Carpenter, M.A. (Oxon), Ph.D. (Leipzig); junior assistants, Mr. B. F. E. Keeling, B.A., and Mr. F. E. Smith, Royal College of Science. It is expected that one or two more junior assistants will be appointed shortly. The alterations to Bushy House and the new buildings for the engineering laboratory are well advanced, and it is hoped to commence work early in October. Of the staff, Dr. Stanton has had a distinguished career at Manchester and Liverpool, and is now professor of engineering at University College, Bristol. His paper on surface condensers, published in the *Philosophical Transactions*, is well known to engineers. Dr. Harker and Mr. Campbell have both done work of real value in thermometry and electric measurements; while Dr. Carpenter, who will have charge of the chemical researches, after a successful course at Oxford, has gained further experience at Leipzig, under Ostwald, and more recently at Owens College. Mr. Keeling obtained a double first in natural science and mechanical science respectively at Cambridge; while Mr. Smith was the most distinguished student of his year at South Kensington, and for two years has been one of Prof. Rücker's assistants.

Wireless Telegraphy Through the Earth.—Further particulars are to hand concerning the experiments referred to in these columns last week which were conducted by Messrs. Pilsoudski and Popp at Le Vésinet, a suburb a few miles from Paris, with a new system of wireless telegraphy. It will be recalled that in this case wireless telegraphic messages were transmitted through the earth, the apparatus mainly consisting of two electrodes. The negative is fixed on the surface of the earth, from which it is only separated by a glass isolating plate; the positive is buried beneath the ground to a depth of about 5ft. This procedure is employed both at the transmitting and receiving end, the distance between the two stations in the experiments in question being under half a mile. The distance is decidedly short, but the locality is thickly populated, and, according to the reports we have seen, the conditions are not such as will lend themselves easily to a successful test of wireless telegraphy underground. We understand that a number of serious objections were raised by scientific gentlemen present at the trials, all of which, however, the inventors profess to be able to overcome. As regards one objection, these gentlemen assert that they will be able to so surround their receiving instruments underground as to prevent messages intended for a particular station from being "tapped" from other points within a given circle. It still remains, however, to be seen whether it is possible to communicate over long distances by this method, and it is stated that a syndicate is being formed with sufficient capital to carry out experiments on a much larger scale, probably between Paris and Compugne, a distance of about 60 miles.

The Glasgow Engineering Congress.—This congress bids fair to a great success as far as numbers are concerned, and from the careful way in which the various sections are being organised, it seems likely that each one of these will have good papers read before it and good discussions. The one point which has troubled the Local Committee is that so many engineers have accepted, that the hotel accommodation of Glasgow will be quite inadequate. The Reception Committee have accordingly issued a list of the names of those who have signified their intention of attending, and are asking local engineers and their friends to offer to entertain privately certain of these. We learn that the result is most satisfactory, and that many offers of private accommodation have been received. Up to the present, the full programme of Section 9, which is devoted to electrical engineering, has not been arranged, but we understand that the following papers are amongst those to be read: "Electricity Supply Meters of the Electrolytic Type," by Mr. J. R. Dick; "The Relative Advantages of Three, Two, and Single Phase Systems for Feeding Low-Tension Networks," by Mr. M. B. Field; "Modern Commutating Dynamo Machines, with Special Reference to Commutating Limits," by Mr. H. M. Hobart; "The Protection of Trolley Wires," by Prof. Andrew Jamieson; "Kelvin's Electrical Measuring Instruments," Prof. Magnus Maclean; "Continuous-Current Dynamo Design," by Mr. H. A. Mavor; and "The Use of Electricity in the Propulsion of Road Vehicles," by Mr. A. R. Sennett. The complete programme will soon be issued, and can be obtained on application from the general secretary, Dr. J. D. Cormack.

Tanning by Electricity.—The methods at present employed in the process of tanning hides are remarkably lengthy, and include circulating the tan liquor so that fresh portions are continually presented to the hide, forcing the liquid through the hide by pressure and using strong aqueous extracts of tanning materials. The *Electro-Chemist and Metallurgist* describes one or two processes by which it is sought to attain the same object by passing a current of electricity through the vats in which the hides are suspended. The first of these is Groth's process, which, it is said, has been found to shorten the time of tanning to a quarter of that required when no current is used. In this device the tan liquor is contained in a tank

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in which is a frame carrying hides, and capable of being moved to and fro, or rotated so as to bring the hide continuously into contact with fresh liquor. Copper electrodes are placed at the side of the tank. For a vat holding 1,500 gallons a current of not more than four amperes is used. The current density is not more than one-tenth ampere per square foot of transverse section of the vat. With this mild stimulus it was found that the rate of tanning was 16 times as fast as when the hides were simply immersed in the tan liquor and allowed to be stationary, and four times as fast as when the hides were moved and no current passed. Considering the well-authenticated test which has been made, it is noteworthy that tanners at large will have nothing to say to electric tanning. In the Worms and Bale process (which was the forerunner of Groth's) the apparatus used is a barrel of about 12,000 litres capacity and taking a charge of 700 km. of hide and 5,000 litres of oak-bark extract. The electrodes attached to the inside of the drum are of copper. A current of 11·5 amperes at a pressure of 74 volts is used. Tanning is said to be complete in 48 to 144 hours, but the process is somewhat violent, the leather suffering from the mechanical pounding which it receives.

The Berliner Decision.—Some four months ago we noted in these columns the very important case being tried by Judge Brown in the United States Circuit Court. It was the action brought by the Bell Telephone Company against the National and Century Telephone for alleged infringement of the well-known Berliner patent, of which the former were the assignees. The full text of the Court's decision has now been handed down, and we find it reproduced in most of our American contemporaries at great length. To summarise very shortly the main points of the case, the patent in question was for a microphone transmitter. The application was made on June 4, 1877, but the patent was not issued until Nov. 17, 1891. The main point on which Judge Brown decided against its validity was that Berliner had not made the invention ascribed to him and covered by the patent granted on that date. Further, that the invention in the patent was radically different from that in the application, that it had been previously patented by Berliner, and that Edison was the prior inventor to such an extent that his work and that of Bell rendered that of Berliner entirely superfluous. The aim of the Bell Company was to read into the Berliner patent Edison's work utilising carbon, and this was the real point on which the learned judge based his decision. In the words of Judge Brown himself, the complainants' case rested upon a patent that should not have been granted, and which was void for error apparent upon the face of the records of the Patent Office; that, as a matter of fact, Berliner, on June 4, 1877, the date of his application, had not made the discovery that speech could be transmitted with the apparatus of the patent in suit, and was at that time, and long after, like other unsuccessful experimenters, attempting to use a broken current. This decision is undoubtedly of the very widest importance alike to the telephone industry and to the electrical profession at large, and is regarded in the States as one of the most momentous ever handed down.

Wireless Steering of Torpedoes.—A correspondent to the daily Press, in describing some experiments concerning the wireless steering of torpedoes, regards the attainment of this object as the death-blow to the utility of the submarine boat. The experiments in question were commenced off Weymouth at the end of last year, and are still being made with a view to extending the distance at which the apparatus can act. For the purposes of the tests, a torpedo of the usual size is used with wireless telegraphic apparatus installed in the place of the gyroscope. In its place there is a Marconi coherer in circuit with a relay and battery. These are in connection with an armature which actuates the valve of a steering engine connected to the rudder. The corresponding apparatus is on the shore or battleship, which works a transmitter. When this acts and closes the circuit in the torpedo, the valve acts and the rudder is turned in a certain direction. When the circuit is broken, the electromagnet releases the armature, and the rudder is reversed. So that when the interruption on shore makes circuit, the rudder is pointed in one direction, and when the circuit is broken it goes in the opposite direction. There is a recess on the top of the torpedo near the stern into which fits a metal float. To this is attached a fine wire in connection with the apparatus. The concussion of discharge releases the float, and it swims on the water and catches the ether waves and transmits them to the apparatus inside the torpedo. In one particular trial on the open sea the torpedo was first sent in a direction about 15deg. to the right of a course straight out from the shore, and for a distance of 80 yards. By means of the shore apparatus it was directed from this point to the left, and finally brought back to the starting point along the main course. Several difficult evolutions, it is said, were made by the craft, and finally it was sent along the main course for about 200 yards, at which point it got out of control of the shore apparatus. Messrs. C. J. and L. Varicas, of Weymouth, are the inventors, and we understand they are now engaged in perfecting the device. While we cannot but congratulate the inventors on the successful results of their experiments in directing the torpedo at short distances, we must again point out in these columns that the difficulty is not so much in the steering of the torpedo as in knowing its exact position at any moment in order to keep it under control. The experiments, which we hear are now going on for the purpose of extending, if possible, the distance at which steering can be maintained, may possibly tend to throw some light upon the point.

The Rontgen Society.—The report of the council of the Röntgen Society for the past year testifies to the continued prosperity of the institution, the membership roll showing an addition of 45 names during the 12 months. Among other things, the statement embodies the report of the jury nominated to award the gold medal offered by the president of the society for the best tube for general X-ray purposes. The number of tubes sent in for competition was 28, of which five were of British manufacture, eight from America, and 15 from Germany. The tubes were, almost without exception, of excellent make, some of them being very fine specimens of glass-blowing. Several of them had special arrangements for taking heavy discharges, and others had more or less ingenious devices for regulating the vacuum. The attention of the jury was mainly directed to four points—viz., definition, photographic effect, penetration, and price—the predominant requirement being that the tube selected should be "practical," by which the jury understood a good all-round instrument for any of the purposes for which X-rays are employed. About 75 per cent. of the tubes failed to satisfy the required tests for definition, and in the opinion of the jury the attention of makers of tubes should be drawn to this defect, because unless a tube defines well, all other advantages it may possess are to a great extent valueless for most of the purposes to which X-ray tubes are put. Thus the arrangements provided in some of the tubes for heavy discharges and the regeneration or regulation of vacuum, which might in themselves have been good, could

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not receive the recognition they might have deserved had the tubes to which they were attached have given satisfactory definition. The tubes which stood the test for definition were subjected to a very severe trial for penetration and photographic effect, and the jury report that a much higher standard of excellence was attained in this respect than in that of definition. The prices of the tubes sent in varied from £4. 5s. to 16s. Many of the high-priced tubes were eliminated by the first test, and the jury think it will be satisfactory to X-ray workers to know that though the price was not the determining feature, yet the tube selected as the best is also one of the most moderate in price. The tube which has best satisfied all the tests applied by the jury is the one sent in as "Cox's Record Tube," made by C. H. F. Müller, of Hamburg. price 18s. 6d., and to this the jury awarded the medal, The council's report further states that Mr. Herbert Jackson, F.C.S., has consented to be nominated as president of the society for the coming session.

Electrical Equipment of a Lightship. — An article in the *Western Electrician* on a new lightship which has just been established off the dangerous Cape Hatteras shoal, embodies some useful information concerning the electrical equipment of the vessel. Of the two generating sets, which are located in an enclosure on the main deck over the engine-room, each consists of an 8¼-kw. multipolar generator, direct connected to a vertical inverted two-cylinder engine. These two sets are placed on lead-lined platforms or boxes (the lead weighing 10lb. to the square foot), which are perfectly oil-tight and firmly secured to foundations on the deck of the ship. Both engines receive steam from the boiler from one pipe provided with 2in. branches to each engine. Inch-and-a-half pink Tennessee marble is used for the switchboard, and this is also placed in the enclosure on the main deck with the generating plant. The principal office of the ship, of course, is to show powerful masthead lights as a warning to navigators, and these lights are flashed by a device attached to each generator at the commutator end. This device consists essentially of a circuit breaker, revolving on a horizontal shaft set at a right angle with the generator shaft. The discs of the circuit breaker are three in number, 4½in. in diameter, on a shaft ⅞in. in diameter. This shaft carries a worm gear with 138 teeth, which engages a worm revolving with and practically a continuation of the generator shaft. The frame containing the bearings for the shaft of the circuit breaker is fastened to the outboard pedestal of the generator by a single stud, upon which the entire device may be swung in a vertical plane, thus allowing the worm gear to be engaged or disengaged at will. According to our contemporary, this greatly improved device, which was designed by the Fore Ship and Engine Company, of Quincy, Mass., has been approved by the United States Government, and adopted in preference to the device called for in the specifications. It will be readily seen that the main advantage of the system is that it entirely does away with belts and pulleys, and secures a positive action by worm gearing. Two resistance coils are connected in series with the masthead lights and the circuit breaker, so that when the lights are on the resistance will not be in the circuit, but the instant the light is turned off this resistance is at the same instant automatically turned on, thus providing a steady load on the engines. The vessel is wired for about 80 16-c.p. 100-volt lamps, with Edison base, and six 100-c.p. 100-volt lamps, three on each mast. All lamps are incandescent. Instead of passing over or around the beams, the wiring is invariably carried through them, they being drilled and fitted with rubber tubing. Accidents to the lighting plant and its equipment have been ensured against by the introduction of duplicate machinery. It is estimated that the lights will be visible on clear nights for a distance of about 20 miles, and about half that distance in stormy weather. Ultimately, it is expected, the vessel will be equipped for wireless telegraphy, enabling it to keep in touch with the mainland at all times.

The Telegraph Service.—An important question was put to the Secretary to the Treasury, as representing the Postmaster-General, in the House of Commons on Thursday week by Sir John Leng, who wanted to know whether an intimation recently made by the Postmaster-General, that the main roads of Post Office telegraphs throughout the country had become so crowded that it is necessary to reserve the remaining space for the public wires which would be required in the immediate future, had been made in view of the recent augmentation in the number of wires by the underground cable to Birmingham and the North; whether the further intimation of the Postmaster-General that his inability to undertake the work would not prevent newspapers obtaining private wires through some other agency than the Post Office, meant that the Post Office had finally abandoned its claim to a monopoly of the telegraph service, and that it was now open to promoters to establish a special telegraphic service for the newspaper Press; and whether the statement in the "Post Office Guide," dated July 1, that the Postmaster-General undertook the construction and maintenance on rental terms of private telegraph and telephone wires for firms or private individuals, was now annulled, and firms or individuals connected with the Press would be excluded from the rights or privileges common to all others. Mr. Austen Chamberlain's reply was in the following terms: In the communication referred to the Postmaster-General did take account of the fact that there is now an underground telegraph line between London and Birmingham, but the difficulty of finding routes for new wires has been only slightly lessened by this addition to the Post Office system. The Postmaster-General has never claimed any monopoly of telegraphic communication except that which was granted to him by Parliament in 1869; and the use of a private wire connecting premises belonging to the same person or firm for the transmission of telegrams relating to the business of the owner was not included in the monopoly. There is, therefore, no special reason why the Postmaster-General should provide such telegraphs. A newspaper proprietor is at liberty to erect a telegraph of this kind for himself or to have it erected and maintained by a private contractor; but he is not allowed to establish a telegraphic system for the general distribution of telegrams to the Press. The statement in the "Post Office Guide" to the effect that the Postmaster-General undertakes the construction and maintenance on rental terms of private telegraph and telephone wires is not to be regarded as annulled. It is expressly stated in the guide that the rates quoted apply to wires of short length only. What the Postmaster-General finds is that his power to provide long wires is limited by the physical difficulty of obtaining routes; and, in view of this difficulty, he deems it expedient to reserve the available routes for the public service, rather than allow them to be absorbed for private purposes. This is of special importance in view of the requirements of the telephone service, as long telephone trunk wires must necessarily be carried above ground. The Postmaster-General still undertakes to provide short private wires. His inability to provide long wires does not apply only to wires for the Press, but to all wires of this character.

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GLASGOW ELECTRIC TRAMWAYS.

(Continued from page 700, Vol. XXVII.)

Main Switchboards.

We now come to the controlling arrangements for the station plant and for the feeders to the five sub-stations.

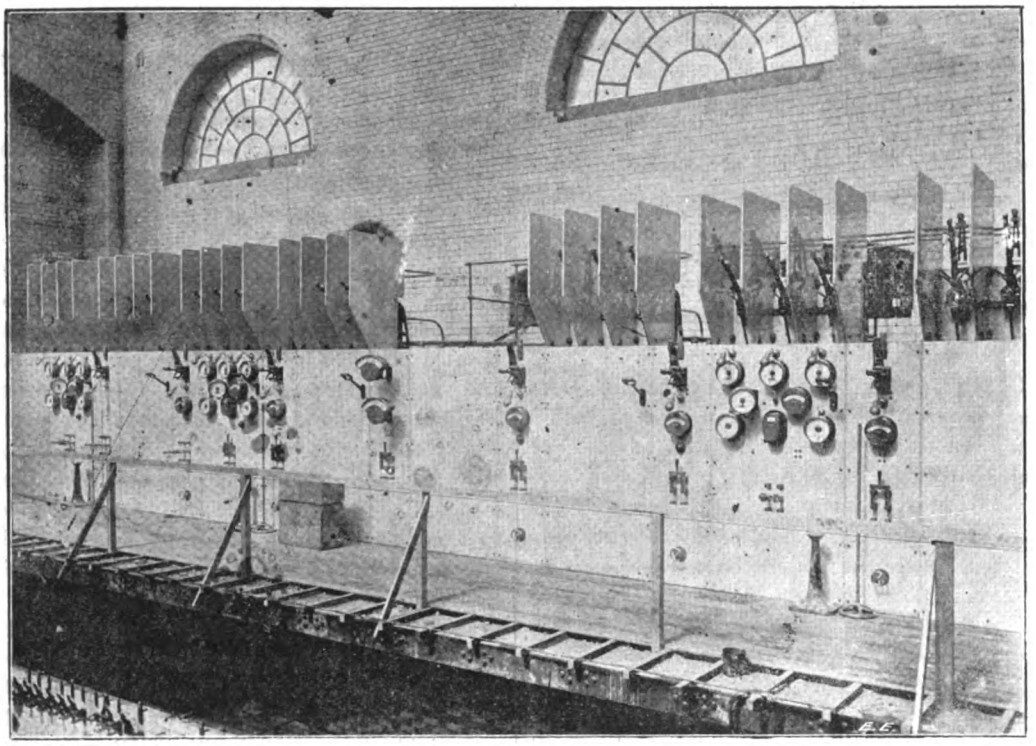

FIG. 9.—Main Switchboard, Pinkston Power Station, Glasgow.

There are two separate switchboards (both supplied by the British Westinghouse Company)—the high-tension alternating-current board and the auxiliary low-tension continuous-current board. The first of these boards (Figs. 9 and 10) is mounted on a gallery about 20ft. above the engine-room floor. It is of white marble, and has an area of 1,500 square feet. It is composed of six main generator panels (two of which are at present blank), six exciter panels, and four interconnector panels. The feeder panels are arranged in five groups of four each immediately behind the generator switchboard. They take the form of "cubicles," two feeders being taken off each side, while access to the connections is obtained from the back, which is left open. In the case of four of these cubicles the front of the square is constituted by one of the main generator panels now in use, while the fifth cubicle occupies a position immediately behind one of the spare generator panels. The high-tension 'bus bars consist of bare copper tubes, whereby economy in energy losses and cool running are secured. They are carried on porcelain insulators similar to those used for high-tension overhead lines, but grooved on the top to receive the copper tubes. The 'bus bars and all high-tension apparatus is at a height of 10ft. above the floor level, so that there is no risk of shock unless through deliberate carelessness. The connections (Fig. 11) are carried out so that the sub-stations may be operated either by the generators singly or in parallel. Each generator panel is equipped with a main high-tension three-phase switch; three ammeters (one on each conductor); a voltmeter; two indicating wattmeters, which give the watts per phase at any instant, and thus show any want of balance in the system; an integrating three-phase wattmeter, measuring the total output of the generator; a voltmeter plug to enable the voltage across each phase to be taken; a field switch with discharge resistance contacts, and the synchronising lamps and plugs. An ammeter is also provided to indicate the exciting current taken by the generator. Directly in front of each generator panel is mounted the field regulating switch, which takes the form of a handwheel actuating a vertical spindle, which passes through the gallery to the field rheostats situated underneath. The instruments are all of the Westinghouse standard patterns, and are worked by means of small series transformer in the case of the ammeters, and shunt transformers for the voltmeters. It will be noticed that no cut-outs are provided for the main generators, as the reactance due to the self-induction of the armature coils is considered to be great enough to prevent any injuriously large currents circulating through the generators, in case of short-circuit in the armature itself, break

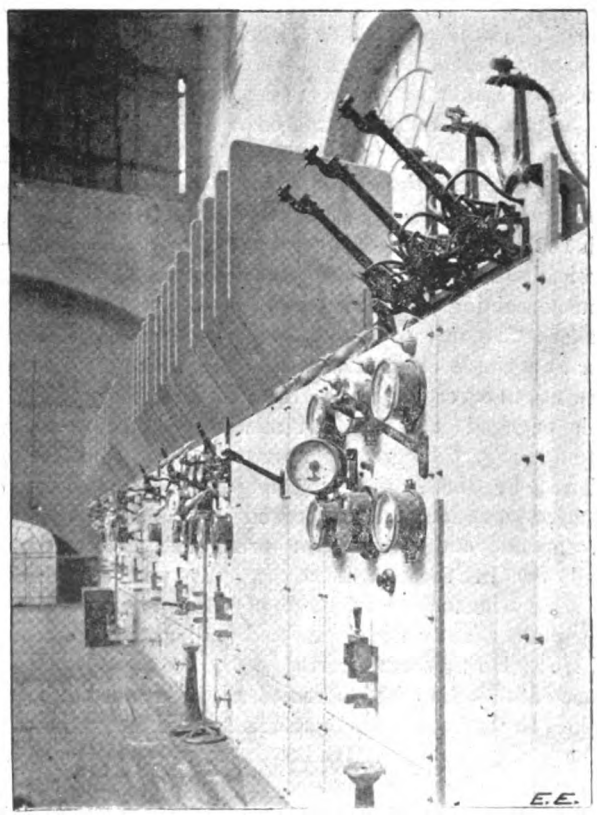

FIG. 10. Main Switchboard, Pinkston Power Station, Glasgow.

of the field circuit, failure of the feeder circuit breakers to act, accidental switching in of a generator armature to the 'bus bars when not properly excited, or any other cause which might result in an abnormal rush of current through

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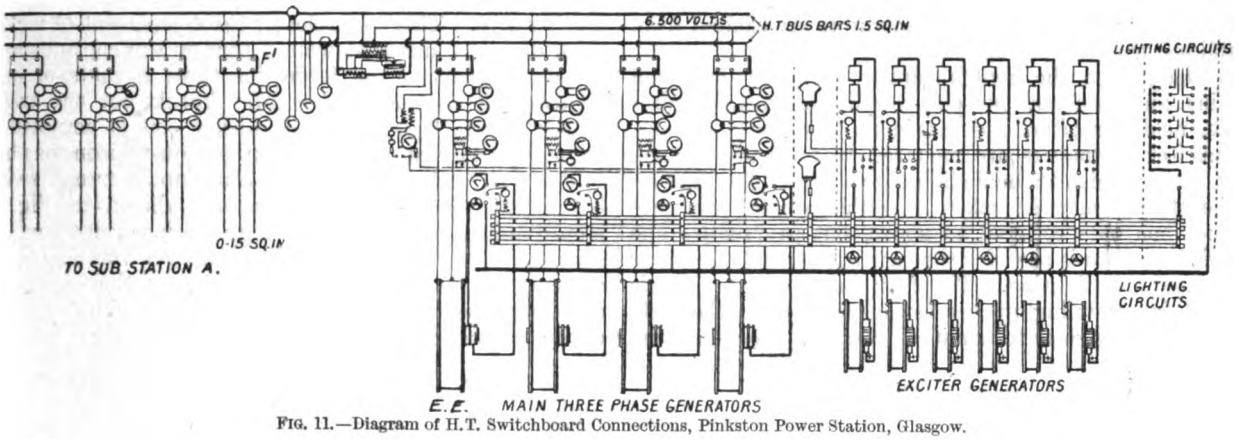

FIG. 11.—Diagram of H.T. Switchboard Connections, Pinkston Power Station, Glasgow.

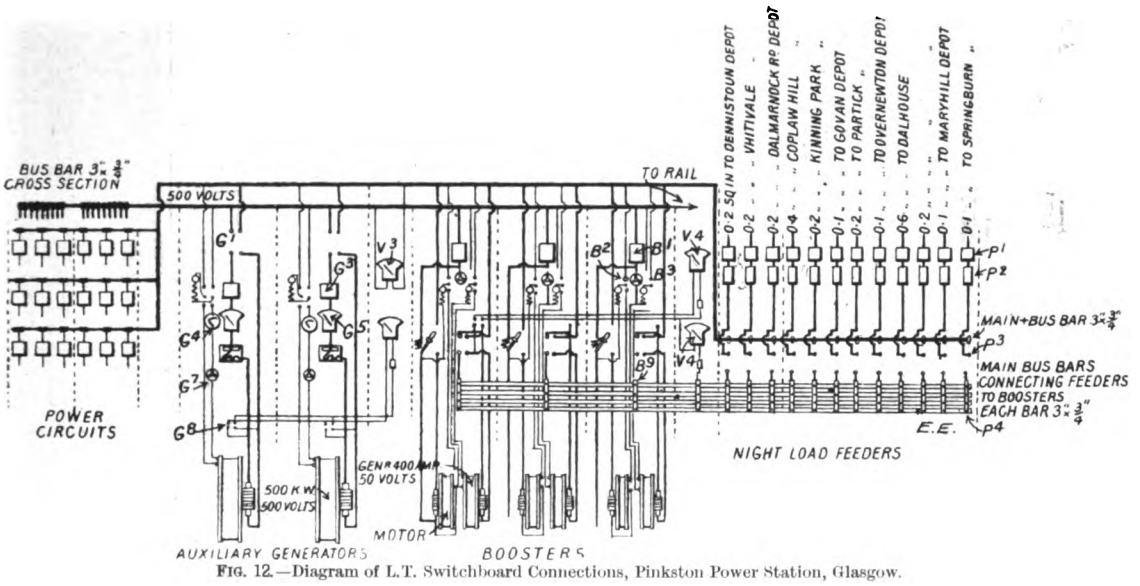

FIG. 12.—Diagram of L.T. Switchboard Connections, Pinkston Power Station, Glasgow.

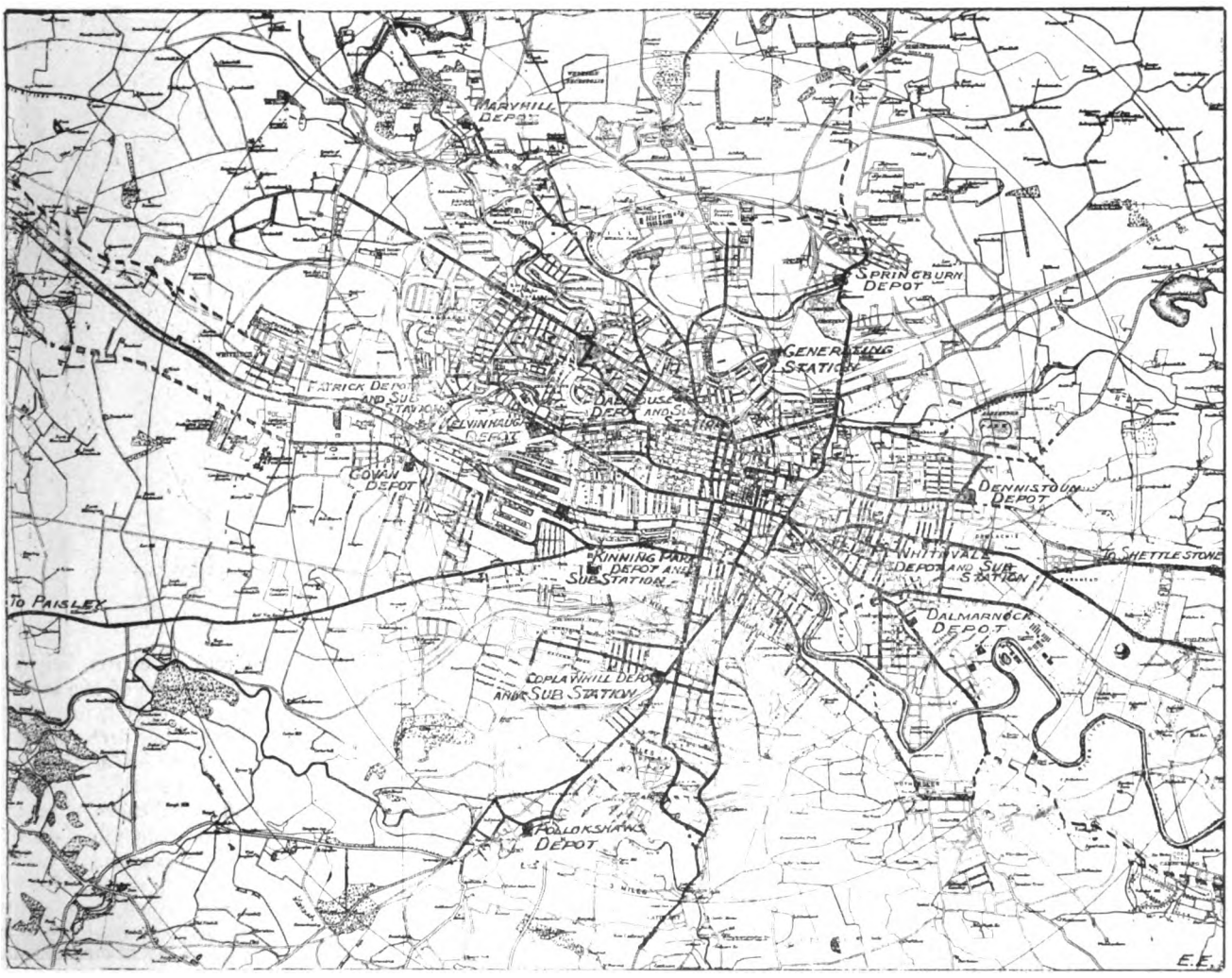

FIG. 13.—Map of Tramway Area, showing position of Power Station, Sub-Stations, and Car Depots, Glasgow.

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the generator armatures. The generators are excited from a duplicate pair of 100-volt 'bus bars, which run along the whole length of the switchboard. Each exciter panel contains an ammeter, two-pole duplicate-contact exciter switch, field regulator, and maximum automatic cut-out. The exciter voltmeters are mounted on a separate panel, which also contains the main lighting switch. The lighting of the station may be taken off either of the duplicate 100-volt 'bus bars referred to above, but in practice one pair of these bars is used for the exciting current, the other being used for lighting. The four interconnector panels are used for coupling up the various sections of the high-tension 'bus bars so as to admit of working the generators moving core. This core releases the escapement of a clock-work device, which is so wound that on the continuance of the short-circuit on the feeder for three seconds, or other prearranged time, a "kicker coil" knocks out the trigger of the circuit breaker. This kicker coil is actuated by continuous current obtained from the low-tension 'bus bars.

There is a large auxiliary continuous-current switch-board (the connections to which are shown in Fig. 22) immediately underneath the high-tension switch gallery. This board is for the control of the two 500-volt continuous-current 600-kw. generators which supply the current for nightwork and for the station auxiliary machinery. Each of the generators is controlled by a maximum and minimum

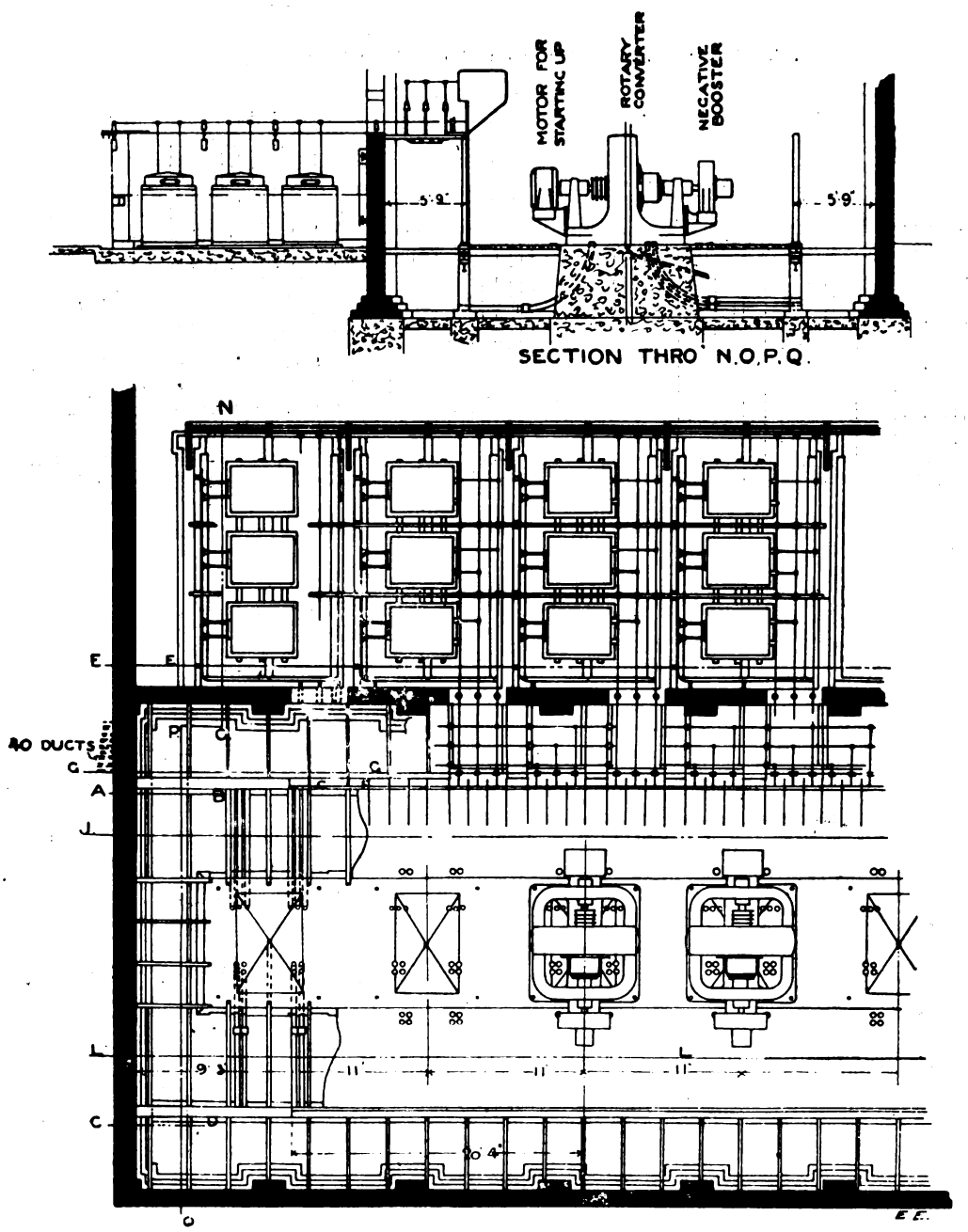

FIG. 14.—Plan and Section of Sub-Station, Glasgow.

singly or in parallel in any desired combination. All the high-tension switches are of the falling lever type, with carbon breaks. The break is about 1ft. when the switch is in the off position, and no special device is made use of to extinguish the spark, which is kept comparatively small by the rapidity of the break and the carbon points. A trigger device enables the operator to open the switch instantaneously if desired. The feeder panels each comprise a three-phase high-tension switch, an ammeter for each of the three conductors, and an automatic three-phase time-limit relay, which operates the trigger of the switch in case of a short-circuit on the feeder. This relay is worked by means of a small three-phase transformer, the secondary of which magnetises a coil containing a cut-out, and each auxiliary motor circuit is controlled by a maximum cut-out. It is a noticeable feature of the switch-boards at Pinkston that no fuses are employed, except for the lighting branch circuits. From the direct-current board feeders are carried to the various sub-stations; in some cases the connection is direct, and in others a feeder is taken to a certain sub-station, and from there a branch feeder of reduced section is carried on to a more distant station. It will thus be seen that each sub-station in the area can be supplied with continuous current direct from the main generating station, and, as was mentioned in an earlier part of this article, this supply is used for nightwork in the various car depôts (of which there are 11 in all), shifting cars, lighting, etc.

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The system of connections in the main station is carefully carried out. A manhole is built in the pit of each generator, and the connections are brought from the three terminals at the bottom of each generator armature to a main tunnel running the whole length of the foundations.

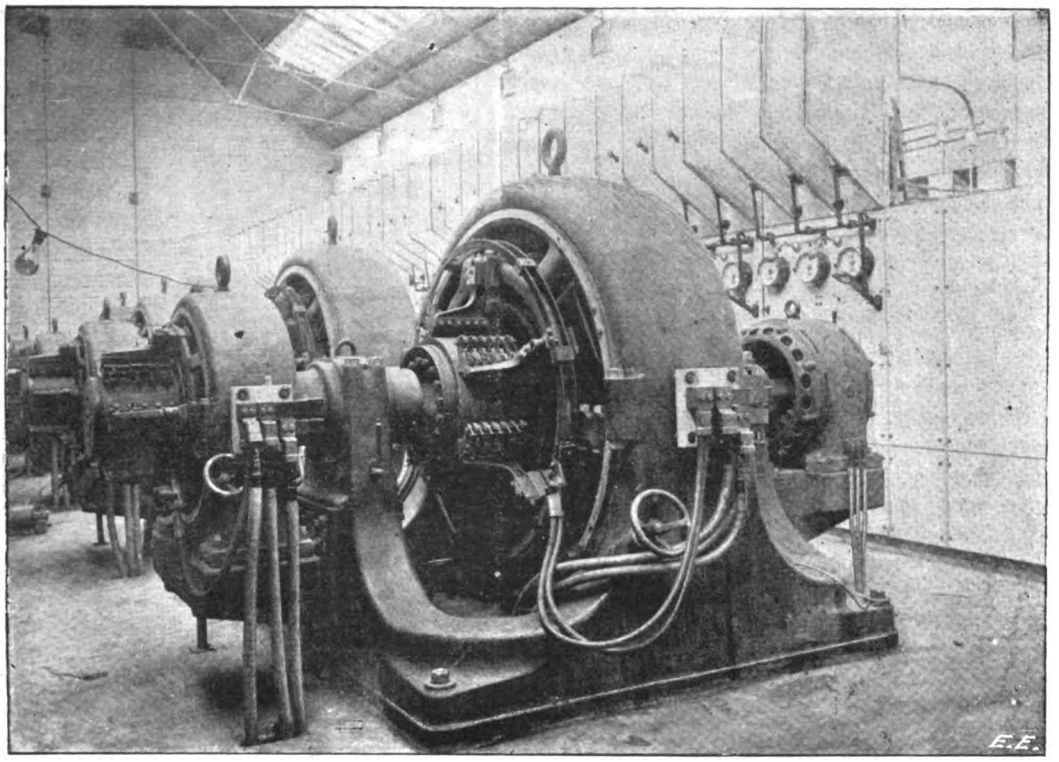

FIG. 15.—View of Sub-Station, showing H.T. Switchboard, Glasgow.

All the connections are made by paper-insulated, lead-covered cables, led through a system of pipes where underneath the foundations, and supported on iron brackets where carried up the wall behind the switchboards.

shows that the existing lines are practically all contained within a circle of three miles radius. The generating station, it will be seen, is about a mile from the centre of the city (which is also the centre of the tramway system), and the five sub-stations are respectively 2½, 2, 2½, ¾, and 1¾ miles from the main station at Pinkston. In addition to these sub-stations, there are six car depôts, situated chiefly at the termini of the tramway routes. The conversion of the 6,500-volt three-phase current is

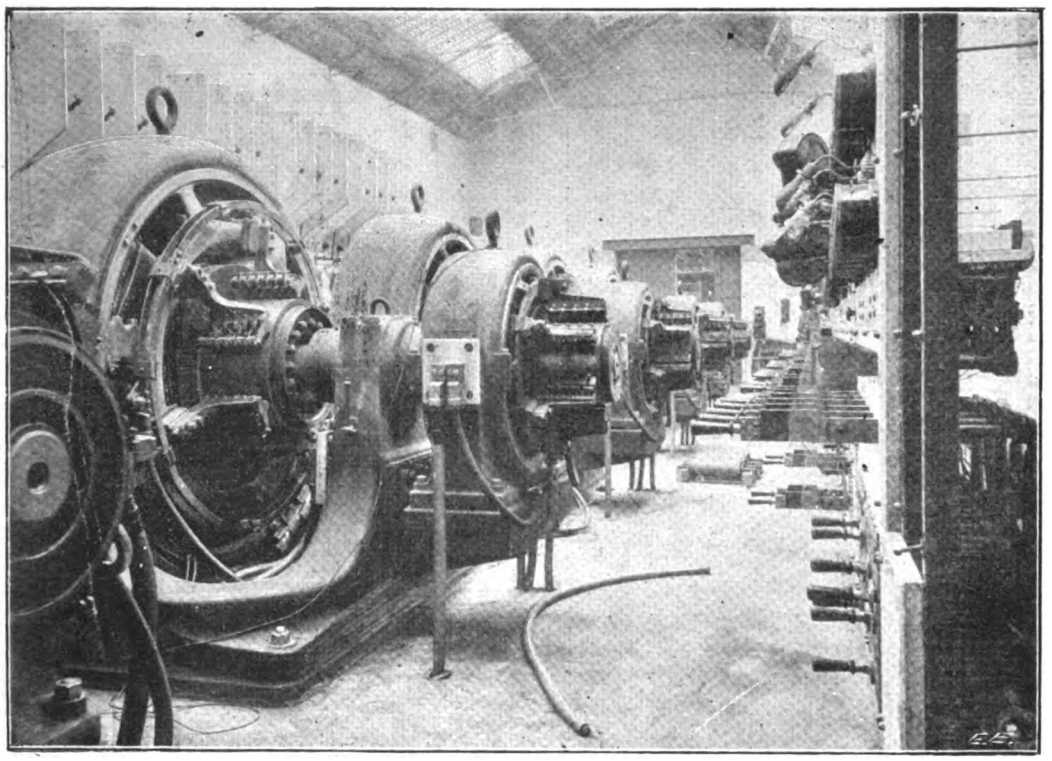

FIG. 16.—View of Sub-Station, showing L.T. Switchboard on right, Glasgow.

Sub-Stations.

We now come to the sub-stations, of which there are five situated at various parts of the tramway area. They were all built on the sites of existing horse depôts. An examination of the map of the Glasgow tramway (Fig. 13) effected at the five sub-stations by 24 transformer and rotary converter sets. Each set consists of three 200-kw. transformers and a 500-kw. rotary converter with starting induction motor and return-current booster, mounted on the same spindle and bed-plate. Each sub-station is identical

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with the others, except as regards the number of units installed, which are arranged as follows: Coplawhill, five units; Kinning Park, four units; Partick, three units;

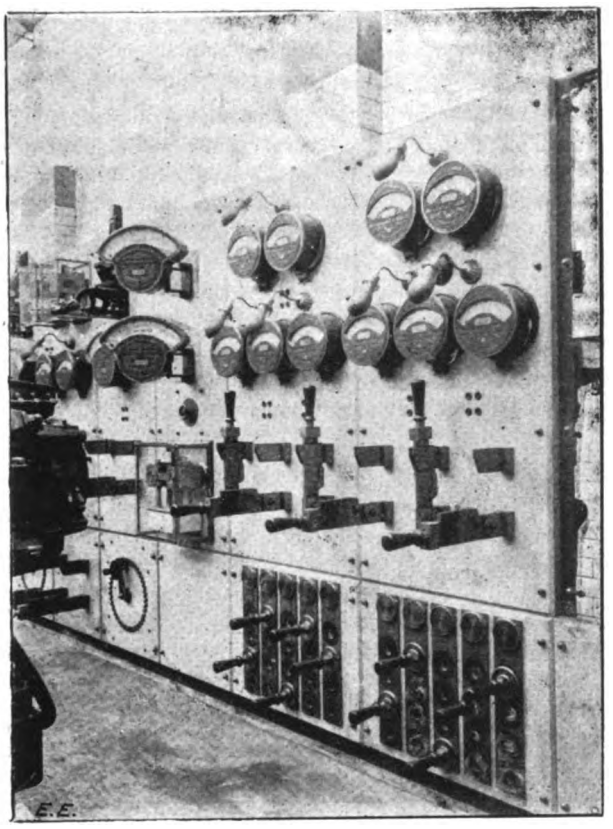

FIG. 17.—Sub-Station L.T. Switchboard, showing Negative Booster Plugs.

Dalhousie, seven units; and Whitevale, five units. Fig. 14 gives a plan and section of one of these sub-stations. At all the sub-stations except Dalhousie provision has been made for a spare unit. The switchboard arrangements in

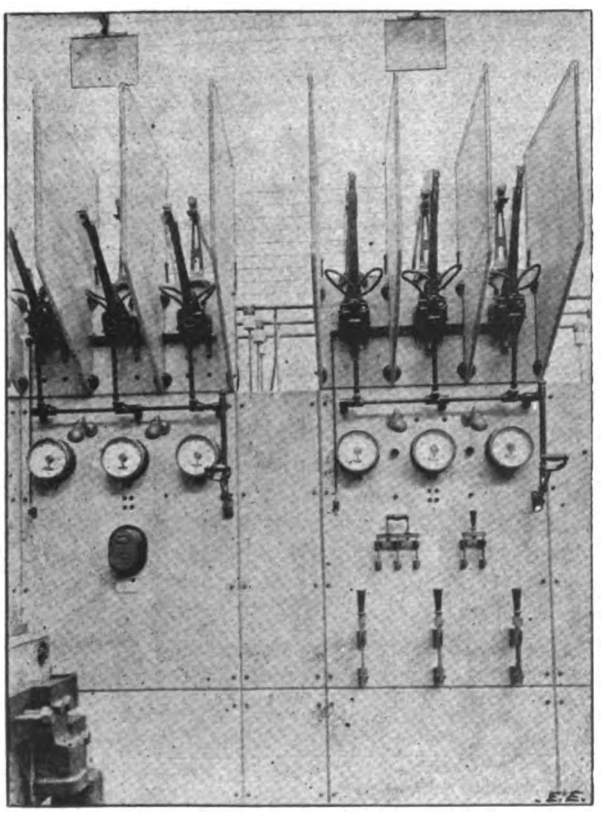

FIG. 18.—Panels of Main Switchboard, Pinkston Power Station, Glasgow.

the sub-stations (see Figs. 15 and 16) is in some respects similar to that at Pinkston. Bare copper bus bars are used on the high-tension side, which occupies one side of the sub-station, the low tension direct-current apparatus (Fig. 17) occupying the other side. A diagram of the connections to the low-tension side is shown in Fig. 19. Immediately behind the high-tension switchboard (Fig. 18) are situated the transformers, which are arranged, as above mentioned, in groups of three, adjacent groups being separated by brick partitions, thus insulating the high-pressure entirely from the low-pressure apparatus. The high-tension three-core feeders are brought into cast-iron dividing boxes, thence rubber-insulated conductors are

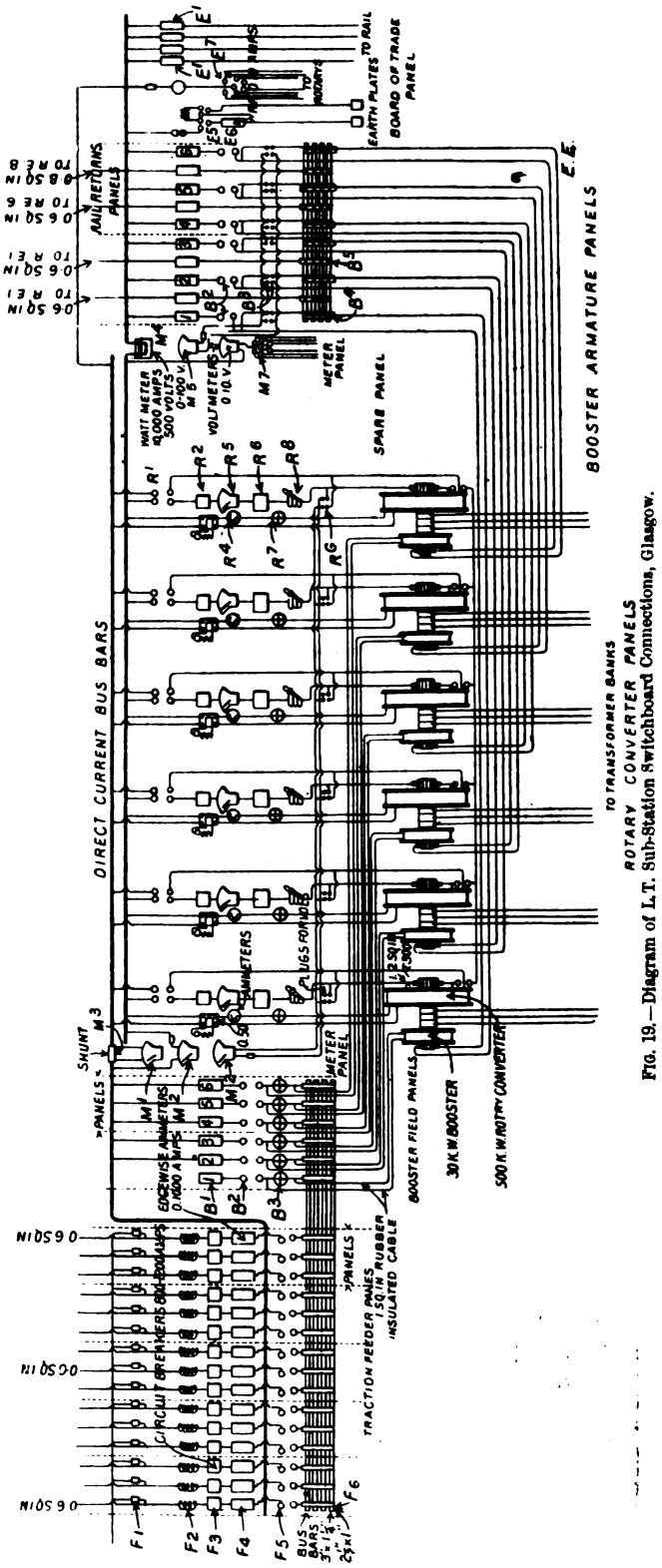

FIG. 19.—Diagram of L.T. Sub-Station Switchboard Connections, Glasgow.

taken to the high-tension three-phase circuit breakers on the feeder panels. These are actuated by a polyphase reverse current and overload relay, acting in a similar manner to those at the generating station end, but instantaneously. On each feeder panel there are three ammeters (reading up to 200 amperes), circuit breaker and relay, and high-tension voltmeter plugs. Each sub-station has four high-tension three-core feeders coming into it, irrespective of the number of units installed.

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The transformers are of the oil-insulated type (Fig. 20), and have a large external radiating surface, the guaranteed efficiency being 97½ per cent. at full load and 97 per cent. at half load. From the high-tension 'bus bars connections are taken to the transformers by means of rubber-insulated cables. These are taken through the cases of the transformers to the high-tension terminals, which are sunk in a marble board. By means of plugs the ratio of transformation can be varied so as to give 310, 330, or 350 volts on the secondary side, which corresponds to 500, 530, and 565 volts on the continuous-current side. The rotary converters are of the British Westinghouse Company's compound-wound six-pole standard type, and run at a speed of 500 revolutions per minute, with a working efficiency of 95 per cent. at full load. The boosters for minimising and controlling the drop in pressure of the rail-return current

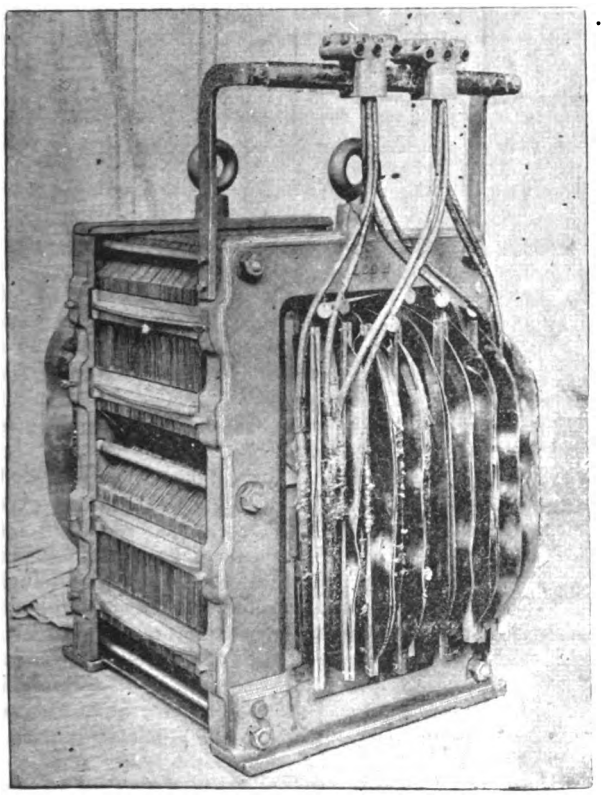

FIG. 20.—Westinghouse Transformer Sub-Station, Glasgow.

are series wound, each having a capacity of 600 amperes at a pressure of 50 volts.

(To be continued.)

WIRELESS TELEGRAPHY UP TO DATE.

Experiments between Brussels, Malines, and Antwerp (January to March, 1901).

(Special Article.)

BY LIEUTENANT FERNAND PONCELET (BELGIAN ARTILLERY).

(Continued from page 50.)

PART II.

M. Guarini's repeater and sundry other of his ideas were tested experimentally during experiments undertaken in conjunction with the author of this article between Brussels, Malines, and Antwerp from January to March, 1901. The Belgian Government had put at the disposition of M. Guarini for three months the monument called the Colonne du Congrès at Brussels, the St. Rombaut tower at Malines, and the tower of Notre Dame at Antwerp. The respective distances of these buildings are indicated on Fig. 18; the numerals in brackets indicate the height of the base and summit of these buildings above sea-level (in metres).

The general plan was the following: In order to demonstrate that the repeater is an apparatus which will really work, it was necessary to prove (1) that a transmitter placed at Brussels or Antwerp could *not* act direct upon a receiver placed at Antwerp or Brussels; (2) that a transmitter placed at Brussels *could* act direct upon a receiver placed at Malines and *vice versâ*; (3) that a transmitter placed at Antwerp could act upon a receiver placed at Malines and *vice versâ*; (4) that a repeater being placed at Malines, and the two extreme stations at Brussels and Antwerp being provided with the apparatus mentioned in (1), Antwerp could receive the signals transmitted from Brussels and *vice versâ*.

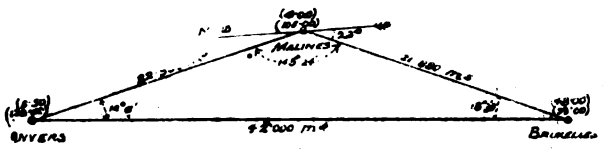

FIG. 18.

In the first three cases M. Guarini was at the first station and the writer of this article at the second; in the fourth case both were at Malines to watch the action of the repeater, assistants having been placed at the extreme stations. The communications were carried out strictly on the plan drawn up beforehand down to the smallest details, the watches particularly being carefully regulated. In the fourth case a Morse receiver had been added to the repeater, and after each test its paper strips were compared with the Morse signals of the end receiving station.

1. *Attempts at Communication between Brussels and Antwerp.*

The diagram (Fig. 19) shows a profile of the land between the Colonne du Congrès and the tower of Notre Dame. Figs. 20 and 21 show the feelers attached to these monuments. (In the two latter figures the relative heights are not given to scale.)

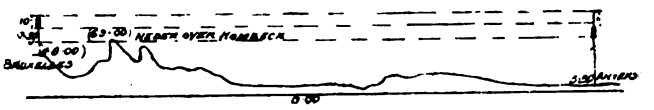

FIG. 19.

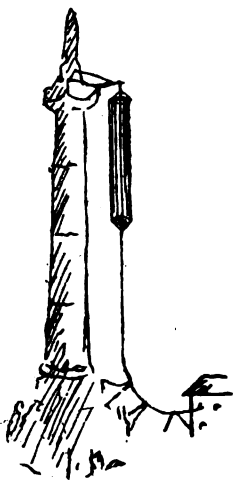

FIG. 20.

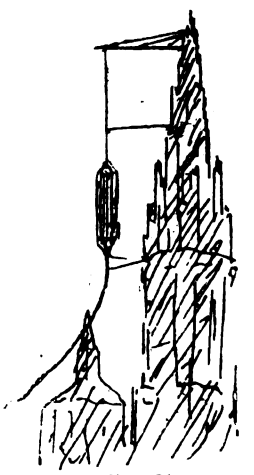

FIG. 21.

Bamboos were securely fastened to the upper part of the monuments. The feelers were let down from these, in as upright a line as possible at the useful parts—that is to say, those visible from one station to the other—and then obliquely, so as to enter the telegraph offices—in Brussels a house in the Rue Van der Meulen, and at Antwerp a hotel in the Place Verte. The useful part had a height of 27·50m. (90ft.) to the summit in each case. It consisted of a single cable of seven wires of 0·9mm. for 17·50m. (57ft.) of its length, plus a cylindrical part consisting of 50 parallel wires of 0·4mm. and 10cm. in height. The section of the cylinder was 50cm. (20in.). At Brussels the cylindrical portion was at the upper part and at Antwerp it was at the lower part of the useful height: it served for receiving.

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Each station was furnished with both transmitter and receiver. The latter instrument included a Morse receiver; the coherers used were of the metal-filing type; all the various models were tried, and the Blondel coherer was found to be the most sensitive. The transmitter included a Ruhmkorff coil giving a 25cm. (say 10in.) spark; the source of electrical energy was a battery of accumulators (16 volts); the current utilised was six to nine amperes. Both the energy of the accumulators and the sensitiveness of the receivers were carried to the maximum of which they were capable; this maximum corresponded, for the transmitters, to a current of nine amperes and a spark of 1·5cm. ($\frac{5}{8}$in.).

Of all the signals which the writer transmitted from Brussels in this first attempt, not one was received at Antwerp. It was the same with the signals transmitted from Antwerp, although once when M. Guarini was able to raise the current to 10 amperes under exceptional conditions, the writer was able to receive two signals at Brussels.

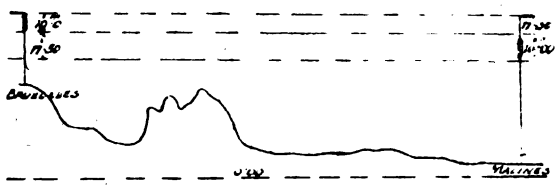

FIG. 22.

After various tests, notably that made to make sure that the passing of the electric tram in the Rue Royale was not affecting the coherer, the writer was obliged to recognise that these signals did indeed come from Antwerp. At the precise time that they were received, M. Guarini, after having removed the earth connection from the oscillator, produced two sparks of 10cm. (4in.) length and a duration of 30 seconds each.

This experiment was not carried further, the object desired by M. Guarini not being to discover the maximum distance to which he could establish wireless communication on land. The result was sufficient to assure us that by placing transmitters and receivers at any future time

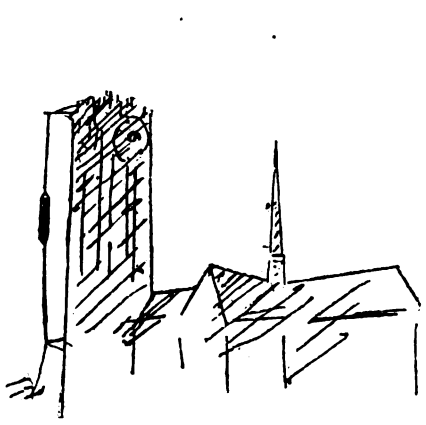

FIG. 23.

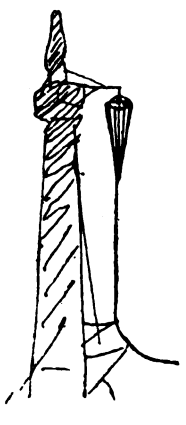

FIG. 24.

under the same normal conditions—nine-ampere current, 1·5cm. ($\frac{5}{8}$in.) spark, earth connection normal, Blondel extra-sensitive coherers, etc.—and keeping the same temporary installations, it was not possible to obtain direct wireless communication between Brussels and Antwerp. In the next part of the experiment, the feelers were placed in, if anything, less favourable conditions. But in any case the possibility is still reserved of cutting out the repeater with its feeler, and making certain by further test that, during this interruption, no signal could be exchanged between the two end stations.

2. *Direct Communication between Brussels and Malines.*

(*a*) *Brussels transmits, Malines receives.*—In Fig. 22 is shown the profile of the land between these two stations. Fig. 23 shows the feeler at Malines attached to the tower of St. Rombaut; the feeler at Brussels remains the same as in the first experiment. The instruments at Brussels were the same as in experiment 1, and those at Malines were similar to those at Antwerp; they were installed at Malines at the Hotel Buda, situated opposite the cathedral.

The experiments gave rise to the following observations: (*a*) The earth connections having been removed from transmitter and receiver, all the signals sent were received; the current was four amperes, at a pressure of 16 to 17 volts. (*b*) A storm having blown down the feeler at Malines, this was placed so that the cylindrical portion was at the same height as the house roofs at Brussels; although the height was still 40m. (131ft.) at Malines, the communication was interrupted. (*c*) The feeler at Malines having been replaced by a single cable of seven strands of 1mm. diameter starting

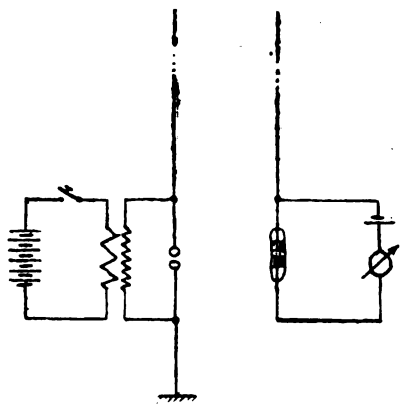

FIG. 25.

from the top of the tower, it was found necessary to bring the current up to six amperes to obtain communication. (*d*) The interlaced or stranded cable (lower part) of the feeler at Brussels having been replaced by a cable of seven strands of 1mm. (strands placed alongside, but not interlaced or stranded), the communication was found to take place with three amperes only.

The whole of these results are in accordance with the theory of the upright feelers, which the present experimenters submitted in 1900 to the considereration of the Académie des Sciences—namely, that the electrical energy is radiated solely along planes normal (*i.e.*, at right angles) to its surface. The maximum effect is, therefore, obtained by using as the feeler a straight cylinder of a considerable height and considerable diameter, the feelers of the two stations being parallel and at the same height. Supposing them to both be of equal length, the planes of their bases ought to coincide and be normal to the generating parts of the cylinders.

(*b*) *Malines transmits, Brussels receives.*—At the beginning of this experiment a storm blew down the feeler at Brussels. On fixing it again, the cylinder of 50 wires was replaced by a cone of 50 wires, 0·4mm., of the same height, the base

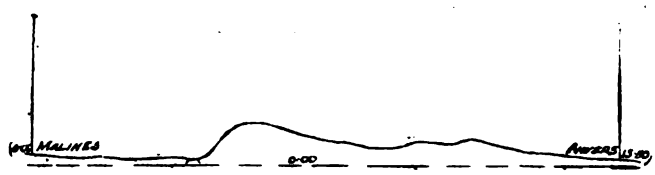

FIG. 26.

or widest part of the cone being upwards (Fig. 24). From this time forward, and until the end of the experiments, the feelers at Brussels remained as represented in Fig. 24, the feelers at Malines and Antwerp being exactly alike, formed from a single cable of seven strands of 1mm.

The experiment 2B gave rise to the following observations: (*a*) In general, the communication was not so good as in the preceding experiment 2A. At the beginning, only an occasional signal was received. This result is attributable first to the form of the feeler, the part serving as receiver—that is, the conical part—being not so satisfactory; further, it is due to the presence of several large metallic masses which ornament the Colonne du Congrès (a bronze statue of Leopold I., a metal handrail, four bronze statues ornamenting the stylobate, two bronze lions, etc.). A similar result has been already observed at Paris in the experiments undertaken between the Pantheon and the Eiffel Tower. No messages could be received at the latter station, while they were quite good at the Pantheon. This was attributed at the time to the

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enormous metallic body of the Eiffel Tower. (*b*) By working the transmitting and receiving instruments to the utmost both of energy and sensitiveness, it was possible to establish a fair communication. The maximum number of signals were received when the vertical plane containing the two feelers was so arranged as not to encounter the buildings by which the apparatus was supported. (*c*) Different tests were made relative to earth connections. The best result was obtained with the arrangement shown in Fig. 25, in which there is no earth connection to the receiving instrument.

M. Guarini concludes from this that in wireless telegraphy the earth plays the part of large capacity.

3. *Direct Communication between Malines and Antwerp.*

1. *Malines transmits, Antwerp receives.*—(*a*) Good results were obtained with a current of 2 to 2½ amperes. (*b*) When reproducing the arrangement shown in Fig. 25, a less favourable result was obtained than in communicating the other way (2 B C). This does not weaken the opinion of M. Guarini as to the part played by the earth in wireless telegraphy, as at Brussels the receiving feeler was furnished with a large capacity on its upper part, the 50-wire cone, and this capacity did not exist at Antwerp. The profile of the land between the two stations is shown in the accompanying diagram (Fig. 26). (*c*) An interesting experiment was made with reference to the use of alternate currents in wireless telegraphy. The oscillator at Malines was disconnected, and the feeler was put to earth after having traversed the secondary of the Ruhmkorff coil; 25 per cent. of the signals transmitted under these conditions were received at Antwerp. (*d*) A signal was received at Antwerp where the earth connection was removed, Malines using the alternate current.

B. *Antwerp transmits, Malines receives.* — (*a*) Less favourable results were obtained than in the opposite direction. A violent wind bent the feeler at Antwerp, and destroyed the parallelism between the two feelers. This is therefore a further corroboration of our theory of the part played by feelers. (*b*) Under the same atmospheric conditions the results obtained were better when alternate currents were used. (*c*) The results were still better when a capacity was added to the top of the transmitting feeler. (*d*) Marconi's tuning arrangement (see Fig. 6) was tried. With complete discord, and although the distance was greater than 2½ km. (1½ miles), the exchange of signals was carried on almost as well as with accord.

With respect to secrecy of wireless telegraphy, a telegram from Nice of April 22, 1901, informs us that in spite of the precautions taken during the experiments at that time proceeding between Biot and Calvi, a telegram transmitted from Biot to Calvi was intercepted at Villefranche in its entire meaning and with perfect distinctness. This result confirms that of the Antwerp-Malines experiment.

4. *Communication between Brussels and Antwerp, with use of Repeater at Malines.*

The three preliminary experiments having given the desired results, M. Guarini could next undertake the definite experiment which was to test the value of his automatic repeater, employed over a long distance. In the laboratory experiments it had always worked in a satisfactory manner. M. Guarini, however, wished to test it over a long distance, this apparatus being specially constructed for the purpose, when acted upon by waves much weakened by distance, of releasing a source of energy sufficiently powerful again to traverse a long distance. It should be stated at once that the experiment was crowned with the most brilliant success. On the last day of the experiment, our part was simply to note, watch in hand, the time of the passing of signals from station at Malines; and when, the experiment being finished, we placed the Morse paper strip, at Malines, side by side with that of the receiving station, it was seen that the two were absolutely identical. Not all the signals transmitted from the Brussels station arrived at Antwerp; but this latter station received absolutely all the signals passed on by Malines, which proves the strict fidelity of the repeater. And, indeed, the prime condition that an instrument should retransmit a signal is that it should have at least received it. The repeater tested at Malines is represented diagrammatically in Fig. 27.

One feeler only was employed at Malines; it was connected to the Ruhmkorff coil. The commutator relay (switch relay) was for the purpose of maintaining or breaking its communication with the receiving parts of the apparatus, according as it was acting as receiver or as transmitter.

Various experiments led to the insertion of a transformer with a glass core and a condenser between the feeler and the coherer. It had been noticed that without this precaution the atmospheric electricity collected by the feeler at Malines, which was a real lightning conductor, acted upon the coherer at each interruption, so that once started off by a wave transmitted from Brussels or from Antwerp, the repeater went on acting without stopping. The switch relay was connected to a transformer by a well-insulated wire enclosed in an iron pipe, the latter being put to earth; it was recognised that lead pipes, even when of great thickness, allow the electric waves to pass through. This wire was led into a metallic box, where it passed through a self-induction coil, surrounded by crumpled tinfoil, put to earth; it ended at the primary of the transformer. The switch relay had a second object, which was

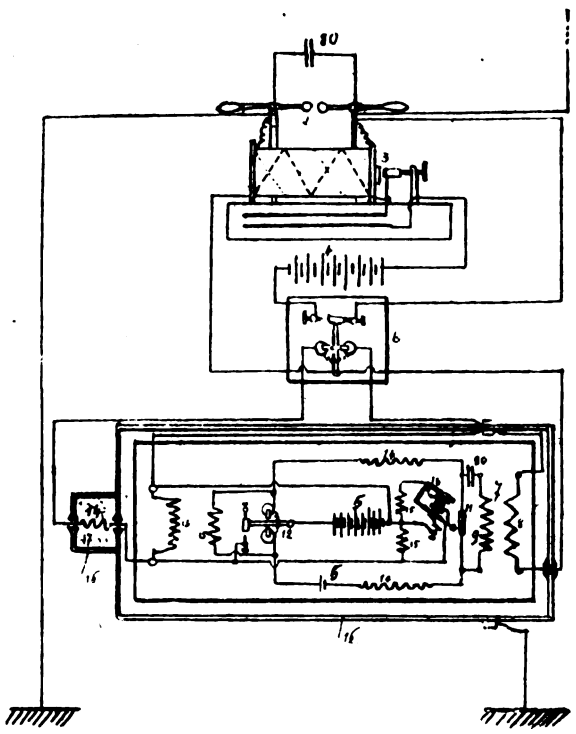

Fig. 27.—1, feeler; 2, oscillator; 3, Ruhmkorff coil, with platinum contact breaker and condenser; 4, accumulators; 5, cells; 6, switch relay; 7, transformer (8 = 0·25 ohm; 9 = 11,000 ohm); 10, condensers; 11, coherer; 12, relay; 13, striker; 14, self-induction coils (40 ohms and 35 henrys); 15, shunts; 16, metallic box put to earth; 17, sheets of crumpled tinfoil put to earth.

to close the primary of the Ruhmkorff coil. Its sensitiveness was $\frac{1}{20000}$th ampere. The coherer which gave the best results was one made with large-sized filings of nickel, with traces of silver, enclosed in a space of 1mm.; air was exhausted from the interior. To obtain an absolutely satisfactory coherer, M. Guarini made a special arrangement as follows: at the moment when the hammer gave the tap a supplementary resistance of 2,000 ohms was added to the resistance of 1,100 ohms which had been already inserted in the coherer circuit. The repeater acted automatically, and in a perfectly satisfactory manner, both with alternate currents and with Hertzian currents.

Part III.—Conclusions.

The result of the Brussels-Malines-Antwerp experiments is that henceforth wireless telegraphy is possible upon land. Transmission was carried on direct between two stations at a distance of 22 km. (14 miles) under very unfavourable conditions: everything was against the experiments—the temporary nature of the installations, the violent snowstorms, ill-natured actions, notably at Antwerp, where M. Guarini was obliged to renew the feeler twice over. The distance of 22 km. (14 miles) was doubled by the use of an intermediate station, without any increase in the service staff being necessary, the Guarini repeater working automatically without loss of time in transmission, the message

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passing through the relay station without stopping and with the velocity of light. The various results of these experiments, especially the successful use of alternate currents, provides the solution for a wireless telegraphy installation at low cost. Each station came to about 2,500fr. (£100), while the ordinary wire telegraph costs 700fr. per kilometre of line (£44 per mile).

It may be asked what benefit will our modern social organisation obtain from wireless telegraphy with Guarini repeaters? The use of the system in military and colonial matters will alone be dealt with here. There are numerous rapid means of communicating orders and information, for which whole armies of horsemen, cyclists, carrier pigeons, and balloons are employed, as well as telephones and the ordinary telegraphs—electric, optic, and acoustic. Now the use of any particular one of these systems to the exclusion of all others does not deal completely and surely with all the cases which may present themselves at time of war. A judicious choice of this or that system is necessary for this or that circumstance. It is therefore certain that the problem of communication must often remain unanswerable in wartime, no chief being in possession of the whole of these systems at the same time. The wireless electric telegraph luckily arrives to turn the flank of the difficulty. If the instruments employed are furnished with an arrangement which will in the first place not allow them to be acted upon by the enemy's instruments, and in the second will enable them to keep the secrecy of telegrams, that they are completed by the addition of the Guarini repeaters so as to reach any distance, then the wireless telegraph will assuredly henceforth replace all other systems wherever these have been found defective.

If we suppose the adoption of a complete network of repeaters throughout the whole extent of the territory, and if each repeater is provided with a Morse receiver, the Government could send out in a few minutes the order for mobilisation and the places on the frontier in two or three minutes, and will be able to blazon forth to the whole country that it has been invaded.

The colonial applications are remarkable. Who does not know of the difficulties of every kind which are met with in the installation and maintenance of telegraph lines in uncivilised countries and of submarine cables? These absorb a large amount of expenditure. In case of a general international conflict, the telegraph service is assured only so long as it is used to the benefit of the nations possessing cables. In the colonies the telegraph lines are cut by the natives, destroyed by forest or bush fires; they require a very large staff for supervision; and lastly, expeditions at a distance are left to their own resources. If the wireless telegraphy apparatus had been known at the time of the North and South Pole expeditions, Andrée and De Gerlache would have remained in connection with the mother country, and the fate of Andrée would not have been left a cruel puzzle.

In such expeditions the use of a series of receivers is a necessity. But to assure us absolutely that a series of these repeaters will work just as well as one, and that the secrecy of signals is completely achieved by his sheathed metal feelers, M. Guarini owes us still one more effort. He must realise in practice the dual project which he has already worked out and planned, down to the smallest details, upon strictly scientific lines. Experiments are being carried on between Brussels, Ghent, Antwerp, Liège, Namur, Mons, and Brussels, and these experiments are to serve as a preliminary for extended experiments between Paris and Brussels. M. Guarini intends to establish wireless communication between these two capitals, distant 275 km. (172 miles), by placing repeaters at Braine-le-Compte, Mons, Berlaimont, Wassigny, Moy, Concy-le-Château, Villers-Cotterets, Betz, and Mitry—that is, with intermediate stations at intervals of about 27 km. M. Guarini can easily clear this distance of 27 km.; the Brussels-Malines-Antwerp experiments leave no doubt whatever on this point. But what he has to demonstrate in these further experiments is the efficacy of his sheathed feelers. If these experiments succeed, which everyone will sincerely hope, a vast field opens itself out for the use of wireless telegraphy, as it will then be possible to have many applications of overland telegraphy not yet realised and impossible of realisation by the ordinary electric telegraph with wires.

Namur, April 29, 1901.

WORKSHOP TRAINING FOR YOUNG ENGINEERS.

BY R. D. SUMMERFIELD.

There is at the present day a tendency in some quarters to question the necessity of workshop training for engineers, and to substitute a technical college course instead. The persons who hold these views are mostly professors and teachers of science and engineering, and as the majority of them have never been through the shops themselves it is natural that they should suppose such experience to be unnecessary, especially if the student receives practical instruction in the college workshop. Students at such technical schools generally hold the same views as their teachers, as the idea of going to work at six o'clock every morning for three or four years and working among ordinary workmen is not one which appeals to the majority of lads. They are, therefore, quite content to tinker about in the school workshop, and when they leave endeavour to get straight into some drawing office, when they imagine themselves engineers.

Now, in the writer's opinion, to provide a workshop for a technical school is a simple waste of money; it is not only useless, but in many cases actually harmful, as the students have to unlearn much of what they were taught there when they become connected with an engineering concern. It is quite right to have laboratories, and such plant as a boiler, steam-engine, pump, dynamo, etc., on which tests for horse-power, steam and fuel consumption, efficiency, etc., may be carried out by the students, as such tests are probably the most important part of the school teaching, if they are carefully carried out, and the value of the results clearly and fully pointed out by the teacher; but to fit up a workshop in imitation of an engineer's shop, and to set the students to make small engines, lathes, etc., is little less than a farce, as far as such training is of any use to them in after-life. The work turned out of these college workshops is often very well done, but it is done with no regard to time or cost; the students spend hours in filing up two or three nuts or in polishing surfaces which would be better left unpolished, etc. The consequence is that when they leave school and go into an engineering works, where economy in production is considered of the first importance, and the theoretically best form of any machine can only be approximated to for good practical reasons, they have to quickly unlearn the out-of-date method of working taught in the school workshop, and they will usually not be long in coming to the conclusion that the time spent there was, to say the least, wasted.

There can be little doubt that no matter what branch of engineering a lad intends to take up—civil, mechanical, or electrical—the best foundation he can have is four or five years' practical workshop training. Less than four years is not sufficient for a lad to really learn much, as it takes a year or more for him to get into the swing. To gain the fullest benefit from a course of workshop training, it is not enough to learn how to chip and file, to turn, make patterns and castings, and to do work as quickly as an ordinary workman. This knowledge will fit a man for a foreman's post, but if the student aspires to become a manager or chief engineer, he would be wise to spend a good deal of his time when in the shops in taking notes, making sketches, and finding out how much things cost to make. This is a part of his training which is rarely impressed upon him, unless his father or some near relation happens to be an engineer, and the student himself is rather apt to look down on the question of cost and economical production of work as commercial, the scientific side of engineering being all that he cares about. He will find, however, when he leaves the shops that the commercial side is usually considered most important, and that the question of cost rules everything, and he will then regret, as the writer often has, that he did not make a better use of his time in the shops.

If the student wants to gain really valuable information,

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which will be of the greatest use to him in after-life, he should take careful notes of such points as the following: the size of the shop in which he works, the number of men and boys who can work comfortably in it and the number of machine tools it will hold, also the amount of work turned out per day and week. Then he should note the time required to turn, plane, or bore a given amount of surface with different metals, and the time required to drill holes of various sizes; in fact, he should try to find out the maximum output of as many different kinds of machines as he possibly can, and in order to find the cost of the work turned out by each machine he must note the class of labour required to run it—whether by boys, unskilled men, or skilled mechanics; also the amount of power taken to drive the machine, generally a difficult matter to estimate, unless each machine is driven by a separate electric motor; but at any rate it is generally possible to discover the horse-power of the main engine, and when the number of machines driven by it is known, some idea of the power taken by each may be arrived at.

Of the knowledge gained in a workshop which can be gained in no other way, not the least important is that relating to the character and peculiarities of workmen. When going through the shops, the pupil works side by side with the men, and as they usually treat him without the slightest deference he soon discovers their likes and dislikes, their real or fancied wrongs and hardships, and the best way to get on with them; and if he should be fortunate enough later on to become a manager, he would find this knowledge of great use in dealings with his men. The student would find it useful to ask himself such questions as the following: "If I were called upon to lay out a works to turn out a given quantity of engines, boilers, or machinery per week or year as economically as possible, what data should I require to work upon?" "If I had to rearrange the driving of a factory, changing from belts and counter-shafting to motor driving, could I make a close estimate of the power required by various tools?" "What class of articles can be made more cheaply by turning out of the solid bar instead of being forged and then turned? "What amount of oil is required to lubricate various tools, and what is the best lubrication when cutting different metals?" "What is the best way to treat workmen to get the most out of them, and yet keep them contented?"

The man who has made such use of his shop training that he is ready with an answer when such questions come to him is the man who quickly rises to be a head, and in order that he may be ready, the pupil should let no detail of shop method or management escape him. Notes which at the time he may think of no importance may probably turn out to be of more use to him afterwards than the skill he attained in scraping up a face plate or handling a lathe. Not that actual work should be neglected by any means. An hour a day should be enough for the student to devote to the surroundings of his work, and he can write his notes out in the evening while the subject is fresh in his mind.

A great advantage of workshop training, at any rate, from a parent's point of view, is that it enables a lad as a rule to obtain a post much sooner than if he had only been to a technical college—a post, that is, in which he earns enough to keep himself. Take the case of schools devoted more particularly to the teaching of electricity, for instance. A great number of people who know nothing about it imagine that electrical engineering is a separate profession altogether, instead of being only a branch of mechanical engineering. They think, therefore, that if their sons go through a two or three years' course at an electrical engineering college they will become electrical engineers, and command good salaries, "for electricity is the coming thing." The student at such a college imagines this also—until he tries to prove it. On leaving college what does he find? Does he find employers falling over one another to secure his services? By no means. After a long and disappointing struggle he probably gets a job as a switch-board attendant at some small station, as a junior in a test office, or some similar insignificant post, and unless he is very smart his chance of rising is but small, as his want of shop experience always stands in his way.

Another advantage of a workshop course, apart from any question of experience, is the health and strength which it gives, if followed in a sensible manner. Probably the chief reason for its healthiness is the early hour at which it is necessary to rise in the morning, 5.30 or 6, but to get the benefit of this it is necessary to go to bed early, not later than 11, though an hour earlier is better; and the enthusiastic pupil who works at his books until past midnight, and yet prides himself on keeping good time at the works, will find no benefit to his health from the shops. Four or five years of steady hard work in the shops, with early hours and the avoidance of excesses, will lay a splendid foundation for a long and active life, and there are few engineers who do not look back to the time spent in the workshops as one of the happiest periods of their life.

VERBAND DEUTSCHER ELEKTROTECHNIKER AT DRESDEN.

[BY OUR OWN CORRESPONDENT.]

(Continued from page 56.)

From the report of a sub-committee appointed during the meeting of the Verband in Kiel last year, it appeared that, amongst other matters, the question as to how far the Verband, as a body, should devote its attention to questions of tariff and commercial policy had received careful consideration. The sub-committee, as an outcome of its deliberations, now recommended that the Verband should refrain from occupying itself with commercial treaties and questions of tariff, beyond collecting data for the information of its members, which recommendation was put to the meeting in the form of a resolution and carried unanimously. That considerable progress had already been made by the sub-committee with the collection of useful data, was evidenced by the exhibition of a collation in book form of foreign tariffs imposed on electrical machinery and apparatus.

The Commission on Hysteresis Losses also submitted a report, which included some important recommendations relating to the testing of dynamo and transformer iron. It is proposed that the sample to be tested shall weigh at least 10 kg., the total losses in the iron through hysteresis to be given in watts per kilogramme for a maximum B = 1,000, and a periodicity of 50. As standard thicknesses of the iron plates, 0·3mm. and 0·5mm. are recommended, the variation from the specified thickness not to exceed 10 per cent. either way over any portion of a plate. A magnetic circuit of prescribed form, and composed of iron of the quality to be tested, is to serve the purpose of the measurement, the specific gravity of the iron being taken at 7·7 unless a more accurate value is available. Should there be any disagreement as to the result of the test, the decision of the Physikalisch Technisch-Reichsantalt, Charlottenburg, is to be final. A magnetic circuit of the proposed form was shown and briefly described by Prof. Dr. Epstein, who submitted the proposals and promised a more detailed description for a later date. A lively discussion ensued as to the suitability of the method of testing advocated, several speakers suggesting that the method described lent itself to abuse. But it was pointed out, in reply, that the aggregate possible error which could arise from the several sources suggested during the discussion, such as difference in wave-form and eddy-current losses, would not seriously affect the accuracy of the result obtained. Mr. Gisbert Kapp pointed out that the meeting was asked to accept the recommendation provisionally. The special commission had formulated the method just explained only after careful deliberation, but it was, nevertheless, put forward as a tentative measure subject to revision, as experience might direct, and he would, therefore, recommend the meeting to accept it as such for a year's trial, and not insist upon immediate modification of the proposals. The force of this argument went home, and the recommendation was acted upon accordingly, whereby the work of the commission was not rendered abortive, a fate which at one time threatened.

The recommendation submitted by another special commission in regard to the efficient protection of buildings against lightning were also approved. It will be remembered that this question has engaged the attention

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of German engineers since 1885, and the regulations now formally adopted are, therefore, the outcome of practical investigations extending over a considerable interval of time. The regulations as they stand are calculated to encourage the use of lightning conductors for the protection of country and outlying buildings generally by simplifying their construction and reducing their initial cost. It is recommended that towers, gables, ridges, chimneys, and other prominent portions of a building should be either crowned with receiving points connected to the conductor system, or provided with individual conductors. The conductors should provide a continuous metallic connection between the receiving points and earth; they should, where possible, completely surround the roof of the building to be protected, and connect the receiving points to earth by the shortest way consistent with the avoidance of sharp bends. The earth connection should consist of metallic conductors, connected to the lower extremities of the house conductors and buried in the ground, being of as large a surface as possible, and preferably placed in damp soil. Metallic portions of the building and large masses of metal in and about the building, especially such as may expose a large contact surface to earth, as fall pipes, should be interconnected and placed in electrical contact with the lightning conductors proper. In erecting new buildings, metallic portions, such as fall pipes, etc., should be utilised to the fullest possible extent, both in order to render the protection afforded more perfect and to reduce its cost. The protection afforded by a lightning conductor depends upon the protection given to exposed points of the building by the receiving points provided, the number of house conductors, and the relative extent of the earth connection. Buildings are afforded a certain amount of protection by the metallic elements in the same, especially if these extend from exposed points to earth, even when not designed to serve the purpose of lightning conductors. Increased danger, due to an imperfect system of conductors, is not generally to be feared. Branched conductors of iron should not be of less than 50mm.^{2} sectional area, and unbranched conductors of the same material not less than 100mm.^{2} For copper half of this section is sufficient. In order to maintain the system of lightning conductors in good repair, periodical examination by competent inspectors is recommended. It may be added that the value of the investigation is already being recognised in Germany in a practical manner, as evidenced by the increased protection against lightning given to newly-erected outlying buildings, which, it is recognised, stand most in need of it, while municipal and other large dwelling-houses in towns are no longer provided with any special protection. The ample provision made for protecting dock-sheds and other similarly exposed buildings is very noticeable, the ridges of farm buildings being also frequently adorned with numerous tall points in connection with a system of lightning conductors.

During the further course of the proceedings a commission was appointed to reinvestigate the question of vagabond currents in connection with electric railways, and to revise previous regulations for the prevention of injury to water and gas pipes, etc., through electrolysis caused thereby.

A commission was also appointed to deal with questions relating to the testing of materials used in electrical manufactures.

(To be continued.)

THE POLLAK VOLTAMETER RECTIFIER FOR ALTERNATING CURRENT.

On June 3 Mr. Lippmann presented a note to the French Académie des Sciences on the rectifier for alternating currents designed by Mr. C. Pollak. In this note the author states that in his researches on the use of aluminium plates as rectifiers of alternating currents and as condensers he has succeeded in using such plates up to 200 volts. He has employed as an electrolyte a slightly acid solution of phosphate of potassium, through which has been passed a continuous current. The first operation in the construction of the apparatus consisted in placing the aluminium plates in a weak solution of caustic soda in order to dissolve out the impurities in the plates. The formed plates are for 200-volt work. When put in circuit they give off a little gas, and a small but continuous current passes through the apparatus. This is due to the purely chemical action of the electrolyte on the dielectric coating of one plate, which is slowly reduced. In consequence, a certain current is necessary in order to maintain this coating, and in practice equilibrium is established between these two actions. The value of the current required to maintain this state of equilibrium is, of course, the no-load loss of the apparatus, and it depends on the purity of the plates. The author finds that the efficiency of the apparatus as a rectifier of alternating currents is from 75 to 80 per cent. This efficiency was found for an apparatus consisting of four aluminium elements working at a frequency of 40 cycles per second. The aluminium plates are dissolved in the electrolyte to a slight extent owing to the action of the same on the dielectric coating; for instance, whenever the apparatus is not in use this coating is dissolved, and has to be re-formed when the alternating current is next switched on. The wasting of the aluminium could, of course, be prevented by the withdrawing of the plates from the solution when they are not in use.

There is a consideration of extreme importance which determines, regulates, and limits, so to speak, the conditions under which such a rectifier can be used, whether the plates be of aluminium or lead. It is due to the heat which is given off while the apparatus is at work. The author finds that, whatever may be the electrolyte used, the temperature of the same increases rapidly, and after a time luminous points appear on the plates, which lower the efficiency, and allow a considerable part of the current to pass. At the same time the plates waste away. Mr. Pollak finds that the temperature below which the apparatus can be relied upon to work in a satisfactory manner is 40deg. C. In short, in order to work for a considerable time the apparatus has to be artificially cooled. It is desirable, if possible, not to cool the same by means of circulating water. The author has devised an apparatus with which his experiments were made in Mr. Lippmann's physical laboratory, with which the inconvenience of cooling is got over in the following way. He uses a receptacle for the electrolyte which is several times higher than the plates themselves. In this way the total volume of the electrolyte is increased, and the apparatus can be worked for a longer time without the critical temperature being reached. In designing the apparatus, the quantity of liquid would be made to depend on the length of time it is wished to work the apparatus without an interval of rest. Of course, with the increase in the dimensions of the apparatus the cooling area is increased and the heating effect is spread over a larger mass.

With the apparatus experimented with in Mr. Lippmann's laboratory at Sarbonne the author employed a column of electrolyte three times the height of the plates, and with the normal output of one ampere per square decimetre of surface of aluminium plate the apparatus could be worked for four hours without the temperature increasing beyond 40deg. C. The table below gives the results obtained in this laboratory with an apparatus consisting of four elements. The apparatus was used to charge a battery of 70 accumulators. The alternating-current supply, at 110 volts and 40 frequency, was obtained from the public supply mains.

Time.	Temperature in degrees C.	Density of the electrolyte.	Current, amperes.	Difference of potential in volts.
2.15	+15·6	1·049	4·5	143·5
3.30	+20·5	1·0475	4·0	145·5
3.50	+22·6	1·0455	5·0	149·0
4.30	+27·0	1·045	5·0	150·5
5.0	+28·8	1·044	5·5	154·0
5.15	+29·7	1·043	5·2	152·5
5.30	+31·0	1·043	5·3	153·0
5.45	+31·8	1·0425	5·5	154·0
6.0	+32·6	1·042	5·8	156·0
6.15	+	1·042	5·9	157·0

The pressure of the alternate-current supply was not verified often during the experiment, and the irregular

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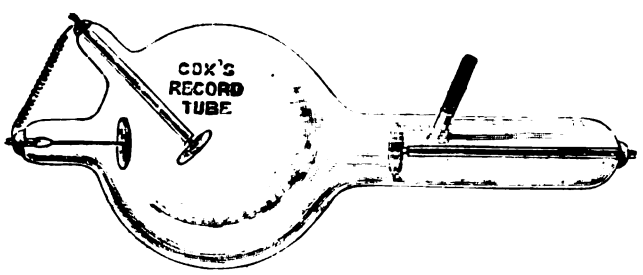
variations in the current and E.M.F. in the circuit carrying the rectified current are the result of the corresponding variations in the supply.

The upkeep of the apparatus is manifestly dependent on the electrolyte and on the plates. The electrolyte becomes more and more alkaline with time, and the plates are gradually eaten away. The wearing of the plates is partly due to the mechanical effect of the gases which are disengaged at their surfaces. After 500 or 800 hours of normal work the plates are so corroded as to be practically useless. The author remarks that it is not possible to connect a number of the aluminium elements in series, either as rectifiers or as condensers. This is so because after a short time the low tension in one of the elements results in the voltage in the others increasing sufficiently to break down the insulating coat, and then the current passes in both directions. This phenomenon is the result of the difficulty, or, as the author puts it, of the impossibility of making the elements exactly alike. The aluminium plates, as far as the author has been able to ascertain up to the present, are only able to act as condensers for alternating currents because they only keep their charge during a small fraction of a second. This is evidently due to the chemical reaction exerted by the electric light on the dielectric coating of oxide.

The above interesting description, for which we are indebted to *L'Industrie Electrique*, shows well the success which Mr. C. Pollak has already achieved in this new type of rectifiers. We are pleased to note the careful way in which he avoids exciting at a too early date the hopes of commercial men, but as he has given such a complete account of the limitations of the method, we believe that he will succeed in solving these difficulties in the near future.

COX'S RECORD TUBE.

We have pleasure in presenting herewith an illustration of Cox's record tube, which has been awarded the gold medal offered by the Röntgen Society for the best and most suitable



tube for X-ray work. Further reference to this matter will be found in the report of the Röntgen Society, of which we give an abstract elsewhere in this issue.

BURY ELECTRICITY WORKS.

In his annual report on the Corporation electricity works to the Electric Lighting Committee for the year ending March 31, 1901, Mr. S. J. Watson, M.I.E.E., engineer and manager, states that the number of consumers and lamps connected at March 31, 1901, were 254 and 18,559 respectively. The units sold during the year ended March, 1901, are given as follows: private lighting at 6d. 107,504, at 3d. 69,829; motors and heating at 3d. 9,711, at 1d. 14,760; public lighting, 51,250; technical school, 8,193—total, 261,247; maximum load, kilowatts, 223·7; load factor, 13½ per cent. It is satisfactory to notice a further increase in the load factor, which now stands at 13½ per cent., showing that the maximum load has been used for an average of 3 hours and 20 minutes per day, compared with three hours only for the previous year. This improvement is principally due to the extended use of the supply for power purposes. The following additional plant has been erected during the past year: one 360-b.h.p. engine, direct coupled to a 250-kw. dynamo, to run at a speed of 370 to 400 revolutions per minute. The engine is of the three-crank vertical tandem compound condensing type, and was supplied by Messrs. Belliss and Morcom, Limited, Birmingham. The dynamo is a two-pole machine, supplied by Messrs. Siemens Bros. and Co., Limited, and gives an output of 500 amperes at 440 to 500 volts. The set is provided with a heavy flywheel, to enable it to be used for electric traction if required for that purpose. The economiser has been extended by 72 pipes, making the total now in use 192. The additional pipes were supplied and fixed by Messrs. Green and Sons, Wakefield. The total capacity of the plant after an allowance for spares is 14,600 8-c.p. lamps alight at once. This will allow about 30,000 8-c.p. lamps to be connected to the mains, as only 50 per cent. of the lamps are usually in use at once. During the year extensions of mains have been made to the extent of 1,344 yards, the total lengths of cables laid to date being 10 miles 460 yards. Thirty-three arc lamps are now in use in the main streets, two lamps having been erected during the year by the fountain in Manchester-road. Twenty incandescent electric lamp fittings will shortly be fitted to the existing gas lanterns in Spring-street and Haymarket-street. The application of motors for driving machinery is making steady progress. For motor and heating purposes 24,471 units were used, compared with 8,328 units for the previous year, an increase of nearly 300 per cent. The number of motors connected to March, 1901, was 29, equal to 98 h.p. The alteration of voltage was carried out in April, the pressure of supply being increased from 220 volts to 440 volts across the outers of the three-wire system. For lighting purposes all consumers are supplied at 220 volts, 440 volts being used only for the larger sizes of motors. A considerable saving in capital outlay will eventually result from this change. Mr. Watson gives the following analysis of cost for the year ending March 1901:

	£	per unit.
Generating costs	2,607	= 2·40d.
Interest and sinking fund	2,307	= 2·11d.
Total cost	4,914	= 4·51d.
Loss	657	= ·60d.
Revenue	4,257	= 3·91d.

The revenue for the year shows an increase of £675, or 19 per cent. The costs, unfortunately, owing to exceptional adverse circumstances, have also increased by £1,516, or 44 per cent., the result being a deficit of £657, compared with a profit of £183 for the previous year. The principal increases in the cost-sheet are as follows: coal, £244; repairs, £336; rent, rates, and taxes, £145; bank interest, interest on loans, and sinking fund, £504. The high price of fuel has necessitated an additional expenditure of £175, the average price paid being 12s. 6d. per ton, compared with 9s. 6½d. for the previous year. The quantity of fuel used per unit sold has been reduced 8 per cent., owing to greater economy in the running of the works with the larger output and better load factor. Mr. Watson concludes by saying that he is again able to report that the generating plant has continued to work in a satisfactory manner, not the slightest hitch having occurred inside the works to interfere with the supply. Much less trouble has also been given by the distributing cables since the repairs previously mentioned were carried out. On one occasion a short-circuit on a service caused the extinction of about 150 lamps for a few minutes, but with this exception any accidental interruptions have been avoided.

We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., for the past year:

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	21,274	15	6
Repairs and maintenance	272	10	8
Management expenses	546	3	9
Distribution	162	16	6
Public lamps	122	8	7
Miscellaneous	796	12	4
Amount carried to net revenue account	1,274	12	6
	£4,379	19	10

Cr. Income.	£	s.	d.
Sale of current	4,191	13	9
Rental of meters	150	7	10
Rental of motors	21	16	9
Private construction	16	1	6
	£4,379	19	10

BALANCE SHEET.

Liabilities.	£	s.	d.
Loans on mortgage	37,519	0	0
Sundry creditors	1,142	8	7
Cash owing bank	6,713	5	7
Sinking fund	1,020	0	11
Debt extinguished	2,245	0	0
	£48,640	15	1

Assets.	£	s.	d.
Amount expended as per capital account	46,300	4	9
Sundry debtors for current supplied	1,640	15	6
Stock of stores	42	2	1
General rate account	657	12	9
	£48,640	15	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			282,056
Quantity sold	Public lamps	51,250	261,247
	By contract	8,193	
	Private consumers by meter	201,804	
Quantity used on works			8,231
Total quantity accounted for			269,478
Quantity not accounted for			12,578
Number of public lamps			33
Total maximum supply demanded (kilowatts)			223·7

Watford and District Tramways.—This Bill has passed Lord Morley's Committee on unopposed measures.

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TO CORRESPONDENTS.

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PAPER v. CASH.

Although the present time may hardly be considered a fair one at which to make comparisons between the industrial methods of conducting business in Great Britain, Germany, and the United States respectively, a few reflections on the state of the electrical industries in these three countries will be interesting. The present commercial crisis in Germany tends to emphasise certain differences. Speaking generally therefore we may say that in Great Britain the bulk of the electrical manufacturers work directly for cash, which they receive from the consumers who take their apparatus. In Germany, the large firms have up to the present obtained cash for their wares, but in that country the money has come largely from the industrial banks, who, in return, have taken up the paper representing the supposed value of the completed undertakings. In theory, the German method has great advantages. For instance, a far-seeing engineer works out a scheme for the supply of electric light and tramways in a given town. He is able to show, as is usually the case, that the capital value of the undertaking, when in complete working order, largely exceeds the actual cost of the apparatus required, even allowing a liberal margin to the manufacturers. The profit between the manufacturer's prices and the face value of the shares in the undertaking would naturally go to the bank, who on paper can quickly make large turnovers. Another advantage, apart from the apparent profit to the manufacturer and the bankers, is that large schemes can be quickly carried through, which is not the case when a number of antagonistical ratepayers have to be convinced of the truth of the engineer's estimate. As a result of the large schemes and the considerable number of them which can be organised, the manufacturer can, or, rather, must, equip large works, and for a time the industry has flourished exceedingly. The fact, however, that the banks have not in many cases been able to unload their paper on the public has led to the present crisis, and to the downfall of some important firms. Another outcome of the situation is that the well-established and strongly-backed firms will now find that the industrial banks are much more chary in accepting schemes. This is resulting in a considerable decrease in the work obtainable, and the consequent increase in the cost of a given article. We do not think we should be wrong in attributing the strenuous efforts which the German manufacturing firms are making to secure English orders to the fact that they wish to keep up the output of their works. The low prices at which these firms are undertaking work is also partly due to the fact that the payments for the machines will be in cash, and not in paper. Turning now to the American industry, the huge electrical manufacturing firms there have themselves acted as financiers, and in the earlier days received payment for their goods largely in paper. There is no doubt that the prices of the goods were higher in consequence, but the more important consideration is that these manufacturing firms were able to bind what were practically their offspring to buy always their supplies and their extensions of plant from themselves. The success of the undertakings so financed has been sufficiently great to enable these later purchases to be paid for in cash, but if our information is correct, the paper prices still hold in spite of that fact. This has resulted in keeping the American manufacturers in high water. In Great Britain, where the electrical undertakers have mostly had to be persuaded to spend hard cash, the progress in certain directions has not been so phenomenal as in the two above-mentioned countries, but the electrical engineering work actually carried out has been, if anything, of a higher standard. The manufacturing undertakings have been

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hampered greatly in the competition with America and Germany by the large production in these countries. We have not, however, had disastrous failures, and there are signs that the manufacturing industry in this country will soon be able to obtain the more ample financial support which it deserves. In view of the commercial crisis in Germany and the labour troubles in the States, the outlook for electrical engineering firms in Great Britain having well-equipped modern works is exceedingly hopeful at the present time. There is large work to be done now and in the near future, and in most cases the firms will be able to obtain payment in cash, and not in paper.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

GILBERT'S SELF-DRIVING WEIGHT OSCILLATING MOTOR.

SIR,—In all my letters on the above subject not one was entitled "Perpetual Motion." My first, 12 months ago, was entitled "A New Power Machine," but it appeared in print under the title of "Perpetual Motion" (to the devil with perpetual motion; I detest the name; you don't want a machine to work eternally), for which I am not responsible, although my motor will work until it stops for want of lubrication, and sufficiently long to generate enough electricity to work all the tramways in and illuminate the city of Newcastle-on-Tyne without fuel. The possibilities of what it can do are enormous. Sir, the monorail or pentarail system could be worked by my machine to an unlimited speed in perfect safety, and which system would be a godsend to the travelling public, because the carriages would be jerkless, and always maintain their equilibrium (not ride on a curve with some wheels off the metals, witnessed with the existing system of transit), and the cost of working a railway on this system, by current supplied by the employment of Gilbert's self-driving motor at the generating stations (don't overlook the fact that boilers and fuel are dispensed with), would be insignificant to that incurred under existing arrangements, but to return to the subject at issue I maintain the following, which is given in one of my specifications: "To provide a motor to revolve continuously by its own mechanical parts without any external aid—such as steam, electricity, gas, compressed air, or water—for driving a dynamo-electric machine, and for other purposes, thereby dispensing with fuel." By my saying in your issue of 7th ult., "for the enlightenment of those puzzling their brains over perpetual motion," I meant they would obtain an important wrinkle from the principle of my motor. So how is it evident I have claimed to have invented a perpetual-motion machine? Perhaps I have after all said and done. Mr. Evans should now, I think, be satisfied with my explanation, but as to the problem of flying being for greater minds than mine, really I don't think it will ever be fathomed until the dexterity of Arthur Gilbert comes to the rescue by giving vent to his sketches and ideas recorded some years ago. This I may do after the motor, my greatest invention, is established. If Mr. Evans will take the trouble of a search he will find that my patents range from a "nut lock" to a "water-closet seat," and the information might be advantageous to him.—Yours, etc., ARTHUR E. GILBERT.

[N.B.—All the statements above would be more impressive if the writer would calmly state what his model has done now that the twisted parts are straightened. Unless Mr. Gilbert can assure us that it goes by itself for, say, an hour, this correspondence must cease.—ED. *E. E.*]

Aluminium Transmission Lines.—The latest move in electrical matters in Italy is the installation of three aluminium electric transmission lines. These transmit power at 3,000 volts from 3-h.p. turbines to the valley of Pompeii, to Larno, and to Torre Annunziata. One of the lines is nine miles in length, while the remaining two are two miles long respectively.

PERMANENT WAY FOR ELECTRIC TRAMWAYS.*

BY W. HOWARD-SMITH, A.M.I.C.E.

Mr. Howard-Smith, who is 43 years of age, is an Assoc. M. Inst. C.E. and a Fellow of the Geological and Royal Meteorological Societies. He served his articles with Mr. Thos. Dudley, consulting engineer, of Westminster, and upon completion became assistant to Mr. G. W. Stevenson, M.I.C.E., F.G.S., of Westminster, afterwards receiving appointments on the engineering staffs of the Lancashire and Yorkshire and South-Eastern Railways. In 1881 he went to Brazil as divisional engineer on the Rio and Minas Railway, and upon his return to England became chief assistant to Messrs. John Fraser and Sons, Westminster and Leeds, under them acting as resident engineer in charge of the construction of several Great Northern branch railways in Yorkshire. He also prepared many important schemes for railways, tramways, steel bridges of large span, and other public works of magnitude. In 1887 he was appointed managing assistant to the borough and waterworks engineer of Leeds, part of his duty there being to design the permanent way for the first tramway in this country to be propelled on the overhead trolley principle. In 1889 he was chosen city engineer of Carlisle, but a temporary loss of health following an attack of influenza caused him after seven years' service to relinquish his post amid expressions of regret from the Corporation and general public of that city. A short residence in the Engadine quickly re-established his health, when he took the opportunity to make an extended tour through France, Switzerland, Italy, and the South of Europe, visiting the municipal and other works of interest in most of the principal cities, making a special study of tramways and electric traction. After 15 months thus spent he again entered upon active professional work as chief constructive engineer on the Lynton and Barnstaple Railway, relinquishing his post early in 1898 to accept that of chief permanent-way engineer to the British Electric Traction Company, Limited, where he has been responsible for the design, construction, and maintenance of a large number of electric tramways and light railways in various parts of the country. From this position Mr. Howard-Smith recently retired in order to commence practice at Westminster as a civil and consulting engineer, specialising in tramway and light railway work.

The author responds with pleasure to the invitation to submit a paper on this subject, one no doubt of interest to many municipal engineers, and as it has not been dealt with in any previous paper presented to our association, he trusts the following notes may at least afford an incentive to an interchange of experiences and ideas from those either at present engaged upon tramway work or who contemplate taking it up in the near future. To successfully design tramway permanent way necessitates the most careful consideration of a multiplicity of small details, many of which may to the inexperienced appear of insignificant import, but a closer analysis will show how greatly they may affect the stability, ease of running, cost of maintenance, or life of track. A well-designed, track which is the outcome of practical experience, will probably have a life double or treble that of one badly conceived. Each year added to the life means not only a saving of the proportion of capital cost and interest thereon, but also the postponement of the inevitable loss of revenue during reconstruction. Every possible means should, therefore, be taken, at reasonable expense, to ensure that the permanent way shall be perfect in design and construction and its standard of stability of the highest.

Though the experience in this country of the wearing effect of electric traction on tramways has been comparatively short, it has been sufficient to conclusively demonstrate that it is much more exacting in its demands for perfection of permanent way than was found necessary under horse, cable, or steam traction. This is primarily due to heavier cars being run at much faster speeds and with much greater frequency. A loaded electric car weighs from 10 to 12 tons as against three to four tons for a horse or cable car, while the maximum speed is generally fixed at eight miles per hour on urban

* Paper read before the annual meeting of the Incorporated Association of Municipal and County Engineers, at Leicester.

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and suburban, and 15 miles per hour on inter-urban lines, these speeds being subject to further restrictions where there is a density of vehicular or pedestrian traffic. When entering or leaving passing places, cars are supposed to slow down to four miles per hour, but it not unfrequently happens that in actual working these speeds are somewhat exceeded.

Electric cars are equipped with more powerful brakes, which are more frequently put into requisition, with attendant use of sand, causing wear. On some steep-grade lines no less than four brakes are provided to the cars, and the Board of Trade have required that, in addition to the usual electric and handwheel brakes, wood slipper brakes, about 18in. long, shall be constantly applied to each rail on the downhill journey, and in one case a special brake or pilot-car with similar brakes is run in front of the passenger car. Perhaps the most powerful brake is the "scotch," applied to both wheels and rail.

The better the permanent way the more use is made of it by vehicular traffic, especially of the heavier kind, quick to take advantage of the lessened tractive effort necessary when cartwheels are run on the smooth rail surface. This is particularly the case when track is of 4ft. 8½in. gauge, which nearly approximates to the usual width apart of wheels on vehicles. So obstructive and detrimental to the wear of the track has vehicular traffic been found at some places that the authorities are endeavouring to obtain powers to relegate it to the sides of the carriageway, but a frequent car service generally results in practically sweeping other vehicles off the track.

Rails.

An ideal tramway track would be one in which, in addition to providing perfectly smooth running for the cars and being unobjectionable to ordinary street traffic, each part would have a similar period of life. This, however, is, unfortunately, far from realisable. Assuming the work to be well executed, the concrete is practically for all time, and the paving, if of granite or other hard stone, may last 30 or more years, whereas the life of the rails will be much more limited, and as their renewal entails relaying the paving and other work, it behoves the engineer to give earnest consideration to every detail tending to obtain longer life in the rails, which, with their accessories, it is not too much to say form the most important part of the track.

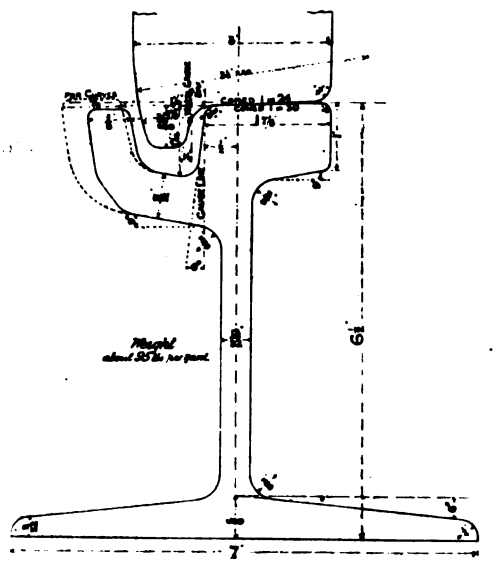
The main duties of a rail are: mechanically, to carry the car and vehicular traffic passing over it; and electrically, to act as a medium for conveying the return or negative current back to the power-house. For this latter purpose it is immaterial in what form the metal is disposed so long as a certain minimum sectional area is provided. The Board of Trade have recently made a pronouncement that this minimum shall be such as to be equivalent to a rail weighing 90lb. per yard—*i.e.*, one having a sectional area of about nine square inches for a hard-steel rail having a conductivity of about $\frac{1}{7}$th to $\frac{1}{8}$th that of copper. The general practice now is to go even beyond this; perhaps about 95lb. per yard may be considered the weight most desirable. Mere weight alone is, however, of little value as affording a criterion of the strength, stability, ease of running, or wearing qualities of a rail; it depends how this weight is disposed—*i.e.*, upon the section or profile—and also upon the chemical constituents. While the section should be such as to provide great vertical and lateral stiffness, the profile of the head of the rail (made up of the tread, groove, and guard), which shows on the street surface, must be such as not to interfere with the general traffic, and its total width should be as narrow as possible.

Until very recently by the Board of Trade regulations the groove was limited to 1in. in width and depth, being varied only in one or two exceptional instances where railway rolling-stock also passed along the tramway rails. Of late this has been relaxed, and grooves of 1¼in. in width and depth have been approved. Undoubtedly a wide groove is an advantage by admitting a thicker and therefore stronger wheel flange to be used; and it is particularly desirable at curves to allow free passage of flange without friction against sides, and straining of underbody of cars when of long rigid wheel base. But with a wide groove on the straight, more side-play is allowed to wheel flange, and therefore the greater the force of impact and vibration, through flange striking sides of groove; again, larger stones, pieces of metal, etc., and more dirt can enter, and there is a greater reservoir capacity for surface water to be splashed up by a passing car into the bearings and motor gearing, with a possibility of damage resulting. With a wheel flange ¾in. thick, a width of groove of 1⅛in. should be ample on the straight and for curves with larger radius than 75ft. For curves of from 75ft. to 50ft., radius 1¼in. width will usually be found sufficient, while those of less radius should never be used; if they are, there will be grinding and great wear, but much depends upon the profile of groove apart from width and depth. It should not be forgotten that the effect of wear is to widen the groove, and that a wide groove is an element of danger to cyclists, tradesmen's tricycles, and other narrow-tyred vehicles. While the purpose of the guard or lip is to form a guide for the wheel flange, it must be strong enough to sustain vehicular traffic coming upon it. It is desirable that the top of guard be made slightly lower than tread, as latter wears away the quicker; dirt can be also easier cleaned from groove. For curves where the guard is subject to be ground away by friction from wheel flanges, it should be made thicker and slightly higher. The web should be so placed that its centre is as nearly as practicable below the tread, so that the resultant of the forces from rolling load of car and lateral pressure of flange shall fall well within the base, otherwise there is a tendency for the rail to tilt under the forces coming upon it. It should, of course, be perfectly vertical; in badly-rolled rails the web is often at an angle and much crippled. An example of this may be seen among the specimens shown: this was not in any way selected, but is a fair sample of the rails used. The base should be sufficiently wide to spread the superincumbent weight on the concrete underbed and to resist the side tilting motion referred to.

Standard Rail Section.

The general adoption in this country of a "standard" rail section is much to be desired. It is difficult to enumerate the many advantages that would follow therefrom. Certain it is that it would assist to great economy, simplification of detail, and more perfect rolling, and manufacturers would gladly welcome it. The cost of a set of finishing rolls alone is about £200, which is, of course, eventually borne by the consumer, and they will only suffice to roll a limited quantity of rails, so that it does not pay manufacturers to specially prepare them unless for a large quantity. With the present multitude of sections (as shown only partially by table in appendix and cartoons), which are being constantly added to, it becomes impracticable for railmakers to stock rails, but with a "standard" section rails would be kept in stock of various lengths, including those for joining up to points and crossings, which have now to be cut on the ground in a somewhat rough-and-ready manner, and at much trouble and expense. Were the disadvantages that arise from the great variety of sections at present employed, and the great advantages that would ensue from the use of a "standard" section, all detailed, but little room would remain for dealing with other matters within the limit of this paper.

Disadvantages are not so apparent in the first laying of a track, when large quantities of rails are required, but should small lots be hereafter wanted for extensions or renewals it will probably be found impracticable to obtain them of the same section without fresh rolls being made or, should rolls exist, at an enhanced price, as it costs a considerable sum to put in a set of rolls, and these difficulties will be still more emphasised with foreign sections. Imagine the result when a track becomes a patchwork of various rail sections, as has been the case on many old tramways, and is even the case in more than one instance on tracks recently constructed. Endless trouble, delay, and cost will thereby be entailed. Joints cannot be properly made, but cranking, joggling, packing, or other unworkmanlike methods have to be resorted to, with the natural consequence that trouble at the joints is quickly experienced, and rails have a very short life. A



Drawing No. 1.

"standard" section would also lead to a "standard" wheel tyre profile, giving much less trouble from broken or worn flanges and longer life—no small advantages. The considerations before mentioned particularly apply to points, crossings, and special work. Take the case of cast crossings, which are made of various angles, and which are often wanted at short notice to replace those worn or damaged. Obviously, it is impracticable to stock these of patterns to conform to the many sections, and if they have to be made, it may mean a delay of some months, whereas with a "standard" rail they would be stocked. Much greater opportunity would also be given for improvement; the present design and manufacture of points and crossings can hardly be said to have reached perfection.

The conditions to be complied with in a "standard" rail are so limited that there should be little difficulty in arriving at the best way of meeting them. We have first a rail of a minimum weight of 90lb. per yard, with a head as narrow as practicable consistent with the duty it has to perform. Experience shows that this should be about 3⅝in., made up, say, of a 1⅞in. tread, 1⅛in. groove, and ⅝in. guard. For curves less than 75ft. radius, the groove should be widened to 1¼in. and guard made ¾in. thick. In Drawing No. 1* is shown, both to natural size and enlarged four times, the profile the author would suggest as embodying the requirements of a "standard" rail. This would weigh 95lb. per yard. Except that the base width is increased, this is, in fact, very similar to one he designed some three years since for the British Electric Traction Company, and adopted by them as their standard rail; most of their lines have since been constructed with it, and it has also met with much general favour, having been adopted for use on a large number of tramways in this country, the Colonies, and abroad. (A list of these is attached to Drawing No. 2.) This section is now known as the Barrow No. 494, the Leeds No. 23, and the Lorain No. 348. With a "standard" rail, all accessories, fishplates, joint-plates, tiebars, bolts, nuts, etc., could also be standardised. Similarly, tools—such as benders, jim-crows, spanners, saws, drills, etc.—could be largely of one pattern, instead of the present multitude, some good and some

* Drawings Nos. 1 and 11 we reproduce. The other drawings mentioned were shown on the wall.

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bad. A standard specification of chemical constituents and tests is also desirable. The author suggests:

Carbon	·45 to ·55 per cent.
Silicon (maximum)	·08 ,,
Sulphur	·06 ,,
Phosphorus	·08 ,,
Manganese	·7 to 1·0 ,,

Tensile, 42 to 48 tons per square inch; elongation, 15 per cent. on a length of 8in. Tup test, one ton falling 20ft. on 5ft. piece on 3ft. supports, without causing fracture.

The present time is most opportune for a consideration of this question, as, in addition to the pronouncement of the Board of Trade, before referred to, a "Standards Committee," representative of the principal scientific societies interested, has just been appointed, at the instance of the Institution of Civil Engineers, to consider the question of standardising all sections of steelwork rolled in this country, as has already become a *fait accompli* in America, Germany, and Austria, with incalculable benefit to all concerned. As the members of this association are those now most largely engaged as tramway engineers, no doubt their views upon the desirability of standardising tramway rail sections and specifications, if put in concrete form, would have considerable weight with such committee. Rails for carhouse yard should be of the Vignoles type, detachable guards being bolted thereto where necessary; by this means sharper curves are possible. It requires from 20 to 30 per cent. more power to run cars with a grooved rail than with a Vignoles rail, due to the side friction and also to running on the dirt in grooves. When gauge is 4ft. or less, special L-shaped rails without overhang should be used for carpits, so as to allow room for taking out motors.

Rail Lengths.

Owing to the small proportion of rail area exposed, the remainder being embedded in the paving, which is practically a non-conductor of heat, variations of temperature in this country do not appreciably affect the dimensions of tramway rails when laid. With a coefficient of expansion in steel of 0·0000065, such differences of temperature simply cause a slight change in the molecular condition of the metal within its elastic limit. By the use of welded joints or rigid joint-plates, practically forming a continuous rail, lengths of several miles have been made without any provision for expansion, and this has also been the case in America, where ranges of temperature are much greater than in this country. But if a rail be wholly exposed to atmospheric effects, there will probably be a measurable difference in length at the hottest and coldest parts of a summer day. Provision should be made for this when cutting rails for closers. The longer the rail the greater will, of course, be the expansion. Until very recently tramway rail lengths were seldom more than 36ft., but as it became recognised that provision was not necessary for expansion and contraction, and that the main element in the life of rails was the joints, with a desire to eliminate as many of these as practicable, rail lengths were increased until at present 60ft. is quite usual—even 90ft. has been proposed. Whether 60ft. is the best length, or that it is preferable to one of 45ft., is more than doubtful. The main argument in favour is that the number of joints is lessened—*i.e.*, 196 per mile of track, as against 232, with a 45ft. rail. If the joints are bad and jolting, it is undoubtedly a comfort to passengers that there should be as few of them as possible, but assume that the joints are as smooth as remainder of rail—and there is no reason why they should not be so made—then all other considerations, including that of cost, favour the shorter rail. These considerations are too multifarious to detail here, but having used large numbers of both lengths, and given much consideration to the various bearings of the question, the author is of opinion that, generally speaking, the best and cheapest track is to be made and maintained with a 45ft. rail.

Rail Joints.

Even the best rails will have but short life unless connected together by thoroughly efficient joint devices, as it is at the joints that the immense vibration, twisting, and pounding effects from electric traction are mainly experienced. In America expense is not spared to secure a good joint, its paramount importance being recognised, but it is not always sufficiently appreciated in this country. Naturally the use of an efficient joint will mean some additional cost over the ordinary fish joint, but the excess will at most be 1 or 2 per cent. of total, whereas life of the track may be thereby extended 50 per cent. or more, much more comfortable and easy running ensured, and much less current consumed. Careful investigation shows that with fishplate joints the average wear is twice as great for a distance of about 12in. from rail ends as at remaining parts, so that the joint governs the life of rail and consequently of track. This detail, therefore, demands much attention, to the end that a smooth and easy riding track with long life shall be ensured. In this country fishplates have been until recently almost universally employed for connecting rail ends together; those having four or six bolts being general, but eight and even twelve bolt fishplates have been used. Long fishplates add little, if anything, to the stability or life of a joint; indeed, consequent upon the increased leverage, they are likely to become a source of weakness. Long fishplates were tried on railways, but the "survival of the fittest" shows that four-bolt fishplates are now standard practice. It seems to be inevitable that with joints formed with fishplates alone, no matter of what form, or however many bolts may have been employed, looseness is only a matter of time. The diameter of the holes in the rails and fishplates being necessarily larger than that of the bolts is one cause, and another is that it is impracticable to ensure such accuracy of profiles as will give a perfect fit between rail and fishplate. As an American authority, Pressel, says: "Even with the most perfect methods of rolling it is not possible to obtain an accurate fit between the whole length of the fishplate and the head and flange of the rail. There can never be contact over the whole length of the fishplate, but only at a few odd points, which may be anywhere. Excessive stresses are unavoidably produced in the neighbourhood of these points; when the bolts are tightened, pressures of an injurious character are set up. More particularly is this the case in the fishplates through the vertical pressure of the joint. In addition, the tightened fishplates tend to produce shearing at the head and flange of the rail, which leads to its destruction."

Experience abundantly shows that in themselves fishplates are insufficient to provide a joint calculated to permanently maintain absolute rigidity and the other requirements of electric traction. Even on tramways constructed only within the last three or four years, and with long and heavy fishplates, there are frequent instances of bad joints, and of packing being constantly resorted to, though, as a rule, the weakness of bad joints is not made manifest until after two or three years' wear, but, once started, deterioration becomes rapid. Herr K. Berger, a tramway engineer of recognised authority, says in a paper read at the recent congress of the International Tramways Association: "Practical experience has shown that with no fishplate joint can an even wear be maintained. Fishplates become loosened and bolts twisted under the severe punishing effect of electric traction." The joint must be absolutely stable and unyielding. If there is the least looseness, the blow from passing car becomes percussive or hammer-like, increasing in force as joint deteriorates, the rail ends quickly becoming surface bent. The presence of bad joints may be easily ascertained, even when one is not riding in a car, if after the business hum has ceased in a town one listens to an approaching car, when will be heard the rhythmic "bump, bump," as it passes over each bad joint. As an American writer remarks: "There is a loud pounding noise, which seems inseparable from the present form of spliced joints."

The inefficacy of fishplates has become so generally recognised that recourse is now usually made to some further device with the object of reinforcing them. Perhaps the first device to be employed for fortifying fishplate joints was in the form of a flat plate or sole-plate bolted under the base of rail, introduced under Winby and Levick's patent in 1887, and, singularly enough, first used in the construction of the Leicester tramways. Not proving entirely satisfactory, and with a view of spreading the stress over a larger area, these plates were sometimes made to extend beyond the rail base; but, as Mr. Jas. More, M.I.C.E., a tramway engineer of much experience, has pointed out, the wisdom of this is questionable, as the effect of the heavy car traffic is to cause these projections to tilt up and lift the setts above. (See Drawing No. 3.) With regard to the value generally of this device as assisting to fortify the fishplates, Mr. W. Dawson, assistant borough surveyor of Bradford, in a recent paper remarks that "sole-plates were placed under the ends of the rails, narrow steel strips were placed on the top of the bottom flanges of the rails at the joints, and the whole bolted together with six bolts. The joints still worked loose, and it is now recognised that this method is insufficient to make a perfect joint." General experience fully confirms this opinion. Further, the use of these flat plates is detrimental to the maintenance of a good track, for reasons shown hereafter.

There have been numerous later devices for the reinforcement of the ordinary fishplate joint. Among those which in themselves are practically modifications in some form or other of the fishplate principle are the Phœnix or Dicker (Drawing No. 4), the Victor (Drawing No. 5), the enclosing fishplate or continuous rail joint (Drawing No. 6), the Churchill (Drawing No. 7), and the Weber (Drawing No. 8). The success of most of these methods is largely dependent upon a more than usual accuracy of profile in rail, fish-plate, and joint-plate to enable the various parts to fit perfectly together, otherwise stresses in joint or on bolts may be set up, which were not contemplated or provided for, and any strength calculated to be given by the joint-piece nullified — indeed, it may happen that in, say, tightening the fishplate bolts, the soleplate bolts will be stripped, or *vice versâ*. When joint devices are employed which depend greatly upon perfection in fit, the surfaces should be thoroughly cleaned from rust and scale: for, as Mr. M. D. Pratt, an American authority, points out: "Rails fresh from the mills are covered more or less with a thin coat of black oxide of iron; much of this falls off during the process of straightening and handling, but there is always some adhering to the rail when placed in the track. This is one of the worst enemies of the joint, for after the latter is applied and the track is used, the jar of passing wheels reduces this scale to a thin powder. This powder, working its way out from between the rail and joit-plate, leaves the latter loose or well started in that direction. This coating of oxide or scale is also found on the joint-plates, therefore the first thing to do is to remove it from the bearing surfaces, which may be done by a hammer, file, or scraper. This matter is of considerable importance." When a fishplate is raised to form part of rail tread, it should be composed of metal of equal hardness to rail (usually fishplates are softer), otherwise the surface will "roll out" and give an appearance of stability which may perhaps hardly be warranted. Such fishplate should also have its fishbolts as high as possible to prevent the upper part becoming the long arm of a lever, with fulcrum at point of bearing of fishplate on upper part of rail base, which condition would, with car running on upper surface, tend to force the nuts and strip the threads of fishbolts.

It is questionable whether fishplates should be relied upon as the principal means of connecting tramway rails, or whether they should be considered only as an auxiliary to a more effective form of joint-piece utilising the broad flat base of rail. The following summary of a recent report of a German State Commission is evidence that this method is now favoured by engineers of experience: "They recommended that side fishplates should not be used, as it has been found better to use joint-plates which would utilise the broad lower surface or flange of rail. Light side fishplates might perhaps be used to still further assist against transverse stress; however, the experiments made showed that their use is superfluous." The utility and advantage of the base-plate method is also recognised in the Lorain

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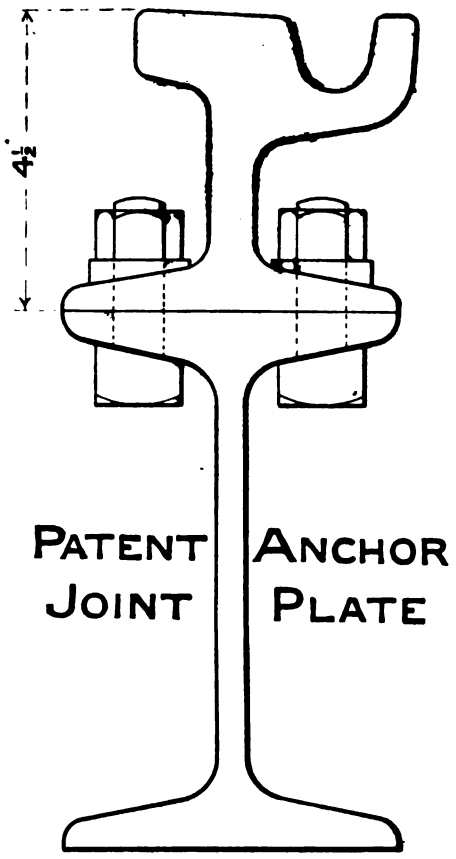
joint (Drawing No. 9), and in the Wheeler joint (Drawing No. 10), both of which have been largely used in America. It will be noticed that while there are fishplates to the Lorain joint, they do not touch the underside of rail head, and the makers of the Wheeler joint say: "There is no attempt to assist the web in holding up the rail head, as we believe the province of a rail joint is to prevent motion of rail ends by keeping the bases and webs in perfect and immovable alignment, thus insuring permanent alignment and surface of the head." At Blackpool fishplates are entirely dispensed with, reliance being wholly placed upon "anchor" joint-plates fixed to the base of rails (Drawing No. 11). It will be noticed that the rail section here used, while weighing 95lb. per yard, is novel in being only 4½in deep, the view of the engineer, Mr. Quin, who designed it, being, I believe, that as a tramway rail has a continuous bearing, and is not therefore subject to deflection, it is not necessary to have a depth beyond that sufficient for the paving, so long as ample depth and stiffness are provided at the joint, which is, in this case, attained by the "anchor" plate. A similar view is now held by many engineers, who point to the waste of material involved in a very deep rail, mainly in order that it shall have sufficient depth at the joint.

As engineer for the construction and maintenance of a number of electric tramways, the necessity for improvement upon the usual forms of rail joints was constantly impressed upon the author's attention, and he gave much consideration to the design of a joint device which, while being simple, should effectually meet the practical requirements of electric traction. He believes this has been successfully accomplished in the "anchor" joint-plate, of which he is co-patentee.



DRAWING No. 11

This is perhaps hardly the occasion to extol its merits, but the fact that some 30,000 of these joint-plates are now in use, or on order, is testimony of the favour with which they are regarded by tramway engineers generally. They have long passed the experimental stage. Over 40 miles of rails, laid under the author's direction, have been jointed with these plates, and a large number of corporation and companies' tramways have been or are being wholly or partially equipped with them. The purpose of this joint is not only to form a thoroughly rigid and efficient connection between the rail ends and make the joint as strong as the rail itself, but also to hold the rails down to the concrete underbed, thus keeping them to gauge and preventing springing, etc. Further, it provides a path for the electric current in case of the failure of bonds, and it has been successfully used without any bonds whatever being fixed at the joints. When this joint is used, fishplates may be considered as an auxiliary.

(To be continued.)

CATALOGUES RECEIVED.

An illustrated pocket list has been issued of "Fire Fly" glow lamps, which have only just been placed on the market by Messrs. J. C. Lyell and Co., of Westminster. These lamps, we understand, are the result of years of experimenting, and the voltage is guaranteed not to vary more than 2 per cent. either way, and the consumption in current more than 6 per cent. at the maximum. The variation in light, t is claimed, does not exceed 7·5 per cent. Our attention is called to the fact that the tests of these lamps are made according to the rules laid down by the Electrical Conference, only the very finest materials being used.

A descriptive list of Mr. W. G. Walker's Concavo-Convex air propeller informs us that the device is the outcome of an exhaustive series of experiments on about 100 differently-shaped blades. The blades are hollow, and have a concavo-convex section, the face being concave and the back convex; they are made of sheet steel brazed together. It is claimed that efficiency is enormously increased by means of the hollow ship-shaped section.

A little pamphlet illustrating the use of adjustable swivel bearings for line shafting, has recently been circulated by the Unbreakable Pulley and Mill Gearing Company, Limited.

From Messrs. Andrew and Co., Limited, of Reddish, near Stockport, we have received a handsomely-designed catalogue illustrating the various types of "Stockport" gas-engines, which are now enjoying an extensive sale. These range in size from 1 to 200 effective horse-power. The firm, we are informed, have recently added many important patented improvements, and have made a speciality of large power gas-engines to work with all kinds of gas.

From Messrs. G. Clark and Sons, of Shipley, Yorks, we have received a handsomely-bound catalogue of their specialities in electrical mains and feeder boxes with internal fittings, etc. Excellent illustrations and designs accompany the descriptive matter, including several views of the firm's works at Shipley. Attached to the cover at the end of this catalogue will be found illustrations of a complete system of distribution for concentric mains, showing each box complete with fittings as in actual use. We understand that this system has been successfully adopted by many of the leading distributing engineers in the kingdom. These illustrations will doubtless prove of considerable service to the profession, and for reference purposes the catalogue will be found extremely useful.

The General Electric Company have sent us an illustrated sheet descriptive of their "Papristeel" conduit, which they are putting on the market. Very similar to the "Union" enamelled steel conduit as regards its merits, the "Papristeel" conduit, it is claimed, has the further advantage of increased insulation It is manufactured of paper tube drawn over with the "Union" steel conduit, the whole being enamelled inside and outside and stoved together, thus forming a highly-insulating damp-proof and mechanical protecting conduit. From the same firm we have received a copy of their well-illustrated Glasgow Exhibition souvenir, part 1 of which is devoted to polyphase machinery, while continuous-current machinery forms the subject of the latter half of the issue. We are informed that the firm are erecting at Witton, near Birmingham, new works, to enable them to cope with the increasing demand for their polyphase and continuous-current machinery. The new buildings are expected to be in full working order within the next three months.

The International Electrical Engineering Company have just issued new price-lists of their entirely enclosed continuous-current motors and of arc lamp carbons as turned out at their remodelled Liège factory. We have also received from this firm a number of photo prints which show the wide range of their manufactures in dynamo machinery, multiphase plant, etc., and these, we think, will give an excellent idea to the would-be purchaser of the construction of the machinery. Among the photo prints we particularly notice an illustration of a 1,000-kw. alternator which was exhibited at the Paris Exhibition, and of a combined rheostat and starting switch for working electric cranes. This latter is an exceedingly neat device, as it enables three-phase motors to be started in either direction and the speed to be regulated at will. Another illustration shows a 35-ton travelling crane, with switch motors and starting switch, from an actual installation in a stone quarry, and yet another, a 60-ton Titan crane for the same use. Among the remaining photo prints we notice illustrations of a new electric locomotive for blast-furnace service and a type of tramcar motor which has been standardised by this firm.

Messrs. Baker and Co., manufacturers of platinum for all purposes at Newark, N.J., have recently issued a handy little pocket-book containing some useful notes upon the use of platinum ware and several valuable tables of weights.

A well-illustrated catalogue recently issued by the New York and Franklin Air-Compressor Companies, illustrates and describes the latest types of New York - Franklin air-compressors. These are especially designed for the operation of pneumatic tools and machinery in machine shops, shipyards, foundries, mines, etc. The catalogue also contains much valuable information and data relating to the points to be considered in the selection of air-compressing machinery and its proper installation in the attainment of economical results.

Messrs. Shipham and Co., Limited, of Hull, send us a copy of their newly-issued list of expansion joints for steam-pipes. This firm are now regularly producing these in wrought copper, mild steel, etc., and from the illustrations given the joints appear to be of good design and finish. Messrs. Shipham and Co. also turn out from their new extensive works at Hull high-pressure steam valves and fittings in different sizes and classes.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the

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question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

395. A fault is located to a length of cable between two disconnecting boxes. What is the quickest and best way of locating the actual position under each of the following conditions: (*a*) cable vulcanised and braided only; (*b*) cable lead covered and lead earthed; (*c*) cable lead covered and laid in compound, the lead being practically insulated from earth? The fault is of low resistance.—E. D. W.

396. Give a diagram showing the connections for the starting resistance, with interlocking switch and maximum cut-out for a three-phase motor; also the connections for reversing the direction of rotation of same, the motor to be worked off the lighting mains.—C. S. M.

ANSWERS.

***Question No.* 387.—It is contemplated to transmit power to a direct-current lighting station a distance of five miles, by means of three-phase alternating current at 10,000 volts pressure. Which of the following systems of conversion would be best: (*a*) synchronous motor-generators; (*b*) asynchronous motor-generators; (*c*) transformers and rotary converters. Consider capital cost, over-all efficiency, and practical ease and safety in working.**

Best Answer to No. 387 (*awarded* 10*s.*).—The best way of treating the question will be to first of all compare the three different systems under the headings of "Practical Ease and Safety in Working," "Over-All Efficiency," and "Capital Cost."

Ease and Safety in Working.—The asynchronous motor-generator is much superior in this respect to either of the other systems, as the motor can be switched directly into the high-tension mains, rotor resistance cut out, and the continuous-current machines regulated in the ordinary manner. These motors are necessarily worked with a very small air-gap, which must be watched, but granted this, no trouble need occur. The synchronous motor-generator has to be run up to synchronism by means of an auxiliary induction motor, and excited before being switched on to the high-tension mains; and this induction motor must be fed from a step-down transformer. When once continuous current is available, either from other motor-generators or from a battery, the motor-generators can be run up from the continuous-current side, and the auxiliary motor dispensed with. If any part of the generating or sub-station machinery is badly designed, the synchronous motors may hunt, but otherwise there are no particular difficulties in their working. The rotary converter is by far the most complicated machine of the three, although when properly designed and worked it is the most efficient. As the ratio between the pressures on the direct and alternate current sides is a fixed quantity, step-down transformers have to be used, which means another chance for things to go wrong. When the current on the continuous side is used for lighting, as in the case under consideration, the converters cannot be started up on the alternate side, as the heavy current they take would upset the regulation. This means that an auxiliary motor has to be used for starting up the first rotary converter. If both the sub-station and generating plant are not both very carefully designed, the rotary converters will hunt. This especially applies to the power-house engines, the cyclic variation of which should not exceed $\frac{2}{p}$ degrees, when p equals the number of pole-pieces on the direct-coupled alternator.

Over-all Efficiency.—A good asynchronous motor-generator of 500 kw. will have an efficiency of about 86 per cent. and a power factor of 91 per cent. at full load. At half-load the efficiency will have dropped to 80 per cent. and the power factor to 88 per cent. The overload capacity of the above machine would be about 25 per cent. for one hour. A synchronous motor-generator of the same output will have about 1 per cent. higher efficiency at full and half loads, but owing to the peculiar properties of the synchronous motor the power factor can be adjusted to unity. The overload capacity of this type of plant will be about the same as the asynchronous motor-generator, being governed in each case by the continuous-current machine. With rotary converters we have the maximum efficiency and overload capacity of the three types. Taking a 500-kw. set as before, and including the step-down transformers, the efficiency at full and half-load will be 92 and 87 per cent. respectively. The same remarks about adjustment of the power factor apply to the rotary converter as well as the synchronous motor—in fact, converters are often compounded to give a 95 per cent. power factor with a leading current at full load and a 100 per cent. power factor at half-load. In the matter of overload capacity, the rotary converter has a distinct advantage over both the other types of machinery mentioned, being about 75 per cent. for one hour.

Capital Cost.—We will make a comparison of relative prices per kilowatt of a 500-kw. set of each type, including regulating gear, transformers, auxiliary motors, etc. The asynchronous motor stands first, and, taking its relative cost per kilowatt at 100, we have the synchronous motor-generator costing 84·5 and the rotary converter 83·5 per kilowatt.

Taking all things into consideration, it would seem that in cases where a small amount of power only is required asynchronous motor-generators are best, as their simplicity of handling cuts down the wages bill at the sub-station; while the question of efficiency is not so very important. Where a large amount of power is required for lighting the synchronous motor-generator would seem the best, as its efficiency and power factor are high, while as the load does not vary very rapidly, fresh sets can be put in or taken out, so that the machines are always working at near full load. In any case where a battery is used synchronous motors are best, as then their simplicity of operation rivals the asynchronous motor, while their power factor and efficiency are higher. In large power and traction schemes rotary converters would seem the best, as their high efficiencies at half-load and their large overload capacities render them very suitable for any case where the power required varies very rapidly.—J. P.

Answer to No. 387 (*awarded* 5*s.*).—As no figures are given of the power to be transmitted, it is assumed that we have 2,000 h.p. to convert from alternating to continuous current at the receiving end of the line; the size of the transforming units to be of 500 kw. in each of the three cases.

(*a*) With the employment of synchronous motor-generators the motor would be of the revolving-field type, the stationary armature of which would permit it being wound for 10,000 volts without any serious trouble. One or two dynamos could be used, and if the three-wire distribution is in use a dynamo would be coupled to each end of the motor shaft and connected in series. For exciting the motors, this is preferably done by means of asynchronous motor-generators fed from step-down transformers; these sets would also be used for starting the first main unit and synchronising from the direct-current side, after which this unit would supply current to start any of the other main units. The starting of the main sets from the alternating side could not be allowed in consideration of it being a lighting system; another method of starting is by means of an induction motor fixed on a bracket, and coupled to the end of the main unit shaft. This motor is fed from a step-down transformer. The efficiency of the sub-station would be approximately 85 to 86 per cent. with a power factor of unity at full load, and at half load 77 per cent.

(*b*) By using asynchronous motor-generators the cost of winding the motors for 10,000 volts would be equal, if not more, than the employment of step-down transformers in conjunction with a lower-voltage motor, as the amount of slot insulation would necessitate a much larger size being taken than the normal. The rotor of the motor would be provided with slip rings for the insertion of resistances, to enable the motor to start with a minimum current consumption. The one or two dynamos would be coupled to either end of the shaft, as in the previous case; regulation could be arranged by resistances in the rotor circuit, but is preferable, as in the synchronous motors, to regulate from

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the direct-current side only. The starting and running of this type of plant is the simplest of all three systems, but the lagging currents in the line are objectionable, and which necessitate the motors being run at their normal output. These machines are not to be recommended for sub-station work of the size in question; their limit lies in the proximity of 80 kw. to 100 kw. The sub-station efficiency with this type of plant would approximate 84 per cent. at full load with a power factor of ·8, at half-load 72 per cent. with a power factor of ·7.

(*c*) Rotary converters have to work in conjunction with step-down transformers, the voltage between the slip rings depending entirely upon that required at the terminals of the direct-current side; with three-phase converters, the voltage between the slip rings being 61 per cent. of the direct-current side. The running and regulation is more complicated than either of the two previous systems. The rotaries would be started from the direct-current side, and fed by an asynchronous motor-generator; they could be started from the alternating side, but on the present lighting circuit this is absolutely out of the question. The rotary does not operate well at a higher periodicity than 40, but if a power system alone is to be used, a periodicity of 25 will give the best results. The rotary runs at a synchronous speed, and has a very large overload, and, like the synchronous motor in (*a*), it can be made to give either a leading or lagging current by altering the excitation; it is more liable to hunt than the synchronous motor. The efficiency of the sub-station would be about 91 per cent. at full load with a power factor of unity; at half load the efficiency would be 87 per cent. These efficiencies are calculated from the high-pressure input to the low-pressure continuous current, and include all transformer losses, etc. When using three-phase transformers, the mesh connection is much to be preferred, for if one phase of the transformer broke down, it could still feed the sub-station machinery with three-phase currents, although at a reduced power.

For the scheme in question, synchronous motor-generators should be used, as described in system (*a*), with the asynchronous sets for exciting and starting the main units. The motors being synchronous, the regulation on the direct-current side could not be bettered in view of the constant lighting load. Although the synchronous sets are about 6 per cent. in combined efficiency less than that of the rotaries, and the cost about 2 per cent. higher than the rotaries, it is compensated by the better parallel running and regulation, and the greater simplicity of switchboard connections of the synchronous machines. Also they can be operated at any frequency, which would bar the rotary. The floor space occupied by the synchronous and asynchronous machines are about equal, while the rotary occupies a space approximately of 5 per cent. less than any of the others. The efficiencies and costs given above have included all losses in the sub-station and the cost of necessary switch gears; also that no direct current is available in the sub-station.—JUNO.

Answer to No. 387 (*awarded* 5*s.*).—The question is divided into three portions—viz., conversion by (1) synchronous motor-generators; (2) asynchronous motor-generators; (3) transformers and rotary converters.

1. Synchronous motors are generally of the revolving field type, the current for exciting the fields being led into the field by means of slip rings and brushes. The synchronous motors require special apparatus for exciting this field, and some special motor must be provided to bring these motors up to speed before switching in. Skilled attendance is necessary with this type of converter.

2. Asynchronous motors have none of the special field-exciting apparatus or starting motors, as the synchronous. The apparatus for these converters is very simple. No starting gear has to be provided beyond a simple rotor resistance for the motor, and as there is no synchronising to be done, skilled attendance is not specially required. A handwheel, which regulates the rotor resistance and stator starting switch, takes the place of the ordinary valve on an engine. Neither of these methods require transformed current, as the construction of the motor lends itself so well to high insulation that they can be satisfactorily and cheaply built for the high pressure of 10,000 volts. The trouble with the high pressure is in the starting gear, and not the motor, but there is little to fear in this respect now.

3. Rotary converters and transformers: This method is far more complicated than either of the others, and even under the best conditions they cannot compare for simplicity with the others in working. The rotaries must be operated at low pressure, involving the use of transformers. Another difficulty presents itself in pressure regulating. With the first two the regulation is performed wholly on the direct-current portion, each part, the motor and generator, being electrically separate. With a rotary converter the magnetic field is the same for both motor and generator, and requires special apparatus for regulating the current.

The capital cost of the systems is as follows, the cost being given per kilowatt for 500-kw. sets:

	Synchronous.	Asynchronous.	Rotary.
Cost	13·2	15·6	13
Efficiency	87 %	86 %	92 %

In summing up, we find that the rotary system leads the way for cheapness and efficiency, but is more difficult to work than the others. Asynchronous systems are the highest in cost and also worst as regards efficiency, but are easiest to operate. Synchronous systems are generally used in work of any magnitude in spite of the skill required to operate. It may be noted that a converter station will require a skilled attendant in any case, and asynchronous motors are found unsuitable for large work. An advantage possessed by the asynchronous motor would be found on a short developing on the direct-current side and overloading one of the motors, the machine would slow down, and upon the fault burning out would speed up again, but a synchronous motor would stop, and considerable difficulty would be found in starting again. Perhaps the best plan would be to have one of the generators in each station of the asynchronous type, and from the direct current generated the synchronous motors could easily be started. If rotary converters are used the frequency must be low, and the machines will start with about 30 per cent. above full load, and will stand about 2·5 times full load without the least instability.—F. M. M.

***Question No.* 388.—In a large continuous-current central station it is believed there is a consumer using his current to earth. Which is the best way to detect and locate consumer?**

Best Answer to No. 388 (*awarded* 10*s.*).—If a consumer is using current to earth, it means that he has connected his neutral wire to earth. If his meter is properly connected up this would not enable him to cheat the supply company, as all meters should always be put in the outers. Such a state of things, however, is very undesirable, and, of course, contrary to Board of Trade regulations. The remedy is an easy one. We will suppose we are dealing with a 200-volt three-wire supply with neutral earthed at station through a fuse in the ordinary way. Proceed as follows: First remove the neutral fuse so that the neutral main is insulated, then put the positive main direct to earth through an ammeter, and small amount of resistance if necessary. If the insulation of the mains is good, however, it will not be necessary to use a resistance, as the object of the operation is to remove the earth, if such exists, by blowing the consumer's fuse. Watch the ammeter at instant of connecting outer to earth. If another earth exists on neutral main, a large current will result. The ammeter may go hard over for a second and then fall back to zero. This shows that the earth has been removed, but does not tell us *where* it existed. If the consumer is not very smart he *may* ring up for his fuse to be replaced, when detection should be easy. No doubt he would first remove the earth connection, but the fact of his fuse going at the time the outer was earthed at the station would be suspicious. Further, it should be noted that whether the consumer is on positive or negative side of system, only his *neutral* fuse would be blown by earthing at the station. Hence, if it is found that only the neutral fuse has been blown, and that by an evident "short" it is pretty certain that irregular use was being made of the current, as it would be impossible to blow *one* fuse only by a short on an installation provided both fuses were the same size. If, however, the consumer elects to replace the company's fuse himself, and say nothing, detec-

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tion is a little more difficult; but in a well-conducted station, the fact that the company's seal had been broken and a fuse of irregular type inserted, would be noted by the meter inspector at the next reading. Here, again, the fact of only the neutral fuse having been blown would be of assistance. It may happen that one or more street fuses will be blown at same time. If so, this would give the locality. This *might* also be estimated from the throw on the feeder ammeters at the moment of earthing, as the feeder nearest the earthed neutral would show the largest momentary increase in current. It has been assumed in the above that the consumer has earthed his neutral *without removing his neutral fuse*, so that the latter is simply shunted by the earth connection. If, however, he removes his neutral fuse when he makes connection to earth, the effect on his installation of the operations described at the station will be rather different. In the first place, as soon as the neutral fuse is removed at station his lamps will go out, or nearly so, as they will only be receiving the current due to the leakage from the system. Secondly, the effect of earthing the outer at station will depend on whether the positive or negative pole is earthed. Suppose consumer is on positive side and positive pole is earthed at station, his lamps will be put out, since the positive main assumes earth potential. If, however, the negative pole is earthed, the positive pole will assume a potential of about 400 volts from earth, and this will be the pressure across his lamps. The result would be to blow his positive fuse, and in all probability break and blacken some of his lamps. These latter effects will occur after his *neutral* fuse has been blown, as described in former part of this answer, unless he has taken the precaution to put a fuse in his earth connection, in which case such fuse would be blown and his lights put out.—E. M.

Answer to No. 388 (*awarded* 5*s.*).—As the system is a large one, it will almost certainly be a three-wire one. Now, as the consumer is intending to cheat the company, there are two ways he may set about it if the middle wire of the supply system is not earthed. He may either connect high-voltage lamps between the positive outer and earth, and hence get more watts whilst paying for current at the low-voltage rate; or he may connect lamps or electrical appliances between the middle wire and earth, as he has probably found out that there is no meter on the cable connected with this main, and that there is a difference of potential between it and earth. Now if there is a recording voltmeter between the positive outer and earth at the central station, in either case when the consumer is sending current to earth there will be a sudden drop on its voltage, hence the time at which he lights his lamps or works his appliances can be accurately determined. If he has merely lamps connected between the positive and earth, then by putting an artificial resistance between the negative and earth, and varying this at the required time so as to alter the potential of the positive outer and make his lamps blink, then by having men to watch outside the houses of the suspected consumers he might be detected. It might be simpler to stop him doing it by earthing the negative outer for a few minutes so that the sudden rise of pressure might burn out some of his lamps.

The second case, when he filches current from the middle wire, would be more difficult to detect. More drastic measures would have to be applied. Small sections of the circuit might be cut off for half a minute or so night after night until the section was found where the voltage of the positive outer rose suddenly when it was cut off. The culprit would then be in this section, and his detection would be easy. Most engineers would, however, put up with a great loss by earth current before they would attempt this method of detection. They would probably instruct their meter inspectors to keep their eyes open on their rounds, and to be very suspicious when the fuse of the middle wire was gone, the positive fuse remaining intact. J. C. R.

Answer to No. 388 (*awarded* 5*s.*).—A consumer would not earth his installation purposely unless it was to benefit himself at the expense of the electric supply company or corporation electricity department. If from laxity on the part of the official responsible for the fixing of the meter it had been placed on the middle wire instead of one of the outers, then a consumer by earthing on his side of the main switch, and disconnecting his main fuse on that pole, would cut out the meter and so be obtaining his energy for nothing. By noting when this earth appears on the recording ammeter, and knowing the periods of load of certain consumers, testing a few of the doubtful ones may lead to the detection of the fault. By this method the writer has located earth faults on a consumer's installation. This applies especially to consumers with a motor load.

If this simple procedure should not be successful, it will be necessary to submit the network to an exhaustive test. The first thing to be done is to split the network into distinct small sections, each section having a feeder to the station; this presumably would be an easy matter on a large continuous-current network. Each section should then be tested separately, using the battery for the supply, the remainder of the network, of which the middle wires are not earthed, being supplied by the generators. The section under test is the only part connected to earth. When the fault has been located on a section, small parts should be taken off and transferred to the main network, and this continued until the fault is located between two boxes. Each installation on this small section should be carefully tested and examined to see if any meter is on the middle wire. This should detect the delinquent; if not, he is too sharp for the engineer. Another method would be, when the faulty section had been found, to earth each outer separately instead of the inner, so causing a short-circuit on the consumer's installation and blowing the corporation main fuse. He would be forced to send to have his fuse renewed, and would be caught in a trap.—W.

***Question No.* 389.—A corporation with a continuous-current electricity supply are contemplating the hiring out of motors, and require a scheme to be fully worked out and submitted to them for approval. What are the essential points to be observed in the drawing up of this scheme, more particularly with regard to the borrowing and repayment of loan?**

Answer to No. 389 (*awarded* 7*s.* 6*d.*).—If a municipality requires to borrow any money for the erection or extension of any electricity works, power must first be sought to do so from the Local Government Board, who, by virtue of the Electric Lighting Act, have power to grant a loan. An important condition of the Act is that the money must only be expended on "permanent works" a period of 10 years. As the hiring of motors does not come within the meaning of this category, according to the Local Government Board, they will not grant a loan for the hiring of motors, arc lamps, etc., notwithstanding that dynamos for generating the energy are within the Act. A somewhat similar clause is used in the Gaslighting Acts, but this has been construed to include the hiring out of gas-engines, gas-stoves, etc. There is no reason why the same clause in the Electric Lighting Act should not have the same wide meaning, and so include motors, etc. As an expedient, the money could be raised by a special rate, which could be redeemed when powers were granted, which will eventually be done in the near future. In Bolton, where the Corporation do the wiring, the capital for this was specially appropriated from the moneys borrowed for electric lighting, and that proportion which has been expended is paid back annually.

In any electric lighting station it is the standing idle of the machinery during the daytime which prevents a fair profit being made. This was the chief cause for the introduction of the motor hiring system by Mr. A. H. Gibbings, late chief engineer to the Bradford Corporation in November, 1896. It is not so much the profit made by a supply of current, but the keeping of the machinery running at the station on a "day load" which is the chief factor in the economical production of electricity. Another point in favour of the hiring out of motors is consumers generally are not to be trusted with the purchase of a motor. The majority would go for a cheap type, which is always being repaired, and so discouraging others in the use of electricity. It works much better from both points of view for the corporation to supply a good motor, either on the hire system or the hire purchase system. From experience it

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has been found that consumers are so pleased that they often buy their motors outright after the first quarter's running. A motor load has increased the output of some stations no less than 50 per cent.

The charges to be made for the hiring of motors are based under three headings: (1) interest; (2) sinking fund; (3) depreciation and repairs. The interest may be taken at about 3 per cent. The sinking fund will vary according to the time over which the capital is borrowed. This is usually about 25 years, which is equal to about 3 per cent. per annum. The life of the motor may be taken as 10 years, which gives depreciation 10 per cent. per annum, and the repairs may be taken at 4 per cent., which gives a total annual rental charge of 20 per cent. of the cost of motor, starting switch, etc. The annual charge has been reduced in Bradford to 10 per cent., and the extra 10 per cent. allowed for in the charge for current.

The following are about the general annual rental charges: ½ b.h.p., £1. 10s.; 1 b.h.p., £2; 2 b.h.p., £2. 10s.; 3 b.h.p., £3; 4½ b.h.p., £4; 6 b.h.p., £5; 7 b.h.p., £6; 10 b.h.p., £8.

A special set of regulations should be fixed up near each motor, and special agreement forms signed by the consumer. The corporation should undertake the fixing of the motor and starting switch, the foundations and wiring to be left to the consumer. The department could also supply oil, brushes, etc.—W.

Answer to No. 389 (*awarded* 7*s.* 6*d.*).—I would suggest the following scheme, and as doubtless a good many customers would prefer to purchase their machines outright, I take the liberty of making this suggestion and provision for it—viz.: The supply corporation to prepare and publish a list of electric motors, with powers, speeds, and prices for purchase, and also giving the cost per annum of hiring. The cost of maintenance should also be estimated, together with the cost of running for one year. It would also be well to mention the number of volts, amperes, and Board of Trade units required per hour. It should also be stipulated that the motors must be provided by the supply corporation, as also the necessary starting and regulating contrivances—*e.g.*, switches, resistances, etc. The purchase price should be arranged to give at least 5 to 10 per cent. profit to the supply corporation on the motor itself, and, of course, all accessories would yield a good profit. Assuming that it is desirable to make the hiring terms appear as low as possible, it would be well to mention that the annual hire would be equal to only a charge of 10 per cent. for depreciation, and a stipulation should be made that the corporation shall do all repairs or get them done at a certain place, so that the corporation might know how all its motors were used—whether well or badly. Commutators should be all that would want attention from year's end to year's end, and this would be charged for according to size, say from 15s. for small ones, up to 50s. or 60s. for large ones each time, all that would be necessary being to put the commutator in a lathe and to turn it truly round and smooth. Once a year should be often enough for this. More serious repairs, such as putting a new commutator, or repairing insulation would be charged for specially according to circumstances. All motors should be well made, and provided with bearings of anti-friction metal, and if properly and carefully used they should last at least 20 years without any further repairs than that above mentioned to the commutator, and so a good profit would be made on a basis of 10 per cent. for depreciation. Careless or wilful damage must, of course, be paid for. A meter should be provided for each customer on the usual terms, or on the same terms as the motor itself.

With regard to the loan of money, this cannot be borrowed on the security of the machines, because they would be in too many places, and would be subject to accident; and security on the current supplied would not be acceptable, because the whole thing would be too much of a venture, at least until the success of the undertaking was assured. Of course, if the corporation goes in for an extension of business it must take the risk, and get a loan accordingly. No lender could be expected to take such a risk unless some very enterprising motor-maker might be found willing to do so in order to get business, and then most likely his machines would be bad and unsatisfactory in proportion. Therefore the corporation would have to borrow in the ordinary way upon the security of its business generally, plant, leases, buildings, etc. If all machines could be sold outright at first a profit might be made from the first start, and no need would arise for a loan, but this is hardly probable. It is much more likely that the greater proportion would have to be lent on hire, as customers would naturally hope to increase their business in the course of a few years, and so would expect to want larger motors or to increase the number of small ones.

Assume the case of a motor hired out for 10 years and its cost to be £100, the annual charge being £10—*i.e.*, 10 per cent. depreciation—and the corporation professing to rely upon the sale of current for profit; and suppose that the corporation borrowed the £100 at 5 per cent. interest and paid cash for the motor. This is an extreme case, as the corporation would get a little discount from the makers, and so the motor should not cost more than, say, £90 at the most, and the customer would pay a good price for extras, fixing, and connections generally, such as resistances, switches, and starting appliances, so that a profit of £10 or £20 should be made immediately, and, therefore, say only £80 would be left to pay interest on. The cost of depreciation being £10 a year, this would be repaid in eight years, but interest on the loan of £80 at 5 per cent. would in eight years amount to £16, so that the total amount of loan and interest payable would be £96, and, therefore, the total time required for the extinction of the debt would be 9⅔ years. The corporation would therefore have paid for this motor in rather less than 10 years, and would then still possess it. This machine should then be worth at least £50 in the open market, and to the corporation it should be worth quite that if a thoroughly good machine to start with, as it is not probable that these machines will be superseded for a good many years, if at all. During this time the machine would have used a good lot of current, and would, therefore, have equalised the load curve and done its fair share towards earning a dividend. Machines let out on this basis would prove very remunerative. Some supply companies encourage this class of work by making a lower charge for current during the day than during the evening, but this is a matter for local consideration.—F. G. A.

SUNDERLAND.

Mr. John F. C. Snell, A.M.I.C.E., F.G.S., M.I.E.E., M.I.M.E., etc., borough electrical and tramways engineer, has just issued his report for the year 1900. Mr. Snell considers that in spite of difficulties arising from the high price of materials, and also from the fact that the department has had to expend a large capital outlay upon machinery for tramway purposes (part of which has only been earning revenue during the last year), the results on the year's undertaking will be deemed extremely satisfactory. The number of lamps connected on March 31 was 50,092, as compared with 35,024 on March 31, 1900, representing an increase of 43 per cent., as compared with an increase of 36 per cent. for the previous year. The number of units sold was 1,218,768, as compared with 640,079 during 1900, representing an increase of 90 per cent., as compared with 35 per cent. increase during 1899. Some of this increase is due to the units sold to the Tramways Committee, but these only represented 256,240 of the total number. The above figures clearly show the rapid growth of electric lighting in the borough, and applications now being received show a continued and steady rise. The increase of the undertaking is shown by Table I.

TABLE I.

Half-year ending	8-c.p. lamps connected.	Max. load in kw.	Number of consumers.	Capacity of station, kw.	Total units sold.
July 1, 1895 ...	2,894	34	83	—	8,324
April 1, 1896 ...	7,724	127	95	—	36,972
Sept. 30, 1896...	8,764	117	104	—	35,352
April 1, 1897 ...	12,672	219	125	—	111,033
Sept. 30, 1897...	13,771	202	142	—	68,631
April 1, 1898 ...	20,803	360	185	—	201,721
Sept. 30, 1898...	21,839	315	250	—	151,792
April 1, 1899 ...	25,617	414	340	—	320,551
Sept. 30, 1899...	30,654	450	387	—	197,215
April 1, 1900 ...	35,024	682	448	—	442,864
Sept. 30, 1900...	42,262	892	580	2,330	318,622*
April 1, 1901 ...	50,092	1,114	640	2,330	900,146*

* Lighting and traction combined.

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TABLE II.

A	B	A+B	C	C-(A+B)	(A+B)-C	D	E	E-D	D-E
Works costs.	Standing costs.	Total.	Revenue.	Profit on station.	Loss on station.	Resulting profit.	Sinking fund and interest.	Charge on rates for the year.	Net profit on station for the complete year.
£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
74 16 3	515 12 5	590 8 8	482 3 8	—	108 5 0	714 13 11	1,357 6 1	642 12 2	—
174 17 0	685 15 2	860 12 2	1,683 11 1	822 18 11	—				
199 13 1	670 4 8	869 17 9	780 17 3	—	89 0 6	690 7 2	1,672 12 10	982 5 8	—
448 1 5	706 1 6	1,154 2 11	1,933 10 7	779 7 8	—				
328 10 9	800 15 6	1,129 6 3	1,103 9 2	—	25 17 1	1,674 3 10	2,256 15 11	582 12 1	—
621 5 9	826 10 4	1,447 16 1	3,147 17 0	1,700 0 11	—				
660 3 5	1,116 16 7	1,777 0 0	2,145 7 8	368 7 8	—	2,865 17 9	2,501 6 5	Nil.	364 11 3
1,131 5 4	1,151 6 10	2,282 12 2	4,780 2 3	2,497 10 1	—				
972 19 6	1,414 0 8	2,387 0 2	3,027 11 8	640 11 6	—	4,047 6 4	3,580 10 9	Nil.	466 15 7
1,773 9 11	1,596 16 5	3,370 6 4	6,777 1 2	3,406 14 10	—				
1,673 0 4	1,741 15 5	3,414 15 9	4,396 17 8	962 1 11	—	7,253 14 9	5,996 14 7	Nil.	1,257 0 2
3,680 3 0	2,177 9 7	5,857 12 5	12,129 5 5	6,271 12 10	—				

Mr. Snell says the last year has been accomplished without accident of any kind whatsoever, and is glad to report that all the plant has been satisfactorily overhauled by the staff, and the whole installation is in a thoroughly sound and satisfactory condition. During the last year four new steam dynamos for tramway purposes, each of 450 i.h.p. have been added, together with complete surface-condensing plant, and recooling tower for the circulating water, four Galloway boilers, with fuel economiser, and induced-draught fans, and this new plant has worked most satisfactorily. The installation of the above has utilised the whole of the available space at Dunning-street. Coal-handling apparatus is also being fixed, part of which has been working for some months, and has proved of great benefit to the efficiency of the station.

During the year the negotiations with the Hetton Coal Company for the purchase of the Hylton-road site for a new station have been satisfactorily concluded. Contracts for all the plant have now been let (with the exception of the coal gantry). The buildings are making rapid progress, and the first boiler will be delivered on the site the week after next. There is, therefore, every prospect that this new station will be so far completed as to deal with the increased demand this winter beyond that supplied by the Dunning-street station. Mr. Snell says the site obtained is an excellent one, both as regards position, foundations, coaling facilities, and water, and upon it some 15,000 h.p. can be laid down. This would suffice for the purpose of supply to all the borough south of the Wear, but in years to come it would be necessary to construct another station on the north side for supplying that portion of the borough.

Table II. gives a statement of the works expenditure and receipts for each respective half-year from Sept. 30, 1895, to April 1, 1901. The actual capital outlay on the undertaking to March 31 is as follows: buildings, £15,366; machinery, £51,030; mains, services, etc., £44,540; meters, instruments, etc., £6,896; professional services and incidentals, £2,082; public arc lamps, £2,000—total, £121,914; representing £52 per kilowatt installed. The year's profit on the station—*i.e.*, the sum available as dividend were the concern a private company—was £7,254, or 7 per cent. on the average capital outlay for the year. The sinking fund and interest was £5,997, leaving a net balance of £1,257 to the credit of the department. The enormous rise in the price of coal, the average price having been 14s. 9d. per ton as compared with 6s. 3d. three years ago, has represented an increased cost to the station of £2,315. Happily, this cost is now on the downward grade. The cost per unit shows in every item (except coal, repairs, and rates) a reduction on the previous year. The cost of coal has been increased by ·06d. per unit, the rates and taxes by ·02d., and repairs by ·02d., the engineering costs being 1·33d. per unit, as against 1·48d. for the previous year. The works and managerial costs are 1·82d., as against 2·1d., and the total costs 3d., as against 3·44d., or a reduction of very nearly ½d. per unit, the average revenue being 3·25d. per unit. Compared with other stations, Sunderland stands fourth in the list of 118 stations for charges to consumers—viz.: Cork, 2·52d.; Nottingham, 2·87d.; Manchester, 3·24d.; Sunderland, 3·25d. The following summary will be found interesting:

	1901.	1900.	Difference.
Coal	·82d.	·76d.	+ ·06d.
Oils	·08d.	·09d.	- ·01d.
Wages	·28d.	·50d.	- ·22d.
Repairs	·15d.	·13d.	+ ·02d.
Total	1·33d.	1·48d.	- ·15d.
Rent, etc.	·14d.	·12d.	+ ·02d.
Management	·35d.	·50d.	- ·15d.
	1·82d.	2·1d.	- ·28d.
Sinking fund and interest	1·18d.	1·34d.	- ·16d.
Total costs	3d.	3·44d.	- ·44d.

The next table (III.) records the efficiency of the station. The increase in the units used at the station are due to the installation of motors for driving the cooling fans and the coal-handling apparatus, but the total efficiency of the station has risen from 85 per cent. to 88 per cent., a result which is practically its maximum limit.

The report closes with some highly complimentary remarks about the excellent services of the whole of staff, especially the superintendents of the various departments.

TABLE III.

1900-1901 (units generated, 1,331,844.) Items.	Units.	Per cent.	1899-1900 (units generated, 746,753). Items.	Units.	Per cent.
Station	51,247	4·78	Station	18,269	2·43
Battery	6,221	0·59	Battery	7,928	1·06
			Alternator	5,533	0·73
Mains	55,608	5·08	Mains	74,944	10·00
Units sold	879,336	81·79	Units sold	559,897	75·05
Public arc lamps	83,192	7·76	Public arc lamps	80,182	10·73
Traction	256,240				
	1,331,844	100·00		746,753	100·00

COMPANIES' MEETINGS AND REPORTS.

ELECTRICAL POWER STORAGE.

The ordinary general meeting of the shareholders in this Company was held at the offices, 4, Great Winchester-street, when **Mr. John I. Courtenay,** who presided, moved the adoption of the report and accounts, which appeared in our last week's issue. He said that everything was being done to keep the works in a first-rate condition and to secure the most up-to-date plant. They were still adding to their contingent fund, which was commenced to provide for any exceptional outlay which might occur on account of their numerous maintenance contracts. Though these maintenance contracts had been running since 1891, they had so far never had occasion to make use of the fund, and this was undoubtedly due to the fact that they steadfastly refused to obtain immediate business by quoting such low maintenance rates as must inevitably entail serious loss in the course of a few years. A company which had recently been established in London, and which had been successful enough to supply cars to her Majesty the Queen, and other notable personages, was now using E.P.S. cells, the Company having been able to give them a battery occupying the same space and of the same weight, but having an output 60 per cent. above that given by the battery of foreign manufacture which came over with the original vehicles. Among the larger contracts completed during the year he might mention extensions for the Corporations or Urban District Councils of the following places: Wigan, Walsall, Bristol, Whitehaven, Doncaster, Bradford, Rotherham, Perth, Motherwell and Ilford, and they commenced the new financial year with work in hand for similar contracts sufficient to keep their factory busy for some considerable time to come. They could, therefore, congratulate themselves on the position of the Company and its prospects, though competition left only a small margin of profit. Indeed, they were constantly hearing complaints about the very low prices which were at present ruling for accumulators.

Sir James Pender, Bart., seconded the motion.

The **Chairman,** in answer to Mr. J. W. Barclay, stated that, having been in the accumulator business from the beginning, he was becoming rather hardened in reference to the reports and statements which were frequently circulated respecting new accumulators. As regarded the latest—the one which was said to have been invented by Mr. Edison—the directors had carefully studied what had been stated about it, and they were of opinion that the ascertained results would not cause any material revolution in secondary battery practice. The Company obtained from the best lead cell an output, weight for weight, equal to that in question. As regarded its cost of manufacture and its durability—the most important factors—the directors had not as yet sufficient data to go upon to enable them to form a reliable opinion.

The motion having been unanimously adopted, a resolution was passed making certain alterations in the articles of association, and a vote of thanks to the chairman concluded the proceedings.

TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The half-yearly general meeting of the shareholders was held on Tuesday at the offices, 38, Old Broad-street.

Sir R. G. W. Herbert, who presided, said the present was the half-

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yearly meeting, at which no accounts was presented, nor was there any formal report to submit. One of the objects of the meeting was to inform the proprietors that, in pursuance of the deed of settlement, the directors were able to pay interest of 10 per cent. per annum for the half-yearly period. With regard to the general affairs of the Company, they were carrying on a very great deal of active work. The factories were working harder now than ever, and, with their improved machinery, they were turning out, perhaps, better work than ever. They had laid a great many miles of cable since the last meeting, and in a very successful manner. The proprietors were informed at the last meeting that a new ship was being constructed, which, it was hoped, would fully rival the "Anglia" in its capacity for carrying out the Company's work, and there was no doubt that long before the necessity for laying the Pacific cable arose next year, the new vessel would be afloat and in a very efficient condition. The Pacific Cable Board was actively engaged in making all the arrangements. The route had been surveyed to a great extent—1,500 miles had already been surveyed—and the surveying ship the "Britannia" was now engaged between Norfolk Island and the Fiji Islands. Block-houses had been erected on some of the islands to receive the cable, and the materials had been got together. The directors were fully confident that without in any interfering with the other work of the Company, which was pressing, they would have the Pacific cable constructed in due time.

A vote of thanks to the chairman and the directors closed the meeting.

CITY AND SOUTH LONDON RAILWAY.

Report of the directors, with statement of accounts, for the half-year ending June 30, 1901, to be submitted to the half-yearly ordinary general meeting of the Company, to be held at the offices of the Company, 71, Finsbury-pavement, E.C., on July 26, 1901, at 2 p.m.:

The receipts from all sources for the past half-year have amounted to £53,653. 19s. 2d., and the cost of working has been £28,096. 8s. 4d., leaving a profit of £25,557. 10s. 10d. Inclusive of the balance brought forward from Dec. 31 last, the net revenue account shows an aggregate total of £26,906. 13s. 7d. After making provision for the debenture stock interest and the transfer to a renewal fund of £2,000, a balance remains available for dividend of £16,964. 1s. 8d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference stocks, 1891 and 1896, and that a dividend at the rate of 1¾ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £732. 16s. 8d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:

Half-year ended	Number of passengers (exclusive of season-ticket holders).	Receipts (including season tickets).
Dec. 31, 1890 (11 days)	165,000	1,568 3 9
June 30, 1891	2,412,343	19,403 6 9
Dec. 31, 1891	2,749,055	19,798 16 6
June 30, 1892	2,813,162	20,931 4 2
Dec. 31, 1892	3,117,602	22,002 17 5
June 30, 1893	3,146,656	22,458 6 9
Dec. 31, 1893	3,093,351	22,067 14 10
June 30, 1894	3,383,154	23,564 10 6
Dec. 31, 1894	3,275,649	23,540 12 4
June 30, 1895	3,113,199	23,711 5 8
Dec. 31, 1895	3,172,438	23,780 3 7
June 30, 1896	3,192,672	24,021 13 0
Dec. 31, 1896	3,368,480	25,456 6 9
June 30, 1897	3,437,810	26,403 3 6
Dec. 31, 1897	3,337,861	25,472 12 10
June 30, 1898	3,478,977	26,356 16 4
Dec. 31, 1898	3,462,814	26,319 14 10
June 30, 1899	3,540,098	26,749 3 0
Dec. 31, 1899	3,442,942	26,197 14 10
June 30, 1900	4,169,717	33,608 2 3
Dec. 31, 1900	5,018,842	44,716 3 11
June 30, 1901	5,887,786	51,013 17 3
Total since the opening of the line..	72,779,608	£559,142 10 9

Your directors report with much satisfaction that the traffic of the line has been steadily increasing during the whole of the half-year, and notwithstanding the high price of coal and other materials the percentage of working expenses has fallen considerably. The extension to Islington is rapidly approaching completion, and will, it is anticipated, be open for traffic by the end of September next. The subway at London Bridge in connection with the Brighton Railway is nearly finished, and is waiting only for the completion of the lifts. In view of the opening of the Islington extension, 36 new coaches of an improved design have been ordered, and, in order to cope with the increasing traffic, arrangements have been made to run an additional coach on each train during the busy hours of the day. The new engine and boilers at the generating station are now nearly ready. The engine and boilers that were provided at the opening of the railway, although still in good order, had been superseded by improved appliances, and it was thought better, both for economy and efficiency, to replace them by an entirely new plant, and the old engines and boilers have been sold. The original cost, £10,704, having, therefore, to be credited to capital and replaced out of revenue, the amount has been debited to a renewal account, which, on the other hand, has been credited with £2,670, the proceeds of the sale, with £1,000 transferred from the reserve fund and £2,000 charged against the revenue of the past half-year, leaving a balance of £5,034 to be liquidated out of the revenue of future half-years. The Company's Bill, approved by the proprietors at the special meeting in February last, has received the Royal assent. The powers for the construction of the subway at the "Angel" station were withdrawn in order to facilitate the passage of the Bill through Parliament. The Euston and Islington Bill referred to in the last report has, with a large number of other Bills for underground railways in London, been under the consideration of a Joint Committee of both Houses of Parliament, who have not yet issued their report. The arbitrator has given his award in the matter of St. Mary Woolnoth Church, in the form of a special case, which raises certain questions of law to be determined by the court. The necessary steps are being taken to bring the matter to a conclusion. As it will be necessary to raise some additional capital to pay off various existing loans, and to provide additional rolling-stock required to meet the increasing traffic, the proprietors will be asked to sanction the issue of the capital authorised by the Act of this session in the form of preference stock, to be raised from time to time as required. No further progress has been made by the City and Brixton Company in the raising of the capital for the construction of the line, and the powers, if not renewed, will shortly expire. A Bill has been introduced into Parliament to extend the powers for another year, but it has not yet passed. The piece of this Company's line between the old station at King William-street and the Borough remains therefore still unused.

Dr. REVENUE ACCOUNT.	£ s. d.
Maintenance of way, works, and stations	1,390 7 0
Locomotive and generating power	9,138 14 11
Carriage repairs	1,353 13 10
Traffic expenses	11,866 4 7
General charges	2,245 4 2
Passenger duty	219 16 3
Law charges	53 4 4
Rates and taxes	1,829 3 3
	28,096 8 4
Balance carried to net revenue account	25,557 10 10
	£53,653 19 2
Cr.	£ s. d.
By passengers (5,887,786)	48,786 15 1
Season tickets (676)	2,227 2 2
Parcels, etc.	256 13 5
	51,270 10 8
Transfer fees	17 2 6
Rent of property	2,074 17 0
Sundry receipts	291 9 0
	£53,653 19 2

Dr. GENERAL BALANCE SHEET.	£ s. d.
Balance from net revenue account	16,964 1 8
Unclaimed interest	144 12 11
Interest payable or accruing and provided for	2,729 5 7
Sundry outstanding accounts	20,970 18 2
Loan account	215,200 0 0
Contractors' retention fund	46,196 7 8
	£302,205 6 0
Cr.	£ s. d.
Cash at bankers and on hand	7,785 9 6
General stores	6,398 16 1
Sundry outstanding accounts	3,843 11 9
Investments	116,000 0 0
Renewal account	5,034 0 0
Debenture stock issued against loans	30,060 0 0
Balance from capital account	133,083 8 8
	£302,205 6 0

BRITISH THOMSON-HOUSTON.

Directors: E. A. Lazarus, Esq. (chairman); C. Burrell, Esq.; W. J. Clark, Esq. (managing director); G. Franklin, Esq.; General Eugene Griffin; J. Hamspohn, Esq.; I. Loewe, Esq.; W. A. McArthur, Esq., M.P.; Dr. J. T. Merz; A. R. Monks, Esq.; J. F. Nauheim, Esq.; Sir Thomas Thompson, Bart.; E. Thurnauer, Esq.

Report of the directors, to be submitted to the shareholders at the sixth ordinary general meeting of the Company, to be held at the Company's Offices, 83, Cannon-street, E.C., on 22nd inst. at 2.15 p.m.:

The erection of the Rugby works is proceeding satisfactorily, and it is expected to complete same by the end of the year. The capital expenditure necessitated thereby was naturally not of earning capacity during the year. The directors have during the past year opened further branch offices in Newcastle, Manchester, and Cardiff. The Royal assent to the Hamilton, Motherwell, and Wishaw Tramways Bill, which was promoted by the Company, was given in July last. Negotiations are pending for acquiring lands, erecting the necessary buildings, and carrying out the permanent way and construction of the whole system. An important contract has recently been entered into for the complete construction of the whole system of the Chatham and District Light Railways. The various works and buildings are in active progress, and it is hoped to open the line before the end of the present fiscal year. The directors are satisfied that the investment in the Cork Electric Tramways and Lighting Company, Limited, continues to be a sound and valuable asset. The maintenance period for which the Central London Railway Company is liable expires at the end of the present month. The plant supplied by the Company has been running satisfactorily in every respect. The Company has successfully carried out the electrical and other works of the London United and the Bristol Tramways, the former being the first in London electrically equipped and successfully running. The latter undertaking

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covers practically the whole of the city of Bristol, and is working most satisfactorily. The Company has secured and partly fulfilled important contracts in connection with the power distribution scheme on Tyneside. This is the first important case of power distribution in this country and the supply has recently been inaugurated. It will be remembered that this Company was successful in the action brought against it by Messrs. Chamberlain and Hookham for alleged infringement of certain meter patents. An appeal was, however, lodged, and is expected to be heard during the present month. The profits, after deducting general and technical expenses, discounts, and interest, amount to £41,014. 8s. 11d., of which sum £13,659. 14s. 9d. has been applied, as shown in the profit and loss account. The available balance is £28,758. 2s. 1d., which the directors recommend be distributed as follows: £18,000 to 7½ per cent. dividend on £240,000 ordinary shares fully paid; £7,550 to 7½ per cent. dividend on £160,000 ordinary shares as called and paid from time to time; £2,050. 14s. 6d. to reserve, being 5 per cent. of £41,014. 8s. 11d.; £1,157. 7s. 7d. to profit and loss new account. The directors recommend that the dividend be paid on July 23. Mr. W. B. H. Martindale has recently resigned his seat on the Board, and the vacancy created has been filled by General Eugene Griffin, a former director of the Company. Messrs. C. Burrell, J. Hamspohn, W. A. McArthur, and J. T. Merz are the directors who retire by rotation, and are eligible for re-election. The auditors, Messrs. Price, Waterhouse, and Co., retire, and are eligible for re-election.

Dr. ABSTRACT OF BALANCE-SHEET.	£	s.	d.
Capital—40,000 ordinary shares, £10 each, fully paid	400,000	0	0
Loan from bankers *per contra*	98,000	0	0
Reserve account	7,975	13	9
Premium reserve account	40,000	0	0
Bills payable	88,449	5	0
Sundry creditors and retentions	161,306	14	11
Balance of profit and loss account	28,758	2	1
	£824,489	15	9

Cr.	£	s.	d.
Goodwill, patents, and licenses	76,600	10	4
Shares and debentures in lighting and traction companies: in hand, £52,025; deposited with others as security, £106,928. 10s. 9d.	158,953	10	9
Office furniture, equipment, etc.	8,836	2	4
Cost to date of Rugby works	96,158	6	5
Plant, stores, and meters on hand	70,474	12	6
Sundry debtors and retention moneys	399,042	7	6
Cash at bankers and in hand	14,424	5	11
	£824,489	15	9

Dr. ABSTRACT OF PROFIT AND LOSS ACCOUNT.	£	s.	d.
General charges, including directors' fees, etc.	27,031	8	4
Technical expenses, including salaries of engineers, etc.	24,793	18	9
Patent department expenses	1,405	3	10
Sales—factory and warehouse department expenses	15,293	6	5
Discounts allowed	2,041	7	11
Balance, being profit	41,014	8	11
	111,579	14	2
Preliminary expenses written off, etc.	1,423	15	2
Litigation expenses, less sums received	1,993	0	7
Depreciation of office furniture, factory, etc.	4,380	2	0
Ditto in value of stocks and stores in hand	1,831	5	0
Amount written off goodwill, patents, and licenses, being 5 per cent. on £80,632. 2s. 4d.	4,031	12	0
Balance carried to the balance-sheet	28,758	2	1
	£42,417	16	10

Cr.	£	s.	d.
Profits on sales of plant, stores, and meters	111,579	14	2
	111,579	14	2
Balance brought forward from March 31, 1900	1,403	7	11
Balance brought down	41,014	8	11
	£42,417	16	10

EASTERN TELEGRAPH.

At the ordinary general meeting of the proprietors, held at Winchester House on Wednesday, **Sir John Wolfe Barry**, who presided, said both in South Africa and China they had received extra revenue owing to recent events, but they would rather rely upon the sound basis of commercial activity for their revenue. On the whole, the net results were satisfactory. There was every reason to hope that before the end of this year there would be cable communication between Mauritius and Western Australia in a direct line, and that the whole of the new system contemplated by the two companies—the Eastern and Eastern Extension—would be completed early next year. As regarded the tariff to India, the directors were anxious to reduce it, but up to the present had been unable to do so in consequence of their relations with other foreign Governments and others interested. The Board, however, had every reason to hope that the difficulties would soon be settled, and that they would be able to accord to India substantial reductions in tariff. He pointed out that 95 per cent. of the traffic was carried on by code, which reduced the cost to about 1d. per word, and that the cost to private individuals of telegraphic communication with other countries was very heavy. Proposals to remedy this state of things, however, had been submitted to the Post Office in this country and to India, by which private persons could telegraph at a much cheaper rate by means of a code. The directors had every confidence that within certain limits they would thus be able to confer substantial advantages on the public. He moved the reception of the report and accounts.

The motion, having been seconded, was then adopted.

HARROW ELECTRIC LIGHT.

At the annual general meeting of shareholders held at the Company's offices, West-street, Harrow, **Mr. C. Colbeck** (the chairman), in submitting the report, said it was natural that the shareholders and directors both should feel that the meeting was not a very jubilant one, since for the second time in the history of the Company they had had to propose that there should be no dividend. Nor was the reason simply and solely, though it was partly, the accidental drawback that all such undertakings had suffered from in the past year—the rise in the price of coal. The one other cause, which had not been mentioned in the report, was that in an undertaking of this kind which continued to grow with fair rapidity the increase in the expenditure of capital kept considerably ahead of its earning power. To a very considerable extent, therefore, the Company had been each year in the position of a company in its first year. And they particularly attributed the extension of their business to the system of wiring houses upon rental, and the outlay therefore affected them more than it did some other companies. The policy was a good one, but still it meant that money was lying dormant, and waiting for the tenants who would pay the rental and pay for the light. Those facts accounted to a considerable extent for their failure to bring forward enough to pay a dividend. Extensions of the Company's mains had also continued to be made, but the directors had not been anxious to extend to any great length unless they could see their way to a return. He moved the adoption of the report and balance-sheet, which appeared in our last issue.

Mr. Townsend Warner seconded, and the motion was carried.

Mr. Bartley Denniss having been re-elected a director, Mr. Ashford was elected to the Board in the place of Mr. R. C. Gilson.

A motion authorising the payment of the final instalment of the interest on the preference shares was then passed, which concluded the business.

NEW COMPANIES.

The following new companies have been registered since our last issue:

Electro-Carbide Lamp Syndicate, Limited.—Capital, £200. Object: to acquire patents and inventions relating to incandescent electric filaments, electric lamps and electric globes, etc.

Arc Lamps, Limited.—Capital, £60,000. Object: to acquire from W. J. Davy and C. W. Milne certain inventions for improvements in electric arc lamps, and to carry on the business of electrical and mechanical engineers, etc.

Harden Star, Lewis, and Sinclair Company, Limited.—Capital, £3,000. Object: to acquire the business of the Harden Star, Lewis, and Sinclair Company, Haymerle-road, Peckham, S.E., and to carry on the business of manufacturers of and dealers in fire extinguishing appliances, mechanical and electrical engineers, etc.

APPOINTMENTS VACANT.

Assistant Electrical Engineer.—Salford Corporation electricity works, £250 per annum, July 27. Details in our advertisement columns.

Demonstrator in Electrical Engineering. — South-Western Polytechnic, Chelsea, £120 per annum, Aug. 6. Details in our advertisement columns.

Electrical Engineer.—County Asylum, Rainhill, to take charge of generating plant and wiring, £3 per week, July 25.

Electrical Engineer, to take charge of small electrical works in the North. Details in our advertisement columns.

Jointer for Siemens's and Callender's armoured cables, 45s. per week. Details in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Blackburn.—The Town Council invite tenders for steam dynamos. Tenders by July 29. Tenders in our advertisement columns.

Poplar.—The Electricity Committee invite tenders for arc lamp carbons. Tenders by July 24. Details in our advertisement columns.

Dartford.—The Council invite tenders for meters (direct-current) and cut-outs. Tenders by July 24. Details in our advertisement columns.

Sunderland.—The Corporation require tenders for erection and completion of proposed electric tramcar sheds, Hylton-road. Tenders by Aug. 2.

Poplar.—The Electricity Committee invite tenders for transforming plant and switchgear, etc. Tenders by July 24. Details in our advertisement columns.

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Cardiff.—The Corporation invite tenders for main switchboard, with instruments complete. Tenders by Aug. 6. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for the supply and delivery of 100 electric tramcars. Tenders by July 31. Details in our advertisement columns.

Kearsley.—The Urban District Council invite tenders for tramway poles, bases, section boxes, overhead line, etc Tenders by Aug. 1. Details in our advertisement columns.

Hapton (near Padiham, Lancs.).—Tenders are required for lighting the Hapton township with electricity from Sept. 1, 1901, to April 30, 1902. Tenders by July 31.

Amsterdam.—The Corporation invite tenders for tramcars for electric traction with overhead wire (perhaps 140). Tenders by Sept. 2. Details in our advertisement columns.

Cardiff.—The Corporation invite tenders for double-deck bogie cars, double-deck four-wheel cars, and single-deck bogie cars. Tenders by Aug. 6. Details in our advertisement columns.

Ilford.—The Urban District Council invite tenders for work to be done in connection with the electric lighting of the town hall. Tenders by July 25. Details in our advertisement columns.

Bury (Lancs.).—Tenders are invited for the work required in the extension of the engine and boiler houses and other contingent works at the electricity works, Rochdale-road. Tenders by July 30.

Greenock.—The Directors of the Greenock and Port Glasgow Tramways invite tenders for the construction of car-sheds, works and repair shops on a site at Ladyburn, Greenock. Tenders by 22nd inst.

Gravesend.—The Town Council invite tenders for boiler-house and engine-house plant, switchboard, mains, meters, crane, dust destructor, etc. Tenders by July 30. Details in our advertisement columns.

Dundee.—The Gas Commissioners invite tenders for surface condensers, electrically-driven pumps, cooling towers, feed-water heaters, etc. Tenders by August 5. Details in our advertisement columns.

Lancaster.—The Corporation invite tenders for water-tank, electric pumps, ejector, condenser, steam, exhaust, and water piping, with valves. Tenders by July 27. Details in our advertisement columns.

Brecon.—The Committee of the Talgarth Joint Asylum invite tenders for the electric lighting of the asylum. Particulars can be obtained from the architects, Messrs. Giles, Gough, and Trollope, 28, Craven-street, Strand. Tenders by Aug. 5.

Aston Manor.—The Urban District Council invite tenders for supply and fixing of generating and distributing plant for their hospitals at Upper Witton, near Birmingham. Tenders by July 25. Full particulars in our advertisement columns.

Shrewsbury.—The Lighting Committee invite tenders for carrying out installation work in the borough on the "free" or "assisted" wiring system. Full particulars may be obtained from Mr. H. C. Clarke, town clerk, Shrewsbury. Tenders by July 25.

Amsterdam.—The Municipality invite tenders for 5,000,000 kilos of tramway rails, with plates, bolts, etc. Specification, 2s. 7d. Tenders by Sept. 2. Information is given at the office of the Director of Municipal Street Railways, Nieuwe Achtergracht, 164.

Newcastle-upon-Tyne.—The Corporation invite tenders for the laying down in Gosforth of about 1,000 yards of double-line tramway, the rails and fastenings and the poles being supplied by the Corporation. Specifications, etc., may be obtained at the office of the City Engineer, Town Hall, Newcastle. Tenders by July 29.

Cardiff.—The Corporation invite tenders for the manufacture and supply of about 2,000 tons of steel tramway rails of British manufacture, also for fishplates, soleplates, tiebars, bolts and nuts, points and crossings, drain rails, etc. Specifications, etc., may be inspected at the office of Mr. W. Harpur, M.I.C.E. Tenders by July 25.

Epsom (Surrey).—The Asylums Committee of the London County Council invite tenders for steam boilers, pumps, and fittings, cooking apparatus and fittings, and installation of electric lighting (excluding generating plant), at the Epileptic Colony, Horton Estate, Epsom, Surrey. Tenders by July 23. Details in our advertisement columns.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection of steel poles, bases, section boxes, overhead line, and accessories for the equipment of approximately five miles of tramways (specification No. 3); and also for the supply, delivery, and laying of feeder cables and pilots (specification No. 4). Tenders by Aug. 1. Details in our advertisement columns.

RESULTS OF TENDERS.

Bradford.—The Electricity Committee have accepted the tender of Messrs. Verity for the supply of a switchboard at the Valley-road station.

East Ham.—The Urban District Council have accepted the tender of Dick, Kerr, and Co., Limited, for the supply of five new electric motor tramcars, at £630 each.

West Ham.—The Works Committee have accepted the tender of Young and Marten, Limited, at £2,032, for the installation of wiring and fittings at Plaistow Hospital.

Buxton.—The Urban District Council have accepted the tender of White and Kelvin, at £466. 3s. 2d., for the supply of a switchboard, subject to Local Government Board sanction being obtained.

Hackney.—The Borough Council have accepted the tender of Mirrlees, Watson, and Co., Limited, Glasgow, at £2,499. 10s. 10d., for supplying the coal-handling apparatus at the electric lighting works with electric driving.

London County Council.—The Fire Brigade Committee have received the following tenders for the extension of the electric light installation at the chief station of the brigade as follows: Siemens Bros. and Co., Limited, £950; Crompton and Co., Limited, £992; Drake and Gorham, £1,031. None of the tenders for the supply and fixing of additional electric lighting plant at the chief station were entertained. The offer of Crompton and Co., Limited, to supply for £87, less 2½ per cent. discount for cash, a spare armature suitable for the machine used in connection with the electric light installation at the chief station has been accepted.

BUSINESS NOTES.

TRACTION.

Croydon.—The work of hanging the trolley wires for the municipal electric tramways has been commenced.

Devonport.—In connection with the new tramways additional plant is to be provided for the electricity station.

Barnes.—The Urban District Council have sealed a petition in the House of Lords against the tramway company's Bill.

West Ham.—The Corporation propose to acquire the High-street and Leytonstone-road lines of the North Metropolitan Tramways.

Glasgow.—The tramway employés have decided to accept the proposals of the committee with regard to wages and conditions of work.

Newcastle.—Out of the 31½ miles of tramway track being laid down, the contractors have put down 19¼ miles, whilst 2⅞ miles are in course of construction.

Ipswich.—The Corporation have sealed an agreement with the Ipswich Tramways Company for the purchase of so much of the undertaking of the company.

Richmond.—The Town Council have arrived at a provisional agreement with the tramways company in regard to the latter's proposal to construct tramways in the district.

Perth.—The Corporation have resolved to offer the Perth and District Tramways Company the sum of £20,000 for their whole property within and without the burgh.

Rochford.—The Rural District Council have decided to enter a formal protest to the proposal of the Southend Tramways Company to construct an electric tramway in Rochford.

South London Tube.—It is stated that the City and South London Railway intend using the abandoned tunnel to the Monument, extending it to Brixton, and then back Citywards again.

Ayr.—The Town Council have decided to divide the tramways into three 1d. stages, two of which will be each divided into ½d. stages. The official inspection of the lines will take place early in August.

Swindon.—The Bill to confirm the provisional order granted by the Board of Trade to authorise the Corporation to construct tramways in the borough has passed the Examiners of Petitions for Private Bills.

Bournemouth.—The Corporation Tramways Bill has passed a Select Committee of the House of Commons, despite the strenuous opposition offered to the proposal to take in a portion of St. Peter's Churchyard.

South-Western Railway.—A rumour is afloat that the directors of the company contemplate adopting electric traction for the London and South-Western Railway's local traffic between Clapham Junction and Waterloo.

Darlington.—With their decision to purchase the tramway company's undertaking, the Corporation have resolved to spend £12,000 on the extension of plant to provide sufficient electrical energy for working 20 to 30 tramcars.

Central London "Tube."—The Central London Railway Bill, which has already passed the House of Lords, will be considered to-day by the Chairman of the Committee of Ways and Means in the Commons as an unopposed measure.

Blackpool.—It is said that it has been found impossible to get the cars in the Marton tram-shed, which is nearing completion, and the borough surveyor and the electrical engineer have been instructed to prepare a scheme to provide accommodation for 30 cars.

Greenock.—The work of hanging the trolley wires for the electric tramways is rapidly progressing. Plans have been passed for the erection at Ladyburn of a building, 290ft. by 90ft., to be used by the Greenock and Port Glasgow Tramway Company as a car depôt.

Kilburn.—A public meeting held to consider the proposed tramway scheme of the London County Council in the High-road, Kilburn, has adopted this resolution: "That this meeting is in opposition to the proposed tramway, but is in accord with regard to the proposed tube."

Leeds.—The Tramways Committee have refused the application of the tramway employés for double rates of pay on Sundays and bank holidays. The committee, however, are willing to consider a scheme by which the men may have more frequent holidays and shorter hours on Sunday.

Hammersmith.—The Law and Parliamentary Committee report to Borough Council that they are of opinion that the speed of motorcars is sufficiently controlled by the existing law. The Council have sealed a *locus standi* petition against the London United Tramway Company's Bill in the Lords.

Halifax.—For the past three months the receipts from the tramways amounted (according to the local Press) to £14,377, or 12·9d. per mile run, the expenditure being £15,813, or 14·2d. per mile. If these figures be correct, a loss of £1,436 for the last quarter must be recorded against the undertaking.

Kirkcaldy.—The Town Council are now making rapid progress with the preliminary arrangements in connection with their electric traction scheme, and the contract for the permanent way has been let. The proposed extension of the system to Dysart is being considered by the Town Councils of both burghs.

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Dublin United Tramways Co.—The directors recommend a dividend at the rate of 4 per cent. per annum for the half-year ended 30th ult., carrying forward £3,374. The sum of £6,337 has been charged against revenue during the half-year for compensation, for accidents and legal expenses connected therewith.

Private Bills.—In the House of Lords the City and Brixton Railway and the Tottenham and Hampstead Junction Railway Bills have been read a third time, and the London United Tramways Bill a second time. In the Commons the South-Western and Isle of Wight Junction Railway Bill has been read a third time.

Greenwich.—A large and influential deputation from the committee formed to oppose the proposal of the London County Council to construct a tramway up Blackheath-hill and across Blackheath was received at the last meeting of the Borough Council, when it was decided to refer the matter to the General Purposes Committee.

Manchester-Salford Dispute.—A conference of representatives of the Manchester and Salford Corporations met last Friday to consider the question of the joint working of the tramway service between the two towns. Terms of settlement were ultimately agreed to, and these will be submitted to the respective Corporations for confirmation.

Sunderland.—On Wednesday morning a Board of Trade official inspected the Villette-road section of the new tramways. The tramway receipts for the two weeks ended 3rd inst. amounted to £2,378, or £1,680 more than the corresponding fortnight last year. It is expected that the Grangetown extension will be finished in about two weeks' time.

Yarmouth.—As the result of a long discussion at their last meeting the Corporation have definitely decided to invite tenders for leasing the tramways undertaking. In consequence of this vote, Mr. F. Arnold, who has fought with great resolution for the working, as well as the making, of the tramways by the Corporation, resigned the chairmanship of the Electric Tramways Committee.

Manchester-Liverpool Electric Express.—Sir L. McIver's Committee of the House of Commons this week continued the enquiry into the merits of the Bill promoted by Mr. Behr for a high-speed monorail between Manchester and Liverpool, when further evidence on behalf of the promoters was taken. On Wednesday the Committee commenced the hearing of evidence on behalf of the opposing railways.

Southend-on-Sea.—Last night saw the official inauguration of the new electric tramway system at Southend, which will provide a long-needed means of communication between the outlying parts and the centre of the town. A special train conveyed visitors to this popular watering place in good time for the meeting at the tramway depôt in London-road. From here an adjournment was made to the Hotel Victoria, where an excellent dinner was served.

East Ham.—The official opening of the electric lighting and tramway undertakings which have just been completed for the Urban District Council of East Ham, took place last night. The ceremony, which was performed by Councillor T. L. Knight, the chairman of the Electric Light and Tramways Committee, was followed by an inspection of the power station and tramway system. At the invitation of Messrs. Dick, Kerr, and Co. the company afterwards partook of refreshments at the car depôt.

West Cumberland Electric Tramways.—The Bill has passed Lord Welby's Committee of the House of Lords authorising the construction of 31 miles of tramways at an estimated cost of £361,579. The tramways will run from Cleator Moor through Whitehaven, Workington, and Maryport to Silloth, and will serve a population of 120,000. The only opposition from local authorities was that of the Cleator Moor Urban District Council in respect to the widening of a bridge and the lighting of certain roads.

Cardiff.—There is some talk of an electric tramway system being established between Cardiff and Penarth. The Tramways Committee have agreed to the doubling of the lines in Newport-road and Cowbridge-road. The question of extending the Wellfield and Castle-road route to the Fair Oak-road has been also raised, it being stated that powers for a single line had already been obtained. It has been decided to communicate with the Board of Trade to see if the Department would sanction a double line.

Huddersfield.—At the meeting of the Corporation on Wednesday the members expressed sympathy with the principle of extra payment for Sunday labour on the tramways, but the information obtained from other towns in reference to the question was of such a nature, it was stated, as to prevent the Tramways Committee seriously considering any application from the men for extra payment on Sundays. From an abstract of the accounts on the tramways undertaking for last year it was shown that for every mile that the steam cars had run there was a loss of 4½d., and it was a question of whether the electric cars had lost ½d. or made ½d.

London Tramways.—On Monday the Select Committee of the House of Lords presided over by Lord Hatherton had under consideration the London County Council Tramways Bill, which seeks powers to make several important extensions in the metropolitan area, and to reconstruct and alter existing lines, details of which have already appeared in these columns. It was stated in the course of the enquiry that the net estimate of the cost of the street widenings proposed was £384,900, and the gross estimate £414,130, the difference being accounted for by what it was expected to realise by selling certain portions of the property which would be purchased but not required.

Teddington.—At the last meeting of the District Council a letter was read from the London United Tramways Company intimating that application will be made before the Light Railway Commissioners for the construction of so much of Railway No. 3, which commences in Hanworth and passes eastwardly along the Staines-road and the Green, Twickenham, as lies within the jurisdiction of the Teddington District Council. The electric trolley system would be adopted. The Clerk reported that the proposals of the Middlesex County Council were identical with the London United Tramways scheme so far as the proposed route of the railway was concerned. The Council agreed to formally object to both schemes.

Obstructing the Electric Trams.—At the West London Police Court, George Beasley, driver of a four-horse brake, appeared to answer a summons before Mr. Plowden for having wilfully obstructed an electric tramcar at Chiswick. Defendant pleaded not guilty. Counsel for the tramways company commented upon the obstruction to which the West London electric cars were subject from drivers of vehicles to which horses were attached. This obstruction seemed to afford considerable amusement to those responsible for it, and they apparently took the keenest delight in causing the drivers of the electric cars as much inconvenience and annoyance as they possibly could. The company was put to great expense in prosecuting the offenders, because the former generally called independent witnesses. In the result defendant was fined 40s. and 2s. costs.

Herne Bay Accident.—A somewhat remarkable electric tram accident occurred at Herne Bay on Tuesday. Three cars, preceded by a trolley truck, were proceeding down the pier, when the front one, which had no motor attached to it, suddenly "jumped" the rails. Smashing through the iron railings at the side of the pier, the car, together with about nine passengers, plunged into the sea. All were quickly picked up by boats, but one lady sustained such injury that she shortly afterwards succumbed. The damage to the car is said to be considerable. At the inquest in the evening evidence was given by the driver to the effect that the car was not going at full speed at the time, which is about five miles an hour. When the trolley in front jumped the lines it threw the front car off on the opposite side. The coroner remarked in summing up that the immediate cause of the trolley leaving the rails was not apparent, and could only be theoretically accounted for. The jury returned a verdict in accordance with the evidence, and expressed the opinion that the pushing of a trolley in front of the trams should be discontinued as unsafe.

London County Council.—We understand that difficulties have arisen in regard to the proposed site for a generating station at Camberwell, and the Highways Committee suggest its abandonment. They have found a better and cheaper site at the Greenwich tramway depot, the development of which it is said will only cost £30,000, as against £80,000 at Camberwell. After a long discussion, the Council on Tuesday decided to make application to Parliament for authority to run omnibus services to and from the tramway termini existing or to be constructed. An amendment in favour of a report on the offer of the omnibus proprietors to take over the services was rejected by a large majority. The report of the Finance Committee shows that the net profit derived from the present omnibus service in the year 1899-1900 was upwards of £1,000. In the year 1900-1901, however, the working expenses were considerably higher, and much, if not all, of the £1,000 profit was probably absorbed; but if the omnibuses were relieved from any share of those working expenses which, in the opinion of the tramways manager, are not increased by the existence of the omnibus service, there would be a balance on the right side. In their report on the subject, the Highways Committee state that the suggestion is not that the Council should seek to embark on the business of omnibus proprietor in the usual acceptance of the term, but that it should endeavour to obtain parliamentary authority to run omnibus services to connect with its tramways undertakings north and south of the Thames, and by this means to afford, under the Council's own control, facilities for direct communication to and from its tramways systems, such feeder services being valuable adjuncts to the tramways services. We understand that the Council have decided to send their tramways manager and also their electrical engineer to America to find out the latest improvements and the best system of providing electric traction.

Yorkshire Schemes.—It seems likely, says the *Yorkshire Post*, that before long it will be possible, with some changing, to travel by tramcar from Leeds to Mytholmroyd, which is but a stone's throw from the Lancashire border. There is a gap between Armley and Stanningley in the lines connecting Leeds and Bradford, but routes on the other side of the latter city are now practically available. Under their Bill, which has just passed through Parliament, the Bradford Corporation have power to take over and convert to electric traction any of the lines now leased to the Bradford Tramways Company or the Bradford and Shelf Tramways Company before the expiry of those leases next year, upon payment of profits based on the average of the last three years. At Monday's meeting of the City Tramways Committee the matter came up in a tentative fashion. The committee are spending on the new tram depôt at Thornbury £1,800, and on cars delivered but not in use £35,320. It was suggested that the Manningham, Thornton-road, and Leeds-road lines should be electrically equipped, and taken over from the company at the earliest possible moment. The effect of this action would be to link up the existing electric lines and to place Thornton on the one side of Bradford, and Stanningley on the other, in direct communication with a thorough system of electric cars. There are electrically-equipped lines to each of these districts, but an intervening stretch has to be covered by steam car. It is further suggested that the Manchester-road, Low Moor, Wyke, and Shelf line shall be taken over at an early date. This line requires reconstruction, but it is thought that the conversion to electric traction necessary on all these lines could be carried out by February next. The scheme was left over for further consideration. In the meantime the Horton Bank Top to Queensbury extension is expected to be in operation in about a fortnight, and this will give direct connection by electric car from Tyrrel-street, Bradford, in the centre of the city, to the Halifax terminus, with a change of car at Queensbury. Thence it is possible by changing cars and getting on the Mytholmroyd car at Cow Green to run straight through to Mytholmroyd. The receipts on the Bradford electric tramways for the week ended 14th inst. were £1,103, or 12·06d. per car mile run.

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LIGHTING AND GENERAL.

Bexhill.—The Electric Light Committee have received applications equivalent to about 9,000 8-c.p. lamps.

Bury St. Edmunds.—Sanction has been received to the borrowing of £11,346 for electric supply purposes.

Belfast.—The consumption of electric light and electric power has increased rapidly during the past quarter.

King's Lynn.—Mr. W. W. Alston, of Bury, has been appointed assistant electrical engineer to the Corporation.

Edmonton.—The Urban District Council have decided to apply for a provisional order for electric lighting purposes.

Wimbledon.—An enquiry has been held into the District Council's application to borrow £7,500 for electric lighting.

Huddersfield.—The Council decided on Wednesday to borrow £100,000 for extending the electric generating machinery and mains.

Tientsin.—According to a telegram to the *Standard*, a scheme is being matured for providing Tientsin with electric tramways and lighting.

Islington.—Mains are to be laid at a cost of £1,079 in Holloway-road, Caledonian-road, and Essex-road, and to the Baptist Chapel in Cross-street.

Patents.—In another column we publish a notice to amend certain patents referring to improvements in the manufacture of incandescent electric lamps.

Harrogate.—The Town Council have resolved to make enquiries in other towns as to the comparative cost of lighting the streets with electrical energy.

Worcester.—We are informed that the name of the newly-appointed mains engineer is J. *B.* Morgan, and not J. *D.* Morgan, as previously stated.

Southampton.—Application is to be made to borrow £600, the estimated cost of laying a separate cable from the generating station to the Ordnance Office.

Bermondsey.—The Borough Council expect to be able to switch on the electric light in October. They have adopted the continuous-current system of supply at a pressure of 240 volts.

British Thomson-Houston Co.—The directors recommend a dividend of 7½ per cent. for the year ended March 31 last, placing £2,051 to the reserve, and carrying £1,157 forward.

Hove.—The preparation of the plans and estimate necessary for applying to the Local Government Board for sanction to borrow for the electric light undertaking in Aldrington is proceeding.

London Gazette.—The partnership subsisting between Messrs. A. Baxter and T. H. R. Wray, 5, Macclesfield-street, Shaftesbury-avenue (trading as Baxter and Wray), has been dissolved by mutual consent.

New Firm.—We are informed that Mr. Edgar C. Thrupp, A.M.I.C.E., for the last 15 years chief assistant to Prof. Henry Robinson, has started as a consulting engineer at 39, Victoria-street, Westminster.

Battersea.—The arc lamps are now being fixed on the standards in the main streets, and we understand that the committee who have the matter under consideration hope to supply current before the end of September.

National Telephone Co.—The directors recommend a dividend for the half-year ended Dec. 31 at the rate of 5 per cent. per annum on the ordinary shares, transferring £85,000 to the reserve fund, and carrying £5,698 forward.

Primitiva Gas and Electric Light of Buenos Ayres.—On and after 30th inst. the coupon No. 1, attached to the preference share warrants, will be paid at the rate of 2s. 6d. per share by Glyn, Mills, Currie, and Co., 67, Lombard-street, E.C.

Burnley.—The Local Government Board have informed the Guardians that they are prepared to sanction the plans for the electric lighting of the workhouse, etc., and for the new boiler-house if copies of the tracings and drawings were forwarded.

Perth.—It is proposed to lay a feeder for Messrs. Dewar and Sons' premises. It has been decided to supply all churches in the city with electric current on the same terms as private consumers—viz., 30ft. from the main, but at the rate of 4½d. per unit.

East Ham.—The Electric Lighting Committee have approved the engineer's estimate for the cables for lighting the new road across Wanstead Flats, amounting to £381. 17s. 6d., and quotations are to be obtained for the supply of the necessary cable.

Heriot-Watt College, Edinburgh.—The three years' course of instruction in mechanical engineering, electrical engineering, and technical chemistry commences in October. Full particulars are published in the calendar of the college early in September. Details in our advertisement columns.

Beverley.—Advertisements are being issued for offers of sites for the generating station, and a canvass is to be made in order to obtain an estimate as to the number of lights likely to be required in the town, and particularly on the line of the mains required to be laid down within the first two years.

Waterhouses (Durham).—The local authorities have decided to supply Waterhouses with an electric light installation. Current is to supplied at 280 volts pressure. Fifty-five 32-c.p. lamps will be erected at a cost of £6 each. Messrs. Reed and Ferens, of Newcastle, have secured the contract for the work.

Halifax.—The Council have fixed the following charges for electricity: accounts under 1,500 units per quarter, 4d. per unit; between 1,500 and 3,000 units, 3½d.; between 3,000 and 4,500 units, 3¼d.; between 4,500 and 6,000 units, 3¼d.; 6,000 units and upwards, 3d.; for other purposes, 2d.; with a discount of 5 per cent.

City of London Electric Lighting Company.—The directors declare a dividend on account of the year ending Dec. 31, 1901, on the 6 per cent. cumulative preference shares, of 6s. per share, being at the rate of 6 per cent. per annum for the half-year ended June 30, subject to deduction of income tax at 1s. 1d. in the £, and payable on Aug. 3.

Electric Light and Libraries.—The recently published report of the committee appointed by the Society of Arts on bookbinding condemns the use of calf-skin and russia leather as most liable to decay. There is a general agreement that the use of gas in libraries has a most deteriorating effect on the bindings—the electric light being preferable.

Greenock.—The last monthly report of the electrical engineer shows that for the month ended June 28 15,494 units of electricity were generated, being an increase of 8,214 over the same period last year. The units sold exceeded last year's total by 4,618. Since last report the applications for supply number 11, and the total to date is 218.

War Souvenir.—Mr. Ernest Croft, manager of the *Western Morning News*, is responsible for the publication of a well-illustrated pamphlet, entitled "Devonshire Infantry Volunteers in the Boer War," which has recently been distributed to the members of the South African contingent of the Volunteer Battalion Devonshire Regiment.

Bristol.—The Electrical Committee have decided to take a hint from the tramways company and put stone bases around lamps standing in the roadways to protect the columns from injury by the vehicular traffic. Extensions of the continuous-current supply in Victoria-street, Temple-street, and Thomas-street have been sanctioned, and others at Clifton are being considered.

Heywood.—The work at the electricity supply station is making good progress. The Technical Instruction Committee have decided to light the technical school by electricity. The manager of the electricity works has received much encouragement from parties who were about to take up the new light, so that altogether the new undertaking is in a very encouraging position.

Cleckheaton.—At Tuesday's meeting of the District Council the Electricity and Destructor Committee reported that they had referred all the tenders for the supply of electrical appliances for the Council's new works to Messrs. Gibbings and Baker, engineers, for their report, and that a sub-committee had been appointed to visit various towns which have similar works in operation.

Direct United States Cable Co.—The directors recommend a final dividend of 3s. per share and a bonus of 1s. per share, both free of income tax, payable on and after 31st inst., making, with the three interim dividends already paid, a total distribution of 3¼ per cent. for the year ended June 30. After placing £10,000 to reserve fund account, there remains a balance of about £3,532 to carry forward.

Keep Cool.—The publishing department of the Westinghouse Company has issued a circular advocating temperance during the hot weather in combination with the small rotating fan manufactured by the company, on the grounds that twopennyworth of electricity applied in this direction—to be used externally—has a greater cooling effect than double the amount spent on iced drinks applied internally.

Glasgow.—An electric explosion took place last Friday at the corner of Maitland-street and Cowcaddens. Three engineers in the employment of the electricity department of the Corporation were working at one of the section pillars, when a telephone cable which they were putting into the box touched a "live head," causing an explosion and burning all three severely on the face and one on the hands and arm.

Stock Exchange.—The Stock Exchange Committee has appointed July 30 special settling day for London United Tramways, Limited, £350,000 4 per cent. first mortgage debenture stock, in lieu of the provisional certificates now quoted. Application has been made to the Exchange Committee to appoint a special settling day in and to grant a quotation to the British Insulated Wire Company's £250,000 4½ per cent. first mortgage debenture stock.

Electric Power Schemes.—Lord Welby's Select Committee of the House of Lords, after several days' consideration, on the 16th inst. passed the preamble of the Clyde Valley Electrical Power Bill, which has already received the sanction of the House of Commons. In the House of Lords the following Bills have been read a third time: Derbyshire and Nottinghamshire Electric Power, Great Western Railway, and Shannon Water and Electric Power.

Enfield.—The North Metropolitan Electric Power Supply Company and the Electric Supply and Traction Company intend to apply to the Board of Trade for permission to supply electricity within the Council's area. On Friday, after a lengthy discussion, the Council referred the matter to the General Purposes Committee to see whether the Council should apply for a provisional order, to whom, it was stated, the Board of Trade would grant one in preference to private companies.

Ferranti Limited.—As will be seen from the prospectus in our advertisement columns, the well-known firm of Messrs. S. Z. de Ferranti Limited is to be reconstructed next week, and an opportunity will be given for the general public to take a certain interest in the firm, which will in future be known as "Ferranti Limited." The control of this manufacturing business will continue in the same hands, as the directors are not changed. The fact that the ordinary shares are not to be issued to the public, but will be held by the members of the present firm, is a sign of their confidence in the undertaking. We are pleased to note that the standard articles manufactured by this firm are finding the demand they deserve, and that the traction department is growing rapidly. In fact, the new company has every chance of a most successful life,

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Coatbridge.—The Scottish House-to-House Electricity Company, Limited, have now made arrangements to alter the system of supply (subject to the consent of the Board of Trade) from the alternating to the continuous current system. When this change is effected, the company will be able to give a uniform pressure of 240 volts throughout the district.

Presents.—This is not exactly Christmas, judging by the weather, but we have received this week two very charming little presents, one in the shape of a very pretty watch-chain charm, in the shape of a miniature Robertson lamp, made by the General Electric Company (1900), Limited, and another from over the seas—viz., a handy dating-stamp, made by Messrs. Baker and Co., refiners, assayers, and smelters, of Newark, N.J., U.S.A.

St. James and Pall Mall Electric Light Co.—The directors declare interim dividends for the half-year ended June 30 at the rate of 7 per cent. per annum on the preference shares and at the rate of 10 per cent. per annum on the ordinary shares. The amount of electricity sold for the quarter ended Midsummer, 1901, is returned at 1,115,593 units, estimated to produce £19,523, as against 1,035,927 units, which produced £18,172, for the corresponding period of last year.

London, S.E.—As our readers are aware, steps are being taken to adopt electric lighting for the parishes of Woolwich, Plumstead, and Eltham The Woolwich Council have decided to purchase the existing local electric light undertaking at a cost of about £100,000. In Plumstead the Council are inaugurating their own system of electric light. The total cost of carrying out the scheme is estimated at £200,000. There will be a central station in the marshes and subsidiary stations at Woolwich and Eltham.

Melton Mowbray.—At the last meeting of the Urban District Council considerable discussion took place on the street-lighting question, and a largely-signed memorial in favour of the adoption of the second scheme of the electric lighting company was presented. The first scheme, which was passed at a previous meeting, was rescinded, and the second scheme adopted, the electric light company stating in a letter that they were prepared to light the town on moonlight nights without any additional cost if they accepted the second scheme.

Leigh.—A report has been issued showing that for the year ended March 31 the receipts from the electricity department amounted to £1,187. 5s. 1d., and the expenditure to £1,288. 16s. 1d., leaving a loss for the year of £101. 10s. 2d. It has been decided to grant from July 1 a discount of 10 per cent. for payment within 14 days after demand on all accounts for electricity supplied for lighting purposes, and to apply for sanction to borrow the sum of £11,250 for extensions at the electricity works in order to meet the increasing consumption of electricity.

Kingstown.—At Monday's meeting of the Urban District Council the following recommendation of the Electric Lighting Committee was adopted: "The committee having learned from Mr. Manville that, in his opinion, the terms offered by the British Schuckert Electrical Company will in all probability cost the townships more than if the electric lighting were supplied under the direct control and management of the Council, this committee is of opinion that it is not desirable to hand over the lighting to any outside body, and recommend the Council to proceed with the scheme themselves."

Leamington.—The Town Council have adopted a report of the Pump Room Committee, stating that the borough surveyor reported as to the conditions under which the Midland Electric Light Company will in future, under their provisional order, supply electric current. The committee recommended that for the present the Council adopt the plan of paying 6d. per unit all through, as being the most economical, although it would be an increase of 50 per cent. in price, and the committee recommended that the surveyor be instructed to prepare an estimate of the probable cost to the Corporation to lay down their own installation.

Hammersmith.—The late Vestry entered into an agreement with the Aberystwyth and Chiswick Electricity Supply Corporation, Limited (who have the power to supply electricity in Chiswick), for providing them with a temporary supply of electricity pending the completion of their generating station The company is now in a position to supply electricity themselves, and the connection with their mains has therefore been cut off. Since the last Council meeting nine additional consumers have been connected, representing a maximum of 393 8-c.p. lamps. These added to the number previously reported show a total of 909 consumers taking current from the mains.

Stafford.—The Town Council have agreed to the purchase from Messrs. Jones and Gillman of two second-hand Lancashire boilers (recently at the Cheltenham Corporation electricity works) for the new boiler-house at a cost of £260 each, subject to satisfactory tests. The electricity output during the last month was 11,295 Board of Trade units, a decrease of 4,315, or 27·60 per cent., this being accounted for by the recent fires at Messrs. Bostock's and Messrs. Rooper and Robins's premises, both firms being large consumers. With reference to the purchase of boilers, Mr. Ward said a saving of £700 had been effected, and they would answer the committee's purpose as well as new ones.

Acton.—At the last meeting of the District Council a letter was read from Messrs. Evershed and Vignoles, stating that they noted the Council did not contemplate proceeding further with the electric supply scheme, at all events so far as the Acton Green portion of the scheduled area is concerned, and that they (Messrs. Evershed) did not see their way to establishing a profitable electric station at their new works at Acton Green without powers to lay mains, and unless the Council was prepared to give them a public supply within a reasonable and definite time, they proposed to move the Board of Trade to rescind the order granted to the Council in 1891. The matter was taken in committee.

Walsall.—The total number of consumers supplied on June 30 last was 189. The total units generated at the station during the month of June was 20,941. The total output from the main generators was 19,921 units. The total units from the transformers was 14,982 (estimated). The total units registered on the meters was 14,209. The machinery has been run for 401 hours during the past month. The wages paid during the month amounted to £77. The tender of Mr. Thomas Tildesley for carrying out the necessary alterations to the building on the site of the new sub-station in Freer-street for the sum of £70 has been accepted. The electric mains are to be extended in Wednesbury-road at an estimated cost of £100.

Bath.—At the meeting on Tuesday the adoption of the report from the Electric Light Committee was moved and power asked to borrow a sum of £8,000 from the bankers, in addition to £4,000 which the report stated was required to complete the purchase of property in Dorchester-street, adjoining the works. It was stated that nearly £5,000 was wanted to pay for work done under contracts sanctioned by the Council, while the balance was for work urgently needed to prepare for demands for the light during next winter. The action of the committee in not giving a detailed printed statement of their requirements was criticised, but an amendment that the borrowing be not sanctioned until details were submitted was not carried.

Grimsby.—During the last meeting of the Sub-Lighting Committee it was stated that at the present about 36 firms were now requiring the light, and they could not possibly get on fast enough at the present time, although a second jointer had been temporarily employed. The Electrical Engineer said that 2,651 more lamps had been wired during the month, making the total 8,039 out of a possible 12,000, which was placed as the station's maximum. A special American Westinghouse dynamo and a 350-h.p. engine are expected to arrive shortly. The Chairman said they would have enough current in the station now supposing they wanted it to run the trams, but they could not do it with the whole 8,000 c.p. of lamps on as well. They had now 59 arc lamps working.

Swansea.—The report of Mr. Cawthra, the borough electrical engineer, on the first quarter's working of the borough lighting scheme states that the works have been supplying current throughout the whole day and night, and altogether since May 13 29,300 units have been supplied to customers. The number of customers now connected is 103, and up to the present there has not been a single complaint. Moreover, the works have run most satisfactorily, and on no single occasion has there been the slightest interruption in the supply of energy. After meeting all charges, with the exception of interest and sinking fund, there is a profit of £173. 4s. 3d. over and above working expenses. The Electric Lighting Committee have expressed great satisfaction with the report. It is stated that the result would have appeared much better if it had not been for the large amount of power used in experimental running.

Whitehaven.—There appears to be an opening here for an assistant electrical engineer. The Water and Lighting Committee in their last report state that they had decided to lay a double main in High King-street, which would add very much to the business comfort of the people in High King-street, and would do away with the necessity of opening the streets across in very many instances. The committee were of opinion that whilst the fitting and wiring of the private consumers premises were being altered so as to make them suitable for the higher voltage to which they would have to turn before the winter—there was a good deal of work to be done in that direction—it was absolutely necessary to have a competent person to assist the electrician, at any rate for some time. If he had not that assistance the work would be very much delayed, and consequently the users of the current would be very much inconvenienced.

Portsmouth.—The Town Council have entered into an agreement with the Hampshire Light Railway Company, Limited, and the Provincial Tramways Company, Limited, for the supply of electrical power to the new railway to Waterlooville, which will shortly be commenced. The charge, subject to certain provisos as to the minimum quantity and cost of coal, will be 2¼d. per Board of Trade unit. A revenue of about £2,500 a year is anticipated. At the last meeting the Electric Lighting Committee recommended an extension of the generating station in Gunwharf-road, and the acceptance of the tender of Mr. T. W. Quick, being the lowest, at £4,715. The report added: "The tenders originally received were all in excess of the estimate made, but after certain deductions had been made from the specification the persons sending in the four lowest tenders were invited to tender again, and these tenders were as follows: Messrs. J. Croad, £5,050; W. Ward, £4,992; W. Learmouth, £4,790." Discussion of the matter was adjourned.

Dublin.—The following notice of motion has, according to the *Dublin Evening Mail*, been handed in to the town clerk: "That, having regard to the important and complicated nature of the 25 contracts entered into for the new electric lighting system, and to the necessity for almost daily attention to and supervision over the numerous details of the work during its progress, a special committee be and is hereby appointed to take charge of all work connected with the scheme, and to report from time to time to the Council. That this special committee (to consist of 12 members) be called the New Electric Lighting Works Committee, and that it shall hold office for 12 months or until such time as the system shall be handed over in complete working order; and that the following members be and are hereby appointed to act on the special committee, vacancies occurring in which are to be filled by the Council: the Right Hon. the Lord Mayor, M.P.; Councillor Irwin, J.P.; Councillor Dodd; Alderman Dowd; Councillor Sir Thomas Pile, Bart.; Councillor O'Hara; Councillor Hutchinson; Councillor George Healy, J.P.; Councillor Bergin; Councillor Begg; Councillor Nanetti, M.P.; Councillor Joynt.—John Irwin, chairman."

Llandudno.—Mr. W. A. Ducat has held an enquiry into the application of the Urban District Council for sanction to borrow £1,027 for the purposes of extending electric light works. Mr. Harold Morton, electric light engineer, stated that in the original scheme mains wer e

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laid down capable of supplying 7,000 8-c.p. lamps. Two feeders only were provided from the works, feeding the distributing works at three different points in the town. At the end of March this year 14,850 8-c.p. lamps were connected with the mains, the maximum load during the year being 320 kw., and it was found necessary to make an extension of plant, a 150-kw. set being laid last year. During last summer the feeders from the works were considerably overloaded, the current density in the feeders being 1,100 amperes per square inch section. It was proposed to join the new feeder to a ·25 square inch section from the works to the corner of South-parade. That would carry 140 amperes, with a maximum drop of 10 per cent., between the station and the feeding point 1,670 yards from the station. The estimated cost of doing this work was £1,027. Of this cable 876 yards would be armoured and lead-covered, and laid in the ground, and 799 yards would be lead-covered only, and turned into the pipes already laid. A tender for the supply of the cables has been received amounting to £858. Mr. R. J. Williams, chairman of the Electric Lighting Committee, and Mr. E. Paley Stephenson, engineer to the Council, were also present.

Gravesend.—We extract from the minutes of the Electric Lighting Committee as follows: "Mr. Trentham stated that his original report included the provision of a cable sufficiently large to carry 260 amperes at any one time, and that the tramway company considered that amount is equivalent to 300,000 units maximum. It was recommended that between 180,000 units and 400,000 units in any one year the charge be 1½d. on the understanding that not more than 400 amperes will be supplied at any one time, and also on the understanding that at present the Council only make provision for supplying 300,000 units, as that is the maximum amount mentioned by the company. If more than 300,000 units are required, the Council should express themselves as happy to make provision for it in due course on a proper agreement being entered into. In order to leave the Corporation free as to the exact site of their station, they should undertake to deliver energy to the tramway company at a spot near the central part of Gravesend. The committee recommended that one year's notice on either side should be required before any arrangement entered into with the tramway company can be terminated, and that it would be sufficient if the British Electric Traction Company, Limited, under seal, guarantee the construction, completion, and fitting of the tramway by May 1. Mr. Trentham was instructed to have the specifications printed, and it was left to the town clerk to settle the form of agreement and conditions with intending contractors. Plans of all buildings were produced and approved. Advertisements were ordered to be issued as to buildings, etc."

Cardiff.—Mr. Arthur Ellis's report on the charges for electric light contains a recommendation that the maximum demand system of charging be retained, but that instead of charging 6d. per unit and 3d. after, the charge for the first hour's consumption be increased to 7d. per unit, and the lower charge reduced to 2d. per unit. The following estimate of further borrowing powers on electric lighting account has been submitted to the Council by Mr. Ellis: buildings, £9,500; two 1,500-h.p. engines, £15,000; two 900-kw. generators, £7,300; six boilers, 30ft. by 8ft., £4,500; mechanical stokers, £1,200; ash conveyors, £250; ash elevators, £150; coal bunkers, £1,500; economisers, 288 pipes, £600; superheaters, £850; water storage tank, £700; two feed pumps, each 6,000 gallons, £500; steam-pipes, £5,024; exhaust pipes, £250; injection and overflow pipes, £350; feed pipes, £500; drain-pipes, £250; engine-house floor, £500; central gangway, £150; switchboard, £1,000; conduits, £4,000; distributing switchboard, £1,500; battery, £10,000; booster, £2,000; sub-station switchboards, £1,500; main feeders, £12,500; distributors (five miles, ·3, ·15, ·3), £5,175; cables to feeding points (three in ·5), £4,620; cables for docks district, £1,000; service cables and joint-boxes, £1,700; meters, 300 at £5, £1,500; high-tension boxes and indicators, £500. Plant on order for present works: engine and alternator, £3,150; boiler, £750; feed-water heater, £143; steam-pipes, £300; switch gear, £100; high-tension feeder to town, £560; transformers, £420; alteration to buildings, £150; lighting of new offices, £100. Further extensions required: boiler, £750; condensers, £1,500; cooling tower, £2,000; coal conveyors, £1,200; steam-pipes, £300; injection and overflow pipes, £650; high-tension cables and service cables, £2,000; motor-generator for Empire, £325; switchboard, etc., and fixing, £100—total, £100,767. During the month of June there has been an increase in the power generated (compared with the corresponding period of last year) of 43 per cent. The figures were 57,250 units, compared with 39,879. The revenue has increased by 54½ per cent.

London County Council.—The Council on Tuesday agreed to lend the Battersea Borough Council £10,065 for electric lighting purposes, this being the sixth instalment of sums amounting in the aggregate to £106,683, and the Stepney Borough Council £18,703 for electric light installation. The Treasury have approved of a period of 42 years for repayment of the loan of £12,500 of the Hampstead Metropolitan Borough Council for the purchase of site for electric light station. A report of the Fire Brigade Committee was submitted on the electric light installation at the chief station of the brigade. The tenders, which are quoted elsewhere, being very much in excess of what was anticipated, the committee state that they have carefully reconsidered the whole question. As a result they do not see their way at present to recommend the Council to incur large expenditure in this direction. However, in order that some provision be made so that in the event of the engine in use breaking down the interruption of the electric lighting would not be of long duration, a spare armature is to be purchased. The following notices under Electric Lighting Acts and Orders were agreed to: from the County of London and Brush Provincial Electric Lighting Company, under the County of London (North) and (Northern Extensions) Orders, 1892 and 1897 respectively, of intention to lay power and high and low tension mains across City-road, along Macclesfield-street and President-street, across Goswell-road, along Upper Ashby-street, Northampton-square (east side), Lower Smith-street and Brunswick-close, across Northampton-street and St. John-street-road, along Corporation-row and Bowling Green-lane, across Farringdon-road, along Crawford-passage, Ray-street, and Little Saffron-hill, across Clerkenwell-road, and along Great Saffron-hill and Cross-street, and to construct transformer boxes in Corporation-row and Ray-street; from the London Electric Supply Corporation, under its order of 1889 to lay high-tension distributing mains along Blackfriars-road, Southwark-street, and Borough High-street; the Metropolitan Electric Supply Company, under the Mid-London Order, to lay low-tension mains from Trafalgar-square, along and across West Strand, to the Northumberland-avenue subway (it is proposed that these works shall be in substitution for certain of the works approved by the Council on Jan. 22, 1901, which, it is found, would interfere with the works to be executed in the vicinity by the Baker-street and Waterloo Railway Company); from the St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, to lay mains along a portion of Purchase-street. There was also a notice from the Stepney Borough Council, under the Whitechapel District Order, 1892, and the Mile End Old Town Order, 1900, of intention to lay mains along Osborn-street, Whitechapel-road, and Mile End-road. The Borough Council is the undertaker under the orders, and the Council has no power of approval or disapproval of the works.

Surbiton.—Colonel Slacke has held an enquiry into the application of the District Council to borrow £50,000 for the purposes of electric lighting. Mr. W. W. Mackenzie, barrister, who appeared on behalf of the Council, stated that the population of the district was 15,019 according to the last census, the assessable value was £142,853, and the ratable value £169,135. Application was made in order to enable the Council to carry out the provisional order obtained in 1891 by the Commissioners, who preceded the Urban District Council, the repayment to be spread over 25 years or longer. They proposed to construct a generating station near the junction of Kingsdown and Ewell roads, which was considered a convenient site for the purpose. The cables would be taken along Ewell-road over the railway bridge to the north side of the district, and along Kingsdown-road to Brighton-road, where they would pass under the railway and go as far as the River Thames. At the site which had been selected there was a good supply of water which could be used for the purposes of the station. The site had been selected out of several plots as the most convenient, and the price of the land, an acre and a half, was £1,500. The proposal of the Council on this occasion was to let a company do the work, and for this purpose they had entered into a provisional agreement, which was subject to the loan being sanctioned. Last summer, at the instance of the upper Board, a canvass was made of the occupiers to ascertain how many were likely to take the current. Circulars were left at 1,420 houses, and the replies showed that 171 occupiers were prepared to take the light at once to the extent of 3,236 8-c.p. lamps, and a large number stated they would be willing to take it when the Council were prepared to supply it. They estimated that the total would reach 10,000 lamps to start with. The only other point was in regard to the company who would carry out the work. This was a matter which the Council had given careful and mature consideration to. Whilst it might be advisable in some respects that the Council should undertake the work themselves, they felt that it might for the first two or three years be a burden on the rates; and deprecating any such burden, they had been in communication with a large number of contractors, and they had entered into a provisional agreement with Callender's Cable and Construction Company, Limited, whose offer had been accepted out of six from the chief firms in the country. Under that agreement the company were prepared to undertake the supply of the whole of the plant, the Council paying the cost, at scheduled prices, and under the superintendence of the electrical engineers of the Council. The company would pay all charges of interest and sinking fund on the capital outlay, and all running and other expenses for at least five years, or so much longer as the Council might please. At the end of five years the Council could put an end to the agreement, and in that case they would pay to the contractors by way of premium a sum equal to 2 per cent. per annum on all payments which had been made to the contractor for plant. At the end of seven years the Council could determine the agreement on a payment equal to 13s. 4d. per cent., and, as a third alternative, the Council could take the concern over at the end of 10 years or any subsequent year without payment at all, except for any extensions or additions that had been made. In the event of the company making default in carrying out the agreement, the Council could step in and take over the works.

NOTTINGHAM ELECTRICITY ACCOUNTS.

From the accounts of the Nottingham Corporation electricity works for the year ended March 31, 1901, it appears that the total expenditure on capital account to date amounts to £216,125. 10s. 6d. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended.

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units		2,481,168
Quantity sold: Public lamps	32,542	2,312,557
Quantity sold: Private consumers by meter	2,280,015	
Quantity used on works		19,741
Total quantity accounted for		2,332,298
Quantity not accounted for		148,870
Number of public lamps		68
Total maximum supply demanded (kilowatts)		2,369

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REVENUE ACCOUNT.

Dr.	£	s.	d.
Generation of Electricity.			
Coal	6,736	19	10
Oil, waste, and water	1,135	18	8
Wages at generating station	1,870	19	8
Repairs and maintenance, buildings and plant	1,128	2	3
Distribution of Electricity.			
Wages	93	8	2
Repairs, maintenance, and renewal of mains, etc.	89	8	0
Public lamps, attending and repairs	194	19	9
Rents	59	0	0
Rates and taxes	313	4	7
Salaries	1,767	4	5
Stationery and printing	86	15	0
Establishment and other charges	530	4	5
Insurance	83	2	9
Consolidated stock, management charges, etc.	44	4	4
	14,133	11	10
Bad debts	16	14	0
	14,150	5	10
Balance carried to net revenue account	17,919	16	6
	£32,070	2	4

Cr.	£	s.	d.
Sale of current per meter	30,649	2	5
Public lighting	416	16	8
Rental of meters	542	18	2
Public lamps, attending and repairs	214	9	8
Connections to consumers' premises, net	176	9	9
Stores	1	11	8
Discounts	68	14	0
	£32,070	2	4

BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account — Consolidated stock, £46,830. 2s. 10d.; less stock purchased and cancelled, £763. 18s. 9d.	46,066	4	1
Loans, £171,680; less repaid, £7,855	163,825	0	0
Sundry creditors	2,990	3	1
General district rate account	6,000	0	0
Sinking fund account	4,567	18	8
Repayment of loans account	7,850	8	0
Reserve fund account	10,091	6	7
	£241,391	0	5

Assets.	£	s.	d.
Discount on issue of consolidated stock capitalised	1,614	9	6
Expenses of issue of ,, ,, ,,	215	13	4
Preliminary expenses	361	6	0
Lands	24,543	19	7
Buildings	42,814	1	11
Machinery	76,022	9	2
Accumulators	1,421	18	11
Mains and services	56,289	15	9
Meters	11,701	9	3
Electrical instruments	337	12	4
Arc lamps	832	14	9
Stores on hand	1,475	3	2
Sundry debtors for current supplied, etc.	13,555	18	7
Nottingham Corporation loans fund—proportion of sinking fund investments	3,803	19	11
Cash in hand	6,430	8	3
	£241,391	0	5

PROVISIONAL PATENTS, 1901.

JULY 8.

13851. Improvements in or applicable to electric motors and dynamos and other like apparatus. Frederick Millington, 1 and 4, Mitre-court-chambers, Mitre-court, Fleet-street, London.

13881. Improvements in inductance and induction coils. Harry Shoemaker and Gustave Paul Gehring, 40, Chancery-lane, London. (Complete specification.)

JULY 9.

13934. The application of an enamel for insulating, or decorating, or the combination of both, to covers and bases of switches, ceiling roses, and cut-outs. Meyer Hart Goldstone and James Henry Ward, 45, Dulton-street, Strangeways, Manchester.

13940. System of vacuum-tube lighting and dynamo machine for use in connection therewith. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Moore Electrical Company, United States.) (Complete specification.)

13947. Improvements in and connected with electrical water-heaters. Harry McDonald Hill, 55, Chancery-lane, London. (Complete specification.)

13956. Improvements in electric railways. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (William B. Potter and Clarence D. Clark, United States.) (Complete specification.)

13957. Improvements in controllers for electric motors. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (John B. Linn, United States.) (Complete specification.)

13958. Improvements in electric indicating instruments. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Caryl D. Haskins, United States.) (Complete specification.)

13984. Improvements in or relating to electrical storage batteries. Henry Kingsford Padwick Barham, 60, Fratton-road, Portsmouth. (Complete specification.)

13986. Improvements in electric cables. George Gatton Melhuish Hardingham, Clun House, Surrey-street, Strand, London. (Felten und Guilleaume Carlswerk Actiengesellschaft Germany.)

JULY 10.

14034. Improvements in leaden plates and bars, or connecting rods or lugs, for secondary batteries or accumulators, and the moulds and tools connected therewith. Philip John Davies, 78, Earl's Court-road, Kensington, London.

14049. Improvements in trolley heads for electric tramcars. John Henry Fooks Bale, 70, Market-street, Manchester.

14059. A form of rotary synchronous alternating-current motor. George Becket Batten, 2, Underhill-road, Lordship-lane, London.

14066. Improvements in the construction of electrodes for accumulator batteries, and in moulds therefor. Robert Jacob Gulcher, 322, High Holborn, London. (Complete specification.)

14102. Improvements in electrical indicating apparatus. Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

JULY 11.

8110A. Improvements in electric couplings and switching apparatus. Haydn Thies Harrison, 46, Lincoln's-inn-fields, London. (Date claimed under Patents Rule 19, April 19, 1901.)

14110. An improved method of automatically regulating the flow of liquids, gases, electricity, chemicals, and powders. William Player Miles, St. Cuthbert's, Grove Park, Kent.

14165. Improvements in or relating to the manufacture of carbon electrodes and of coke. Eduard Pohl, 322, High Holborn, London.

14170. Improvements in or relating to covering the conductors of multiple or other telegraph or telephone low-capacity cables. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

JULY 12.

14219. Improvements in means and apparatus for operating and controlling telegraphic and other apparatus or mechanism from a distance without wire or other like connections. James Tarbotton Armstrong and Axel Orling, 40, Vartry-road, Stamford Hill, London.

14235. Improvements in or relating to electric signalling or whistling devices. Stuart Augustus Brown and John William Points, 111, Hatton-garden, London. (Complete specification.)

14236. Improvements in the working and controlling of electrically-driven cars. Siemens Bros. and Co., Limited, and Alexander Siemens, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14237. Improvements in and connected with electric arc lamps. John Owen Girdlestone and Carl Frederik Grimur Thorkelin, 16, Davies-street, Berkeley-square, London.

JULY 13.

14295. Wire guard for electric arc lamps. John William Richards, 62, St. Vincent-street, Glasgow.

14319. A new or improved arrangement for producing the voltaic arc between metal electrodes. Joseph von Kowalski and Ignaz Moscicki, Palace-chambers, Westminster, London.

14323. Improvements in electrical machines. Horace Milton Abel, 111, Hatton-garden, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 3.

1900.

12709. Electric arc lamps. Lewis.

13533. Electric motor road vehicles. Draullette.

13679. Holders for electrolytic incandescent lamps. Drake, Sheppard, and Nernst Electric Light, Limited.

15718. Preparation of conducting material chiefly designed for the manufacture of brushes for dynamo-electric machines. Lake. (Fay.)

16299. Construction of electric switch. Schulz.

23155. Arrangement and connection for single and multiplex wireless telegraphy. Feeny. (Allgemeine Elektricitäts Gesellschaft.)

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1901.

5017. Electric batteries. Heidel.

8395. Telephone transmitters. Hughes.

10275. Controlling electric motors. British Thomson-Houston Company, Limited. (Day.)

10459. Storage batteries. Apple.

10506. Magnetic separating apparatus. Edison Ore Milling Syndicate, Limited. (Edison.)

10976. Electrolytic cells. Justice. (Castner Electrolytic Alkali Company.)

12119. Method of and combination of apparatus for translating and relaying telegraph cable signals. Gorton.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	July 13	949	753	+ 196	—	—
Birmingham Tramways	,, 15	4,905	4,675	+ 230	122,622	120,234*b*
Blackburn Corporation	,, 13	574	520	+ 54	13,162	12,006*b*
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 13	1,042	949	+ 93	1,827	1,750
Bolton Corporation	,, 14	1,690	1,575	+ 115	39,628	30,309*b*
Bradford Corporation	—	—	—	—	—	—
Bristol Tramways Company	,, 12	5,066	3,604	+ 1,462	—	—
Carlisle Tramways Company	—	—	—	— *b*	—	—
Central London Railway	,, 13	6,145	—	—	12,224	—
City and South London Railway	,, 14	1,872	1,436	+ 436	3,844	2,883
Cork E. T. and L. Company	,, 11	611	526	+ 85	12,205	10,599*b*
Darwen Corporation	—	—	—	—	—	—
Dover Corporation	,, 16	274	272	+ 2	5,382	5,009*b*
Dublin & Lucan Electric Railway	—	—	—	—	—	—
Dublin U. T., electric cars	,, 12	4,172	3,849	+ 323	—	—
Dublin S. District, Electric	,, 12	1,205	1,144	+ 61	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 13	12,962	9,855	+ 3,097	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	,, 13	1,101	725	+ 376	13,661	10,674
Hull Corporation, E. S.	,, 13	1,775	1,357	+ 418	3,502	2,669
Liverpool Corporation	,, 6	9,936	8,440	+ 1,496	231,574	198,468*b*
Liverpool Overhead Railway	,, 14	1,765	1,755	+ 10	3,497	3,442
Oldham-Ashton-Hyde Tramways	,, 12	553	546	+ 7	13,525	13,066*b*
Portsmouth Corporation	,, 13	979	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 14	3,907	—	—	—	—
Southampton Corporation	—	—	—	—	—	—
Southport Corporation	—	—	—	—	— *d*	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. *b* From Jan. 1. *d* From April 1 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £263 decrease.
Barcelona Ensanche y Gracia, £44 decrease. Barcelona, £228 increase.
Brisbane, £923 increase.
Buenos Ayres and Belgrano Electric, £.28 increase.
Calcutta, £155 increase.
Cape Town (month of June), receipts, £13,119; expenditure, £6,380.
Mexico Electric (month of June), receipts, £18,465.
Perth Electric, £448 increase.
Port Elizabeth (month of June), receipts, £2,983; expenditure, £1,800.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅜-½
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	11-16-13/16
—— Ordinary, 1-125,000	1 ..	⅜-½
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	6¼-6¾
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4½-5
British Electrical Engineering, Ordinary	2 ..	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	103-108
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	107-111
—— Ordinary	5 ..	14-15
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	3 ..	3¼-4
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	1-1½
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	92-96
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	100-103
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9½-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	15½-16½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	101-104
Telegraph Construction and Maintenance	12 ..	36-40
—— 5 per cent. Bonds	100 ..	101-104
Telegraph Manufacturing, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	95-100
Bournemouth and Poole, Ordinary	10 ..	12½-13½
—— 4½ per cent. Cum. Pref.	10 ..	11-10
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	7⅞-8¼
—— 7 per cent. Preference	5 ..	8¼-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7⅞-8¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	102-104
Chelsea Electricity Supply	5 ..	5¾-6¼
—— 4½ per cent. Debentures	100 ..	107-110
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	12½-13½
—— 5 per cent. Debenture Stock	100 ..	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	100-102
County of London and Brush Provincial, Ordinary	10 ..	8¼-9½
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	103-106
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¼-6
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7½-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11¼-12¼
—— 4 per cent. Debenture Stock, Red.	100 ..	102-105
Kensington and Knightsbridge and Notting Hill	100 ..	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1½
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13¼-14¼
—— ,, 85,001-98,769	5 ..	13¼-14¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	108-111
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	94-97
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1½
—— £5 Shares	5 ..	7-7½
—— £4½ Shares, New	4½ ..	6-6½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5¼-6¼
—— 4 per cent. Debenture Stock	100 ..	101-104
River Plate Electric Light and Traction, Deb.	100 ..	65-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11½-12½
Electric Railways.—		
Central London, Ordinary	100 ..	91-94
—— 4 per cent. Pref.	100 ..	98-101
—— ,, deferred	100 ..	92-95
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	54-56
—— Ordinary	10 ..	5¼-5¾
—— 4 per cent. Debenture Stock	100 ..	112-117
—— 5 per cent. Pref. Stock '91	100 ..	132-137
—— ,, ,, '96	100 ..	122-128
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-129
Blackpool and Fleetwood Tramroad	10 ..	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¼-3½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	101-103
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¼-7
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14¼-15½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-13
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅞-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5¾
—— 5 per cent. Deb. Stock, Red.	100 ..	102-105
—— Prov. Cert., all paid	100 ..	96-99
Cape Electric Tramways, Nos. 1-400,000	1 ..	1¾-2
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5¼-5¾
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11½-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	98-102
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	105-107
New General Traction, Ordinary	5 ..	3-3½
—— 6 per cent. Cum. Pref.	10 ..	4½-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	12-13
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	105-108
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	6s. ..	5/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	30 p.c. ..	30 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	3⅜-3⅝
—— 6 per cent. Cum. First Pref.	10 ..	11-12
—— 6 per cent. Cum. Second Pref.	10 ..	11-12
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-4⅜
—— 4 per cent. Deb. Stock, Red.	100 ..	95-98
—— 3½ per cent. Deb. Stock, Red.	100 ..	90-93
Oriental Telephone and Electric Company	1 ..	½-1

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NOTES.

Municipal Telephones. — We are given to understand that to-morrow the Lord Mayor of London will publicly inaugurate the municipal telephone system at Tunbridge Wells.

Junior Engineers.—A number of members of the Institution of Junior Engineers will, on Monday evening next, make a visit of inspection to the recently-inaugurated electric lighting and tramways installation of the East Ham District Council.

"Chloride" versus "Tudor."—The cricket clubs of the Chloride Electrical Storage Syndicate, Limited, and the Tudor Accumulator Company, Limited, played a match at Dukinfield on Saturday last, resulting in a victory for the Chloride. The scores were: Chloride, 57; Tudor, 33.

Tramways and Light Railways Association.—The annual dinner of the Tramways and Light Railways Association has been fixed to take place at Glasgow on Wednesday, Sept. 4. This date is believed to be the most convenient for the majority of members, inasmuch as the International Engineering Congress will meet in Glasgow that week.

Royal Warrant.—We are informed that the King has been graciously pleased to grant to the Electrical Power Storage Company, Limited, of 4, Great Winchester-street, E.C., a warrant of appointment as makers of electrical secondary cells to his Majesty. This company had the honour of holding a similar warrant from her late Majesty, which warrant was the first ever granted to any electrical manufacturer.

Swiss Enterprise.—We hear that the Swiss town of Davos proposes to introduce electricity for all industrial and domestic purposes, thus dispensing with fuel of any description. An extensive electrical generating plant would be erected at the confluence of two mountain torrents, and, it is stated, a prominent firm of Swiss electrical engineers has obtained the necessary permission to utilise the torrents for this purpose. The cost of the first installation is put at about £340,000.

Faraday House.—As a result of the recent scholarship examination, the following awards have been made by the Board of the Electrical Standardising, Testing, and Training Institution: to F. T. Homan, of Portsmouth Grammar School, an exhibition value 30 guineas, tenable for two years; to R. A. Harris, of Portsmouth Grammar School, and A. T. Morris, of Bedford Modern School, special prizes of 20 guineas each; and to S. P. Smith and H. W. Swann, special prizes of 10 guineas each.

A Russian Electric Railway.—The first electric suburban railroad in Russia has, we note, just been opened for traffic. The new line connects the manufacturing town of Lodz, in Russian Poland, with the neighbouring towns of Zgierz and Pabianico, and is 13½ miles long, while the total cost is put at £112,000. It is one of the provisions of the charter that the Russian Government shall receive a share of the profits, also the right to purchase after 20 years, and that the road intact shall become Government property at the expiration of 28 years' time.

An Inevitable Accident. — A peculiar accident, which, however, serves to illustrate the great need for a reserve in connection with the running of an electric power plant by water power, occurred recently in California, and resulted in the temporary closing down of the Folsom power station, which supplies current to the Sacramento Electric, Gas, and Railway Company. The State rock-crushing plant close to the station was destroyed by fire, and the wreckage, falling into the Electric Company's canal, completely choked it up. This caused the temporary shutting down of the electric plant, and for several hours the greater part of Sacramento was in darkness.

Nernst Lamp Filament.—In the Nernst type of electric lamp the anode contact acquires a higher temperature than the cathode contact, which may sooner or later produce rupture near the former contact. The rupture takes place either in the platinum wire or in the filament near the contact, the cause in either case being the excessive temperature developed at this spot. The *Electrical World* records a patent granted to B. M. Drake, of London, in the United States on the 2nd inst., in which means are described for remedying this defect. The invention consists in dissipating the heat generated at the anode contact by supplying that contact with heat radiating devices; these devices consist of spirals of wires embedded in and projecting from the anode contact.

Starting-up Nernst Lamps.—The *Electrical World* records a patent which has just been issued to Isidor Kitsee relating to means for starting-up electrolytic lamps when introduced into circuit. When the pencil of this kind of lamp is moistened with a solution containing a slight percentage of metallic salt it becomes a partial conductor, and the method invented by Kitsee consists in spraying the pencil with a liquid consisting of a solution of 2 per cent. of magnesium or 1 per cent. of acid. When the switch connecting the pencil to the circuit is closed, the pencil is sprayed with the liquid by means of a bulb attached to the lamp. The passage of the current will then raise the temperature of the pencil to such a high degree that the moisture will evaporate, and leave the pencil with a temperature sufficiently high for the passage of current even after the moisture has entirely disappeared.

Electrolytic Production of White Lead. — Inventors have of late been paying considerable attention with regard to producing white lead by electrolysis, and several important patents have been issued for improvements in this direction. Among the most recent patents which have been issued in the States we notice one which consists in adding to the sodium nitrate solution in the anode compartment of a partitioned cell a certain amount of sodium chloride, lead anodes being used. The lead nitrate, which is formed upon passage of the current, is at once transformed to chloride, which is kept in solution by heating the electrolyte. Continued action of this current oxidises the chloride of lead to chlorate, and from this hot solution white lead is precipitated by means of an alkaline carbonate, obtained by injecting carbonic acid into the cathode solution.

Treatment of Copper Ores by Electrolysis.—Among the recent patents granted in the United States is one to John C. Kessler for a process for the treatment of copper ores. A solution of hydrated oxide of copper in ammonia, or any of the cuprammonium salts, as the carbonate, sulphate, or chloride, may be used in this method, and in practice this solvent is admitted to tanks in quantity sufficient to cover the ore, the evaporation of ammonia being checked by a surface stratum of water. The solution becomes reduced by taking up the metal to the lower state of oxidation, and electrolysis is invoked to regenerate it with recovery of one-half of its copper. It is claimed that 24 to 28 hours suffice to entirely exhaust the ore of its copper, that other metals present are unattacked, and that the action is accelerated by the addition of ammonium salts to the solution.

A New Wire Insulation.—A patent recently granted in the States to C. E. Woods refers to the use of animal

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intestines in the insulation of conductors. The inventor has found that the intestines of many animals, especially of the sheep and hog, form very perfect insulating material when properly prepared and applied. The intestines are thoroughly cleansed and purified, the inner and outer walls being chosen for the purposes of insulation. It is also preferable to have the intestine with its natural moisture in it. It is wrapped around the conductor so that the edges overlap, thus forming a continuous sheath, for when so wrapped the two overlapping edges of the intestines become firmly united together. The natural shrinking of the intestines so applied form a very close, firm, and continuous sheet of coating for the wire. This coating, however, may be overlaid with a cotton or silk wrapping, shellac, or colouring matter, or a coating of vulcanite. We trust that such wires will not cause another mutiny in India or amongst wiremen. They certainly would be useful adjuncts to a ship's crew cast away without provisions.

Post Office Telephones.—As previously announced, the inauguration of the State telephone system in London is expected to take place next October, and efforts are already being made to get together an efficient staff of operators, etc. In this connection we note that the Postmaster-General has issued a circular notifying that girls of from 17 to 19 years of age will be eligible for employment as telephone operators. Among the numerous qualifications which will be considered in the election of candidates, good articulation, the pitch of voice, and general self-possession figure prominently. For example: any candidate showing indication of nervousness, hysteria, or a strongly-marked local dialect is not likely to be accepted. The examination to which the girls offering themselves for employment in this capacity will be subjected, should not give much difficulty to those who have passed the fourth or fifth standard at an elementary school. In London the pay will be 11s. a week for the first year, 14s. for the second, the maximum of 20s. being reached in the fifth year. The rates for the provinces will be 2s. a week less, commencing at 10s.

The Workshops Acts and "Transforming."—A meeting of the Standing Committee on Trade of the London Chamber of Commerce was held on Monday, when the Factory and Workshops Amendment Bill was further considered on the proposal of the Electrical Trade Section of this chamber to exclude "transforming" from the requirements of the Factory and Workshops Acts in regard to electrical stations. The acceptance of this amendment was urged upon the Home Secretary by Mr. H. Seton-Karr, M.P. It was admitted by Mr. Ritchie that the Bill would involve an enlargement of the existing law, and that as the clause stood it would cover transforming stations which were dangerous and those which were not, and also stations where people were regularly employed and others where no one was employed. Mr. Mather, M.P., also pointed out that the words used were ambiguous, and were likely to go further than was intended. Ultimately, Mr. Ritchie promised to confer with the Board of Trade on the subject, and also to consider any representations that might be made to him on behalf of the industry before the Bill was finally disposed of.

Technical Education.—We are pleased to note that the London County Council are moving in the matter of making provision for special training in advanced technology. The Technical Education Board reported to the Council on Tuesday that they had appointed a sub-committee to enquire and report (*a*) as to the need and present provision for special training of an advanced kind in connection with the application of science, especially chemistry and electricity, to industry; and (*b*) as to what, if any, developments are needed to secure efficient training in these subjects for senior county scholars and for advanced students who desire to equip themselves to take leading positions in scientific industries. The Board state that the institutions already at work, together with those projected and in various stages of completion, will go far to provide every district of London with adequate evening class teaching in the more elementary grades of scientific, artistic, and technological instruction. But it has been represented that it is in the provision for technological instruction of high grade, especially in chemistry and electricity, that London is now most lacking. A special enquiry is, therefore, to be made into the subject.

The Telegraphic and Telephonic Services.—A short while ago the Associated Chambers of Commerce of the United Kingdom presented a memorial to the Postmaster-General urging the need of a more efficient telegraphic and telephonic service between the commercial and manufacturing centres of the country. Mr. Lamb, on behalf of Lord Londonderry, has now replied to the effect that, with the object of securing the greatest efficiency, his lordship has recently appointed two experts of great experience, whose duty it is to examine the working of the telegraphs at all the larger offices, and to concert measures for effecting any necessary improvements of service. The reply then goes on to give details of the efforts that are being made to improve both the telegraphic and telephonic services all over the country, and to keep pace with the constantly increasing requirements of business men. In addition to the system, containing about 29,000 miles of wire, purchased from the National Telephone Company, about 47,831 miles of wire had been erected by the Post Office up to the end of March last, making a total to that date of 76,831 miles. The number of trunk circuits which have been authorised year by year from March, 1896, to March, 1901, is as follows: for the year 1896-1897, 83; 1897-1898, 65; 1898-1899, 74; 1899-1900, 93; 1900-1901, 125; and a large number of additional circuits will be authorised during the present financial year.

Electrical Equipment of the District Railway.—The company known as the "Metropolitan District Electric Traction Company, Limited," which Mr. Chas. T. Yerkes has formed for the purpose of introducing electric traction on the District Railway, has now been duly registered at Somerset House. The capital of the company is £1,000,000, in £20 shares, and, with one exception, the subscribers to the memorandum of association all hail from the States. The objects of the new company are set out at length, the principal intention being to carry into effect certain agreements with the Metropolitan District Railway for the "electrical equipment and traction of the District Railway, or any railways of which the railway company is part or joint owner, or over which it has running powers, or in which it is interested"; also to enter into an agreement with the District Railway Company and the Brompton and Piccadilly-circus Railway Company for the erection of a generating station upon lands belonging to them, and "for the working and use thereof." Other objects of the company include the construction of subways and ducts, the laying down of cables and rails, and the building of sub-stations, the execution of all the necessary works for the conversion of the railways to electric traction, the equipment and maintenance of the generating station or power-house, etc. There will be no initial public issue. The number of directors is not to be less than three nor more than five, the first to be appointed by the subscribers.

Rapid Transit.—The latest New York scheme, which would make an important addition to the rapid transit

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facilities of that city, is the proposal to construct an electric road from Manhattan to the suburb of Portchester. The most interesting feature as regards the equipment of this line, which would cover a distance of about 25 miles, would be the introduction of the third rail. The proposal is to lay down four sets of metals, two of which would be used for express trains only. Such a system, of course, would carry with it enormous advantages, enabling, as it would, the long-journey passenger to reach his destination without experiencing the long and tedious stoppages *en route* to take up and set down passengers. These stoppages, however, are inevitable where only one track is available, and in London, perhaps, the delay in metropolitan communication due to this cause is more apparent than in any other great city. Here the advantages of such an express metropolitan train service would be especially welcomed by business men travelling from the suburban districts to the City, who seldom have occasion to alight at the intermediate stations. Notwithstanding the comparatively short time now occupied in making the journey from Shepherd's Bush to the Bank on the Central London Railway, for example, no one could deny that a duplicate set of tracks entirely devoted to an express service would result in the greatest benefit to the general public, as well as giving a decided impetus to the business of the company itself, as it would at least halve the time spent on the journey.

X-Rays in the Treatment .of Lupus.—In the current number of the *Lancet*, Mr. J. Startin, senior surgeon to the London Skin Hospital, records several cases of lupus, rodent ulcer, and other affections of the skin which have proved the great value of the X-rays as a therapeutic agent. The instrument with which Mr. Startin has been working consists of a 15in. sectional coil, worked at 16 volts with a mercuric interrupter. The average speed of interruptions is about 250 a minute, the average current about from three to five amperes. The surgeon explains that he places the tube generally at a distance of 5in. between the anti-cathode and the part to be exposed, and the duration of the exposure lasts from 10 to 15 minutes, giving four or five exposures on consecutive days. As far as his experience leads him at present, the most suitable cases for treatment by the X-rays are lupus (both true and erythematous), rodent ulcer, psoriasis, and other diseases of the ringworm class. To these may be added superficial cancerous affections and dermal tuberculosis. Mr. Startin gives five instances of the successful application of the X-rays for rodent ulcer, true lupus, erythematous lupus, foul ulcer, and psoriasis respectively. All were extreme cases, and are, therefore, the more conclusive as to the value of the X-rays for affections of the skin. The writer's inference is that when the penetrative power can be got to extend still further than at present, if it be true that cultivated bacteria can be destroyed in 15 to 20 minutes, then the X-rays show a future use in antiseptic surgery.

Communication between Sark and Guernsey.—The question of connecting the island of Sark with Guernsey by wireless telegraphy was raised in the House of Commons on Monday, when Mr. Henniker Heaton asked the Secretary to the Treasury, as representing the Postmaster-General, whether he proposed to continue the policy of his predecessor in refusing an offer of Marconi's Wireless Telegraph Company to connect the two islands by wireless telegraphy without any expense whatever to the Government. Mr. Austen Chamberlain replied to the effect that the Postmaster-General has not received any fresh application for the connection by telegraph of the island of Sark with Guernsey. He was in correspondence with the Attorney-General of Guernsey, who took much trouble to obtain the necessary guarantees, but unfortunately without success. The Postmaster-General has no reason to suppose that the Marconi Wireless Telegraph Company are prepared to maintain permanent telegraphic communication between Sark and Guernsey without charge, and it is, of course, permanent communication that is required. Mr. Henniker Heaton, however, pressed the point, asking whether the hon. member was aware that the Marconi company were prepared to supply communication without charge either temporarily or permanently. Why had the boon been refused? Mr. Austen Chamberlain said he was not aware of that fact. The information supplied to him by the Postmaster-General was not in accord with that statement. To the further enquiry as to whether the hon. gentleman was aware that the offer had been put in writing, no answer was made.

Arc Lamp Photometry.—Prof. C. P. Mathews communicated to the recent meeting of the National Electric Light Association at Niagara Falls an interesting contribution on photometric values of arc lamps. We are pleased to remember that Prof. C. P. Mathews, who has done such good work in the United States in connection with standard of lights and photometry of arc and incandescent lamps, received his training at the Central Institution, Exhibition-road. The last apparatus devised by Prof. Mathews avoids the difficulties usually met with when ascertaining the mean spherical intensity of the light coming from an arc lamp. The author arranges a series of mirrors, which are placed round the arc, thus forming a segment of a cone. The angles of these mirrors are so arranged that the light is reflected by all of them on to the photometer, which in this way gives with a single reading the mean spherical intensity of the light from the lamp. In connection with this apparatus the author also arranged supports for six arc lamps. These were connected on to a wheel which could be revolved so as to bring any one of the six lamps into a position to be tried. The object of the arrangement was that experiments could be carried out on the lamps over a considerable period, such as, for instance, the life of the carbons in an enclosed arc lamp to see how the candle-power varied with time. In the paper a great many useful figures are given which were obtained by the author with this apparatus, and anyone especially interested in the photometry of arc lamps should obtain the full paper from the association. What particularly strikes one in glancing over the results is the comparatively low candle-power of the arc lamps in question.

Electric Traction in the Metropolis.—So far back as June, 1899, the London County Council's Highways Committee had it referred to them to investigate and report as to the practicability of constructing a shallow underground electric tramway from Westminster to the Bank, thence under Moorgate-street to the terminus of the North Metropolitan at Finsbury-pavement, on a similar principle to those laid down under Andrassystrasse, Budapest and in Boston, U.S.A. The suggestion also included provision being made beside the tramlines for suitable subways to contain electric light, gas and water mains, telephone wires, etc. For the past two years the matter has been engaging the attention of the committee, during which time various reports by the responsible officers of the Council with regard to it have been presented and considered. The home of such schemes as that referred to above, however, is largely in America, and it has now been decided to send the Council's electrical engineer and its tramway manager, as officers accredited by the Council, for the purpose of observing in what way such schemes have been carried out there, and to report as to whether similar schemes could with advantage be carried out in London. In their report containing this recommendation the

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Highways Committee say that while this would be the primary object of the visit of these officials, they would, no doubt, be able to obtain information which would prove valuable with reference to the latest developments in America concerning the application of electrical and other forms of mechanical traction to tramways in that country. We quite agree with the committee's conclusion as to the great importance of obtaining the very latest information possible with regard to electric traction, and are pleased to see that they have adopted a course which will bring matters to a head.

Testing Large Transformers.—In a recent number of the *Electrical World* Mr. J. S. Peck has a very interesting article on the testing of large transformers, in which a number of good points are brought out. The 2,250-kw. transformers which were tested are the largest yet constructed. The iron core weighs 6½ metric tons, or for each kilowatt of full-load activity of the transformer there is provided not quite 6½lb. of iron core, representing an activity per unit mass of about 150 watts per pound of core. The cyclical magnetic density is also carried up to nearly 12 kilogausses, and the total cyclic flux appears to be nearly four mega-maxwells. The efficiency is a maximum in the neighbourhood of full load, and amounts to nearly 0·987, which represents a loss of about 1·3 per cent. at full load, the loss at 10 per cent. of full load being only 2·7 per cent. The reactance factor of the transformer is only about 2·6 from the figures given, which is decidedly low considering that the high-pressure coils withstand 22 kilovolts normally, and are tested up to nearly 50 kilovolts effective. The full-load copper drop is about ¾ of 1 per cent., and the full-load reactance drop nearly 2 per cent. An interesting point is that the reason for the use of the transformers referred to is the reduction of pressure at the junction of the overhead and underground conductor systems near Buffalo, New York, from 22 to 11 kilovolts. This shows the importance of obtaining an insulating material for underground cables which shall be cheap, and which shall at the same time be capable of withstanding a high pressure. The only reason that the author can suggest for the reduction from 22 to 11 kilovolts is to assist the subterranean cables, which if guaranteed against the higher pressure would have to be made much thicker and more expensive. It has therefore been judged preferable, concludes the author, to pay a toll on the transformers of some 2 per cent. in the power transmitted to Buffalo, in addition to the extra copper loss for the lower pressure, rather than pay for the extra insulation which would sustain 22 kilovolts safely.

Photo-Telegraphy.—We have this week had an interview with Mr. Alfred Blasendorff, who has explained to us some ideas of his, having for their object the transmission of ordinary photographs or of coloured pictures by means of electricity. A brief *résumé* of his suggestions may be of interest, but he has done practically no work towards the actual carrying out of his ideas. In the first place, the photographs, either plain or coloured, which would be transmitted would have to be prepared on a transparent film, which could be coiled round a revolving cylinder. A source of light inside this cylinder would project a beam through a small portion of the film on to a selenium cell in the electric circuit. By means of a screw thread and a uniform rotation the actual portion of the film through which the light would pass on to the selenium cell would be gradually varied, and the current in the transmitting circuit would be correspondingly varied according to the thickness of the image on the film or its colour. A somewhat similar apparatus revolving in synchronism at the opposite end of the line would be used to produce a fac-simile photograph. In the case of a black and white image, a single wire with earthed connections would, in Mr. Blasendorff's opinion, be quite sufficient, although we think he would require other wires in order to synchronise the revolving apparatus. For the transmission of coloured photographs, three wires and earth are suggested. The three wires would be—one for red rays, one for yellow, and one for blue. In place of the selenium cell, either a heated resistance or a thermo-electric couple might be used. It will be gathered from the above that while in certain details Mr. Blasendorff's ideas may be novel, they are not unlike those which have been evolved by other students in electrical matters in connection with the influence of light on selenium. The interval of time which has to elapse before the selenium responds to light, and the corresponding interval before reaching its normal state after the light has been removed, hampers exceedingly the realisation in practice of such ideas. In the present case we do not see much reason to hope that the transmission would be much quicker than the ordinary postal dispatch, and every reason for suspecting that the result would not be so accurate.

The Nodon Rectifier.—In our last issue we gave a description of a rectifier for alternating currents designed by Mr. C. Pollak, in which aluminium plates in a solution of phosphate of potassium are used to rectify alternating currents. We now notice in the current issue of our French contemporary, *L'Electricien*, a reference to an apparatus designed by Mr. A. Nodon with the same object. For this apparatus it is claimed that much higher voltages can be rectified than with the apparatus before referred to. A full description of Mr. Nodon's apparatus is promised by the editor shortly, but the principles on which it works are set out as follows: In the usual type of these rectifiers an electrostatic charge is produced in the condenser, which is lost to a certain extent because the E.M.F. which it sets up is much higher than that corresponding to the primary current during the half period which is not redressed. In order to avoid this inconvenience, Mr. Nodon makes the surface of the active electrode much smaller than that of the passive electrode, which is of graphite. The ratio is about 1 to 1,000. In other words, he utilises separately the two half periods of the current on different circuits on which their action is made to be the same. Under these conditions, he claims to have obtained an efficiency of from 90 to 95 per cent. The so-called active electrode is made of an alloy of zinc and aluminium, and the passage of the current through it in one direction is prevented by the formation of a coating of a double phosphate of zinc and aluminium at the surface. In the half period which follows the formation of this insulating coating it is instantly dissolved, leaving a free path for the current in the opposite direction. When the coating is blocking the current in one direction, it takes an electrostatic charge, and the resistance which is interposed in the condenser circuit is different to that of the circuit utilising the redressed current. In this way the author claims to have obtained about equal current for each of the half periods. We look forward with interest to the publication of the details of this apparatus and a further description of the high voltages with which it has been successfully used. In the note now before us it is said that it is applicable up to 2,000 volts, which is much higher than could be used to any apparatus of the same type of which we have previously heard.

Heating of Magnet Coils.—The *Electrical World* for the 13th inst. publishes an interesting paper on this subject by Messrs. S. S. Neu, A. J. Levine, and O. A. Havill, who give the results of an investigation to determine the distribution of heat in the coils of field magnets under various

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conditions. From the results obtained curves were plotted showing the temperature in different parts of each layer of winding, and these are presented with the paper. The machines experimented upon were a 1-h.p. and a 5-h.p. Crocker-Wheeler 115-volt bipolar shunt motor, the field coils being specially wound in 16 sections of equal cross-sections. In the first place, the authors observed that the ultimate mean temperature elevation of the field coils under full excitation is nearly the same whether the machine be running or stationary. If the machine be stationary, the armature is not a source of heat, and consequently the iron field frame absorbs a large amount of heat in the early hours of field excitation, with a corresponding retardation of rise in field temperature. When the machine is running and the armature is heated, however, there is an appreciable cooling action due to the movement of the air in the neighbourhood of the machine under the action of the revolving armature, and tending to offset the heating influence of the active armature. After a sufficient lapse of time, therefore, the final mean temperature elevation of the field coils is not very different in either the stationary or running condition. Another interesting point is that the hottest zone in the active field coil is not far from the centre of symmetry of the cross-section of the coil, being very nearly half-way up their length. Again, it is interesting to observe that the maximum temperature elevation is nearer to the mean temperature elevation when the machine is running than when the machine is at rest, and since the running condition is the normal condition for which the machine is tested, and at which heating occurs in practice, the tendency to overheat the centre of the field coils by marked increase above average temperature indicated by coil resistance is less when the machine is running than if the coils be heated with the machine at rest. With regard to deductions concerning ratio of temperature elevation shown by thermometer to temperature elevation shown by resistance, the author's conclusion is that the value of 0·6 obtained in these measurements is more than usually low, owing to the relatively large thickness of the field coils in the comparatively small dynamos tested.

Constant-Potential Constant-Current Transformation.—At the recent convention of the Canadian Electrical Association a paper was read by Prof. R. B. Owens, in which the author particularly referred to the advantages of a method of obtaining constant current from constant potential by means of a combination of impedance coils and condensers. The method in question, which was due originally to Leblanc, and treated mathematically by Steinmetz and others, although known for some time, has not, in the author's opinion, received the attention it deserves. It can be shown from the theoretical consideration that when a constant potential is applied to two equal magnetic reactances with a variable non-inductive receiver circuit, the receiver circuit and one reactance being shunted by a condenser whose capacity reactance equals either magnetic reactance, the current in the receiver circuits will remain constant and be independent of the receiver circuit resistance. In order to test such an arrangement, two impedance coils were constructed, their impedance being made variable by the insertion of strips of rubber under their keepers, and connected in series with a smaller coil of constant reactance and a variable non-inductive receiver circuit. The coil consisted of 490 turns of No. 12 B. & S. wire having a resistance of ·98 ohm. Regarding the arrangement of the apparatus, a 28-microfarad condenser shunted the receiver circuits and the two impedance coils. The reactance of the two coils in the receiver circuit was made as nearly as possible equal to the reactance of the remaining impedance coil and also of the condenser. Five hundred volts at 50 cycles were then applied to the main circuit, and the efficiency of the power factor of the combination noted, as well as the current in the receiver circuit. The power factor of the receiving circuits was varied from a small value to something over 80 per cent., and the power factor of the main circuit therefore remained throughout practically unity. The test showed that the efficiency is nearly constant through a wide range, although not high in this particular case, due to the design of the impedance coils. The current in the receiving circuit varied only some 6 per cent. between half and full load, a result which the author regards as sufficiently satisfactory. Perfect regulation, however, can be obtained with better proportioned apparatus. The results in this case, however, clearly point to a method of constant-potential constant-current transformation possessing the characteristics of high efficiency, unity power factor, close regulation, absence of moving parts, and requiring a comparatively small floor space.

Electricity in St. Marylebone.—The Lighting Committee of the Corporation of the metropolitan borough of St. Marylebone had a report last night before the Council which, in our opinion, displays a great want of good judgment on the part of the committee. In the first place, it must be remembered that the Metropolitan Electric Supply Company has the electric lighting of the district, and that the old Vestry of Marylebone and the new metropolitan Borough Council have been anxious to acquire the rights of that company and its plant within the district. Instead however, of giving the company facilities for carrying on its works, there has been for years unreasonable opposition offered to most things which the company has wished to do. As regards the laying of mains in the public streets for distributing electricity, the Corporation has not much option, except that it can object to the positions in which it is proposed to lay these mains, and to any deviations from the plans submitted. On these grounds several objections have been raised and fought. The company recently wished to lay some high-pressure mains in Edgware-road to connect with works in Paddington, and permission to lay these has been refused on the ground that they are not required for the lighting of the district. The company accordingly has appealed to the Board of Trade. The committee now recommend the Council that in the event of the Board of Trade's decision being unfavourable to the Council, legal proceedings should be taken to support the Council's contention, that the company has not power under its Acts and orders to lay mains for the purpose of bringing current from Paddington. We suppose that the committee have taken legal advice on the subject, but fancy they would have a hard task to prove their case in view of the decision of Parliament respecting wayleaves. In another instance we also find that the committee have refused permission to lay new pipes, because they are informed that there is a certain amount of room in the pipes already laid down by the company. We can hardly credit a belief that a company would wish to open up streets and lay down new pipes at the great cost involved unless there was an absolute necessity for the extension, and we do not think that it lies within the province of the local authority to decide what pipes or mains are actually required for the carrying out of the obligations of an electric lighting provisional order owned by a company. The obstruction displayed towards this electric lighting undertaking is, in our opinion, both childish and unfair. The only reason we can see is that there is a wish to depreciate the value of an undertaking which the Council wish to purchase.

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EAST HAM'S ELECTRICAL UNDERTAKINGS.

On Thursday evening last week took place the official inauguration of the East Ham District Council's electric light and tramway undertakings in the presence of a large number of invited guests. A full description of the works and tramway system will be found below. Punctual to time the chairman (Councillor John Savage, J.P.) called upon Councillor T. L. Knight, the chairman of the Electric Lighting and Tramways Committee, to "switch on" the electric light, and to declare the undertaking open. This ceremony over, the company inspected the power-house, after which an adjournment was made to the car-shed, where five of the Council's new cars were in waiting to convey the visitors over the tramway system. A start was made in the direction of Ilford, and after the excessive heat of the day the ride proved most refreshing. On returning to the car-shed the visitors were entertained to a cold collation by Messrs. Dick, Kerr, and Co., the principal contractors. Speeches, of course, followed.

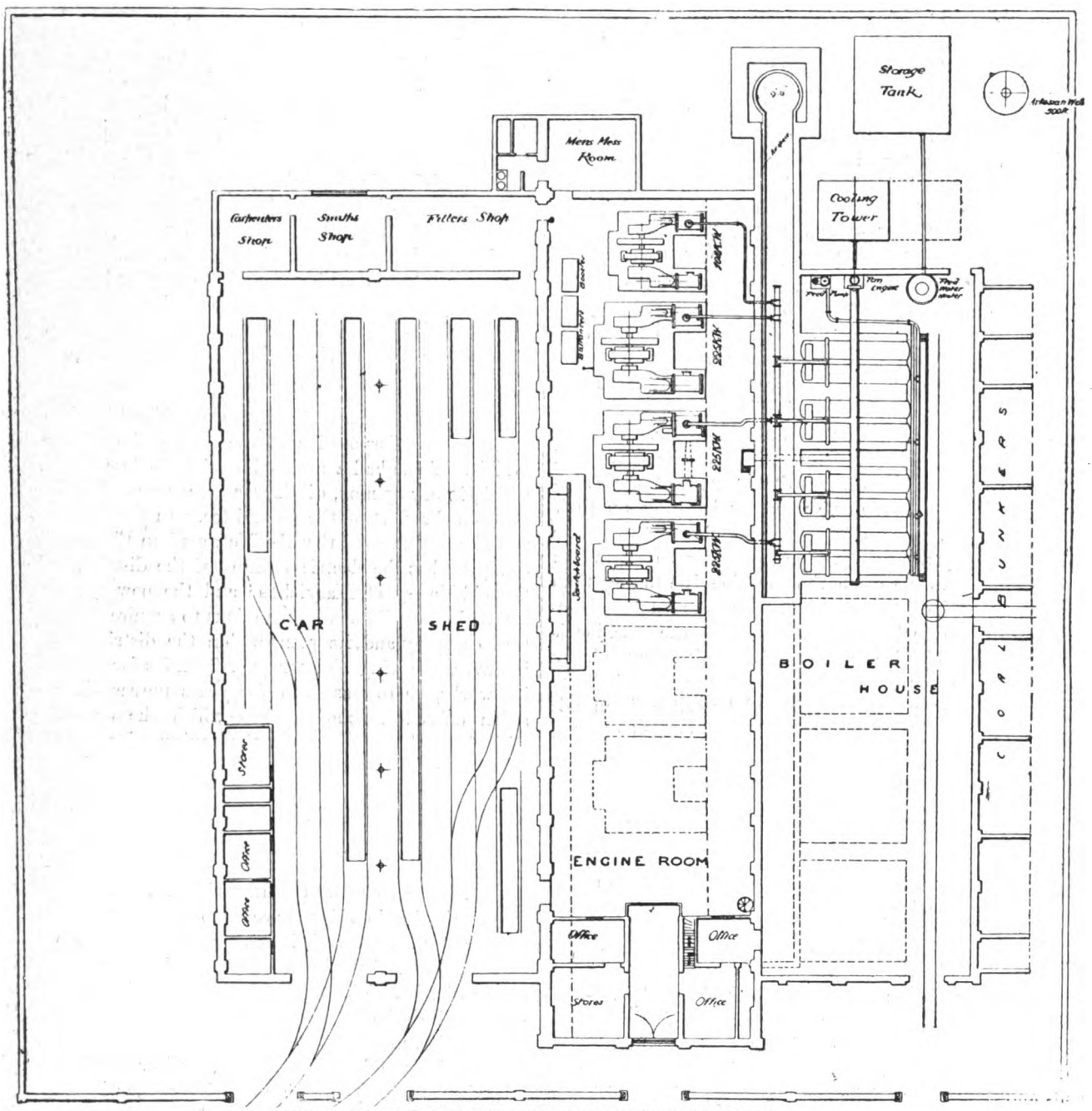

FIG. 1.—Plan of the East Ham Electricity Works and Tramway Depot.

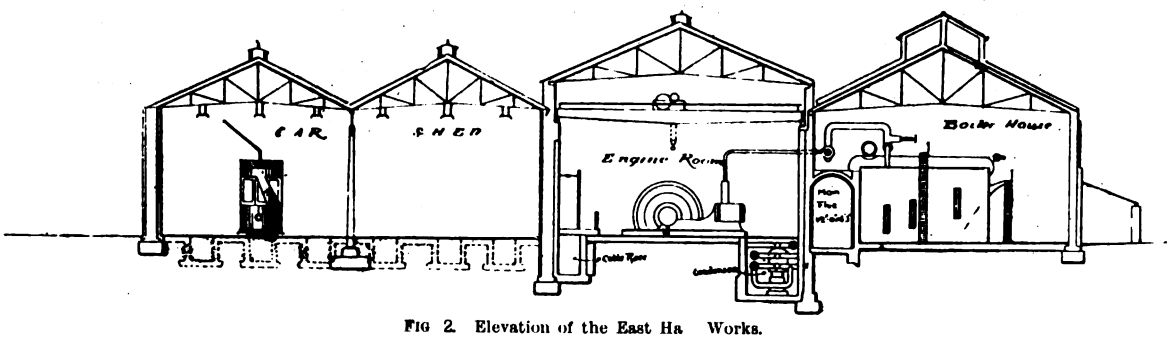

FIG 2. Elevation of the East Ha Works.

The loyal toasts having been duly honoured, the CHAIRMAN remarked that practically the whole of the success which had attended the fulfilment of the electric lighting and tramway schemes was due to Mr. W. C.

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Ullman (the Council's electrical engineer), whom he regarded as one of the first electrical engineers in the land.

Councillor CARTER then proposed a vote of thanks to Councillor Knight for declaring the undertakings open. This was seconded by Councillor LONG.

Mr. GEORGE FLETT (managing director to Messrs. Dick, Kerr, and Co.) said the contractors' work on this contract had been very simple for several reasons, but mainly because they had had a man like Mr. Ullman to deal with in his capacity as electrical engineer to the Council. They

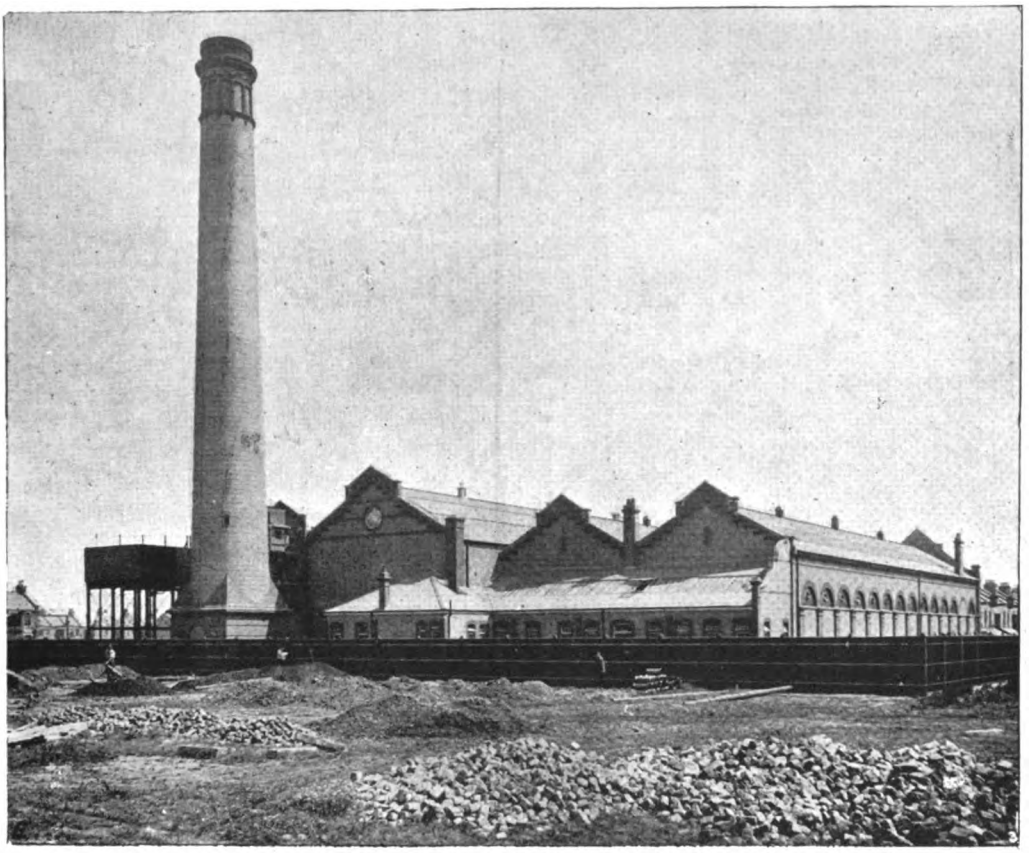

FIG. 3.—General View of the Works.

Councillor KNIGHT, in the course of his reply, stated that for the first five weeks during which the electric trams had been running the working expenses had only been 50 per cent. of the fares taken. He congratulated the contractors on the expeditious way they had carried out the contract. They had concluded the work in a manner which, he thought, had given satisfaction to everyone.

had inaugurated a system that day which, with the aid of the London County Council, he foresaw would sooner or later enable them to enter a car at East Ham and leave it at Putney. He saw no reason whatever why the working-man in this country, so far as means of transport were concerned, should be behind the working-man in other countries. Referring to the works, the speaker pointed

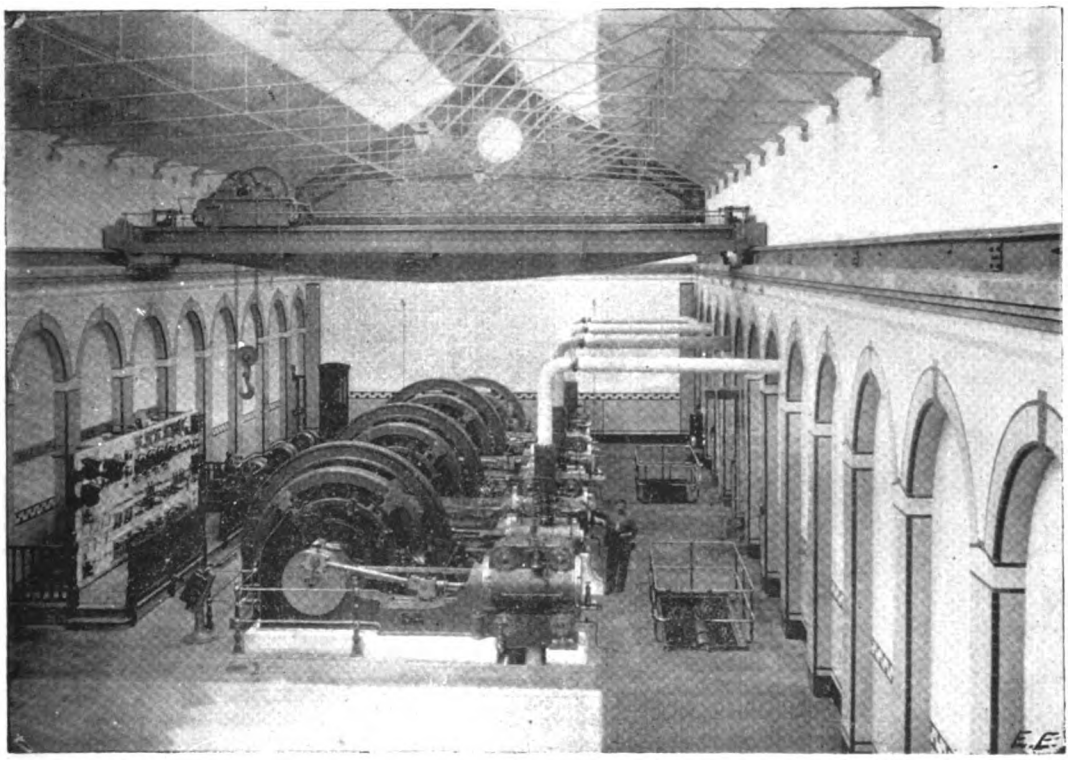

FIG. 4. The East Ham Engine-Room.

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out that the whole of the machinery installed in the power-house was the result of British labour and the output of British shops.

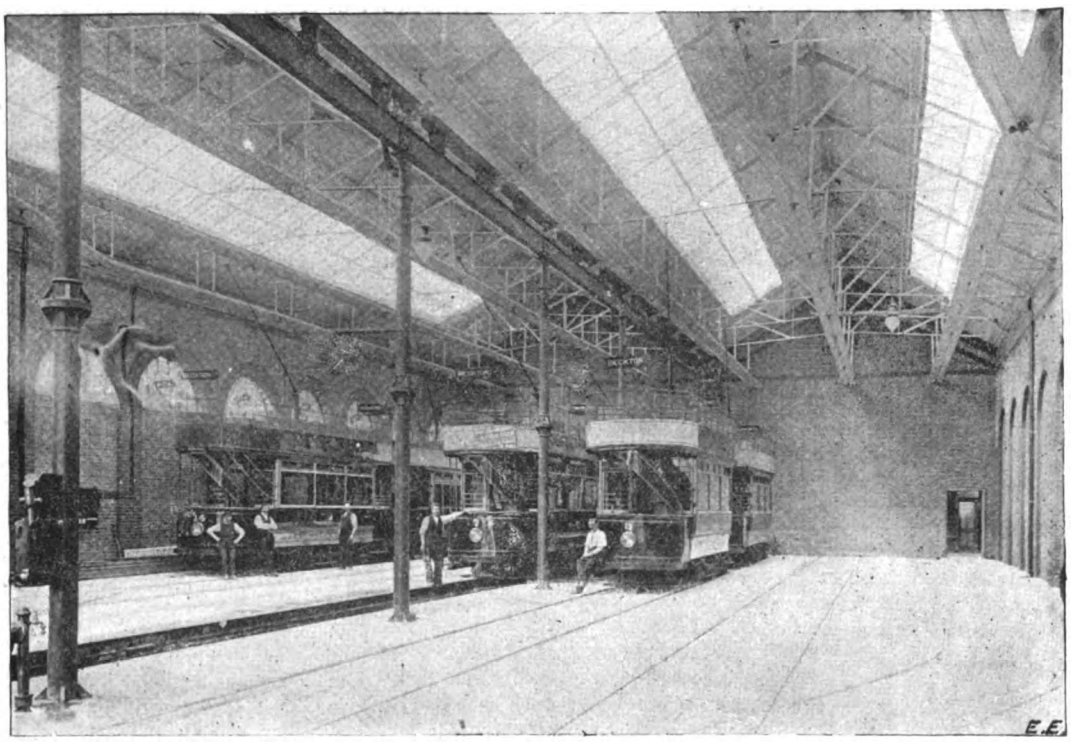

FIG. 5.—View of the East Ham Car-Shed.

Mr. J. O. CALLENDER (a director of Messrs. Callender's Cable and Construction Company, Limited) also replied. He was convinced, in spite of all that might be said to the contrary, that the British manufacturer could turn out a good and satisfactory article at a reasonable price.

Mr ULLMAN, in returning thanks for the eulogistic terms in which reference had been made to him, said he felt a certain amount of pride at being connected with the first municipal electric tramway in the Metropolis. He would prophesy that in the course of the next 10 years London would be encircled by a network of electric tramways—north, east, south, and west. Although to the West must be given the credit of having the first electric tramways in London, at least in the East they claimed to have the first municipal electric tramway undertaking.

A vote of thanks to the chairman for presiding was cordially extended, and the company separated.

THE TRAMWAY AND LIGHTING UNDERTAKINGS.

During the last decade the district of East Ham has, from a small town with a population of 33,000, become an important part of the Metropolis with a population of over 95,000, and to it belongs the credit of inaugurating the first municipal tramway system combined with an electric

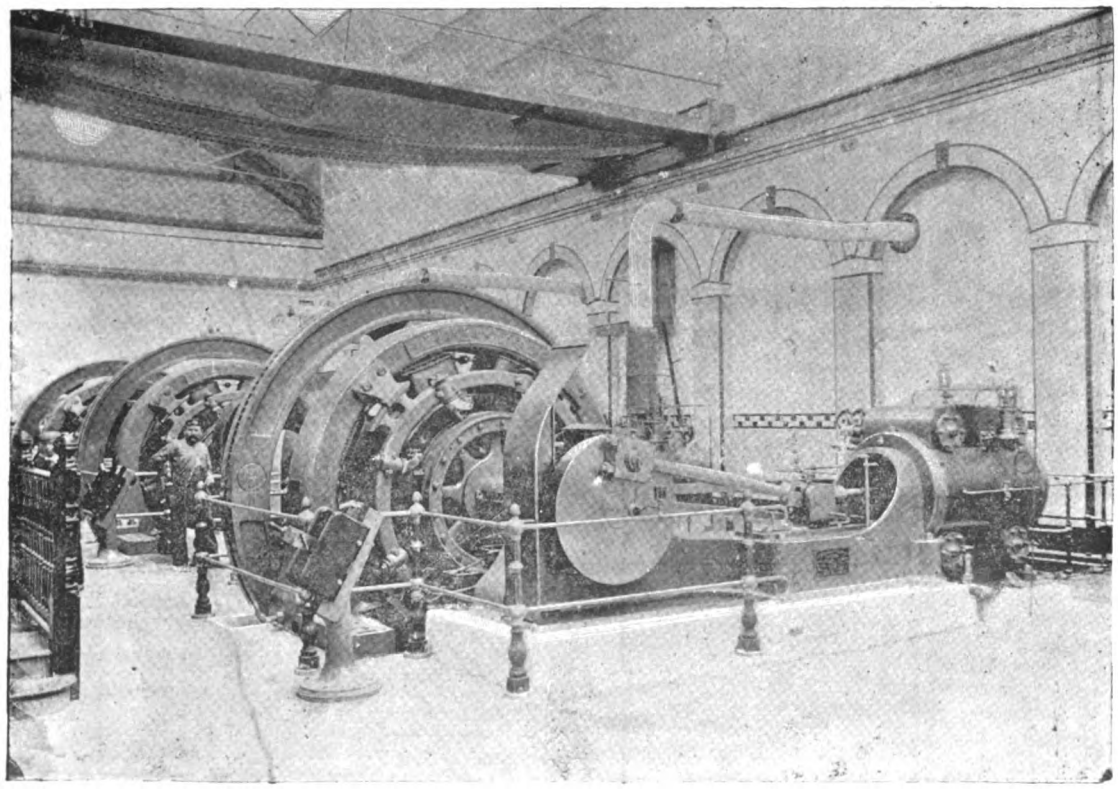

FIG. 6.—The Generating Sets at East Ham. Musgrave Engines and English Electrical Manufacturing Company's Dynamos.

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light undertaking in London. In 1898 the District Council of East Ham obtained provisional orders for the lighting of the whole of the district by electricity and for the first three sections of tramways. Further powers were obtained in 1900 for tramway extensions, making a total length of 9⅛ miles of line—*i.e.*, 2¼ miles of double track and 6⅞ miles of single track. Of this length 4½ miles have been completed, and, together with the electric lighting system, were formally opened at the latter end of last week. The remaining authorised lines will be constructed as soon as possible. Mr. Wm. C. Ullman, M.I.E.E., was appointed resident and consulting electrical engineer to the Council in February, 1899. This gentleman was at once authorised to prepare a complete scheme for the carrying out of the works under the powers obtained, and we are pleased to be able to say that it is mainly owing to the ability and foresight shown by Mr. Ullman that the adoption of a combined system suitable for the working of both the lighting and tramway schemes has been brought to such a highly satisfactory conclusion. In his report Mr. Ullman estimated the expenditure for the first section of the combined schemes

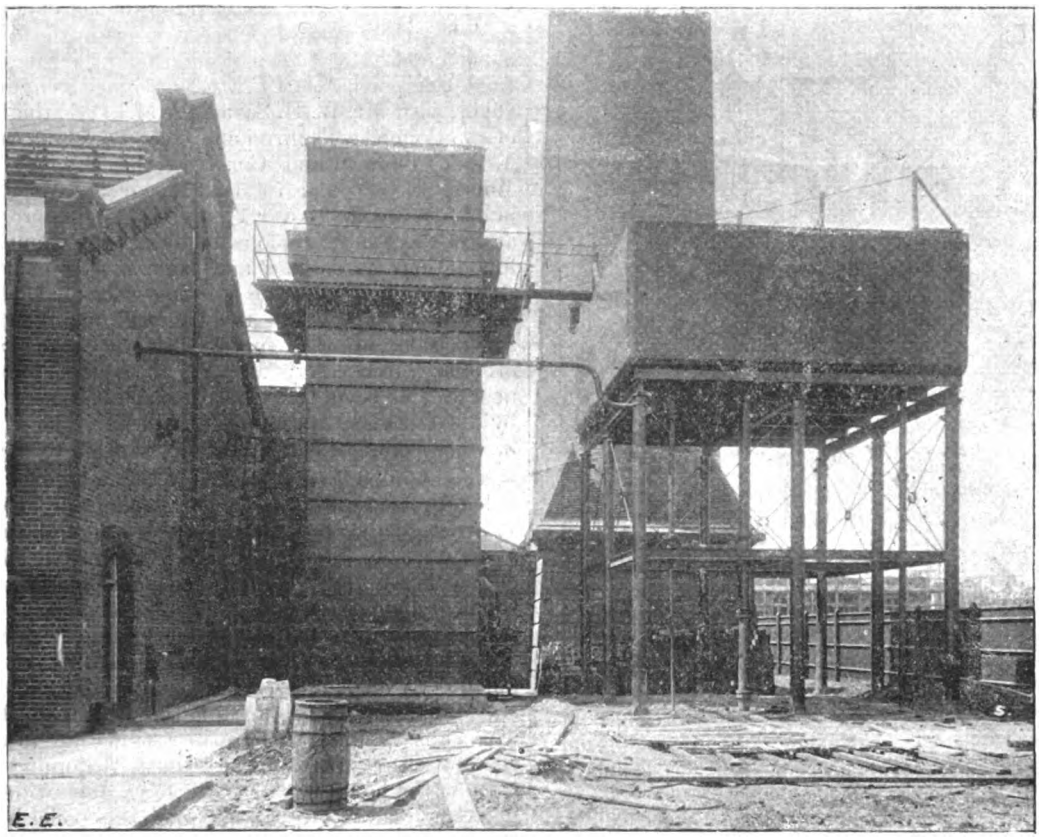

FIG. 7.—The Wheeler Cooling Tower and Water Tank at East Ham.

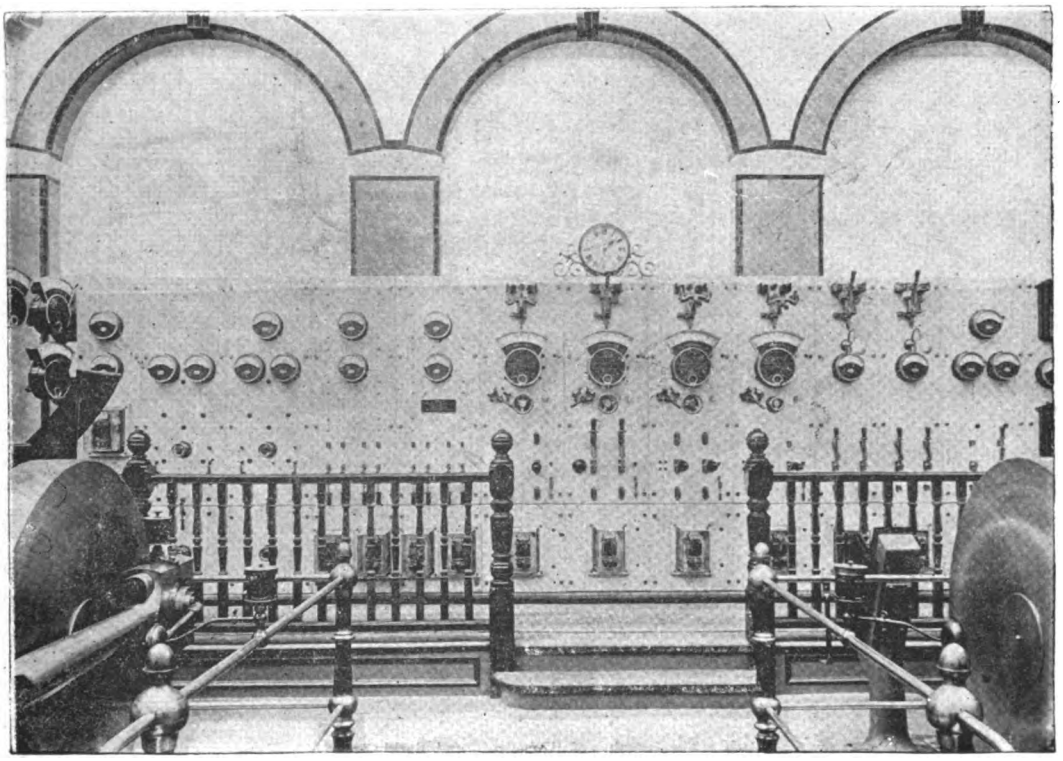

FIG. 8.—The East Ham Switchboard.

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at £47,760 for the tramways and £41,428 for the lighting, and we understand that these figures have been practically adhered to.

A further estimated expenditure in connection with the tramways extension order of 1900 to the extent of £42,220

FIG 9.—A Typical View of Overhead Construction and Car, showing the Arc Lamp on the Bracket.

has since been granted, together with £6,540 for extensions of lighting cables and £2,645 for building extensions, making a total estimated expenditure of £140,593. The engineer's recommendations, including the adoption of the overhead trolley system of traction, were unanimously accepted by the Council, and under Mr. Ullman's supervision the work of construction was carried out with the utmost dispatch.

The power station and offices (Figs. 1 and 2) have been erected on the plot of five acres in the centre of the district—at the corner of Barking-road and High-street—secured by the Council for municipal buildings, and where the town hall and public offices are now in course of construction. The whole of the buildings are contained in one block, and with the exception of the chimney and iron roof construction have been carried out by the Council's works department from designs by and under the supervision of Mr A. H. Campbell, A.M.I.C.E., the Council's engineer and surveyor, with Mr. W. H. Savage, A.M.I.C.E., the late surveyor of the Council. The iron and steel work was carried out by Messrs. Pierson and Co., and the chimney by Messrs. Wilson Bros. The total area covered by the electrical buildings is a little over 1¼ acres. The approximate total cost of the buildings alone, including the chimney stack and foundations to engines and boilers, is estimated at about £19,000. Generally the building works have been carried out by the employés of the Council, under the immediate supervision of the surveyor, from plans and details originally drafted by Mr. W. H. Savage, the then engineer and surveyor to the Council, and carried to completion by his successor, Mr. A. H. Campbell. The whole block of buildings (Fig. 3) is a handsome addition to the district.

The main engine-room (Fig. 4) is under one bay, having a length of 117ft., width 42ft., and clear height of 26ft. It is designed to contain six sets of engines and dynamos. It contains also the general administrative offices for the engineer and staff, and the general stores and testing-rooms. The principal offices of the department are conveniently arranged at the southern end of the engine-room, and workshops and men's messrooms are provided at the northern end, outside the main building. A 20-ton travelling crane runs through the length of the building. The walls are lined with opalite tiling up to the level of the girders supporting the same. Adjoining the engine-room is the boiler-house, 148ft. long, 46ft. wide. The coal bunkers (Fig. 1) run parallel with the boiler-house, having access in front of each boiler. The chimney is circular, 135ft. high, with an internal diameter of 9ft. 6in. A feature of the boiler-house is the artesian well, 13½in. diameter, bored to a depth of 500ft., which when completed is expected to yield 12,000 gallons of water per hour. On the opposite side of the engine-room is the car depôt (Fig. 5), having a length of 148ft. and total width of 65ft. Accommodation is provided for 28 motorcars, with all the necessary pits for cleaning, repairing, etc. In the car-shed are also offices for the traffic staff, rooms for inspectors, motormen, and conductors.

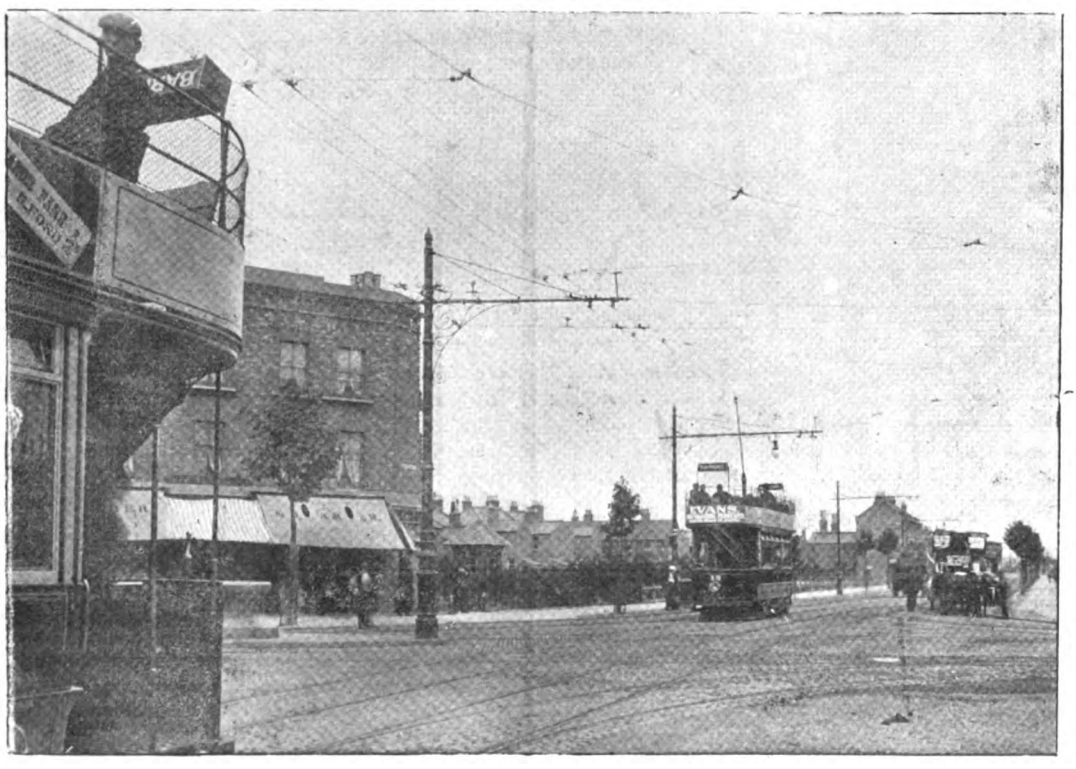

FIG. 10.—The Crossing of High-street and Barking-road.

The boiler-house equipment consists of four Babcock and

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Wilcox boilers, with superheaters, each having a heating surface of 3,580 square feet, and capable of evaporating 10,000lb. of water per hour at 150lb. pressure. A "Boby" patent heater detartariser is also supplied capable of heating and purifying 3,000 gallons of water per hour. The boiler feed is arranged from Blake simplex type of pump, so designed that it can work as two entirely separate pumps, or as one compound pump if required. A Barnard-Wheeler cooling tower is also provided, capable of dealing with the circulating water when condensing. Messrs. Babcock and Wilcox have also supplied two Wheeler condensers with combined air and circulating pumps, so arranged as to be available for any one or two of the main sets which may be running.

The engine-house plant consists of one 100-kw. set and three 225-kw. generators (Fig. 6). The engines were all supplied by Messrs. Musgrave and Sons of Bolton, and are of the horizontal cross-compound type. An ordinary piston valve controlled by an automatic crankshaft governor is used on the high-pressure side, while the low-pressure side is fitted with Corliss valve gear. The 150-h.p. engine has cylinders of 9in. and 18in. diameter with 24in. stroke, and runs at a speed of 150 revolutions. The 350-h.p. engines have cylinders of 13½in. and 27½in. with 27in. stroke, and a speed of 135 revolutions. The dynamos were manufactured by the English Electric Manufacturing Company, of Preston, and are designed for both lighting and traction work. They are worked as shunt machines for lighting loads, and can give 580 volts without using the series coils. The armatures are of the slotted-core type, drum wound, with interchangeable coils. Special ventilating ducts are provided in the cores. A negative booster has also been supplied by the same firm for use in the return feeders. Two balancing dynamo sets are in use for balancing the load on the three-wire network.

The above firm also made the main switchboard (Fig. 8), which consists of 13 panels of white marble—*i.e.*, four generator panels, two balancer, two lighting feeder, two traction feeder, one station lighting, one booster, and one Board of Trade panel, with all the usual switches, instruments, etc.

The whole of the cables for both lighting and traction were supplied and laid by the Callender Cable and Construction Company. The feeders both for lighting and traction are lead-covered single cables, insulated with impregnated jute. The lead sheathing is covered with well-compounded bitumen tape. The largest lighting feeders have 0·42 square inch cross-section of copper, and the traction feeders 0·3. The total length of feeders laid at present is 7·5 miles. The three-wire 240-volt distributor cables are laid on Callender's solid system in wooden troughing filled with bitumen. A total length of 13 miles of distributors has been laid in the district. Three-core pilot and telephone cables are also laid to the extreme ends of the district for both lighting and traction purposes. The whole of the conduits used for both lighting and traction feeders are laid in the centre beneath the permanent way. The conduits used for the feeder system are "Sykes" patent, with self-centering Stanford joints. These are laid in concrete with draw-in boxes placed at intervals of about 100 yards.

MR. W. C. ULLMANN, M.I.E.E., ELECTRICAL ENGINEER TO EAST HAM.

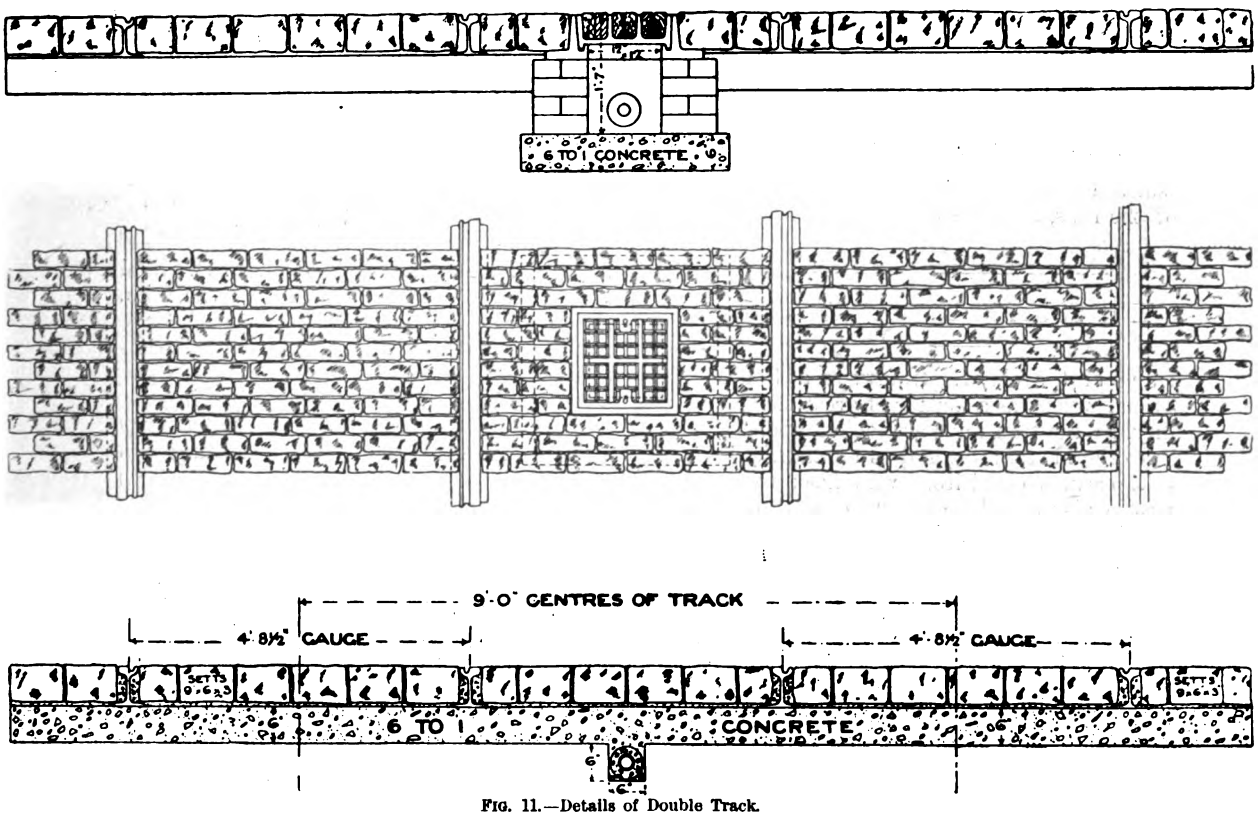

FIG. 11.—Details of Double Track.

The overhead line for the tramways (Figs. 9 and 10) is arranged on the side-pole and bracket type of construction, the maximum length of any bracket being 18ft. One feature of the overhead construction is that the street arc lamps are suspended from the bracket arms, in a position so as to be as near to the centre of the street as possible. In connection with the street-lighting, arrange-

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ments have been made to light the whole of the tramway route with arc lamps of Messrs. Johnson and Phillips's "Ark" type; altogether 135 arcs will be used in the main thoroughfares. The lamps are run in series of five, connected across the outer of the three-wire distribution mains, each lamp being provided with a switch and substitution resistance to enable any single lamp to be cut out while on circuit. The cars, of which 15 have been provided, were made at the Electric Tramway and Carriage Works at Preston. Each car is mounted on a Brill 21E truck, and has a seating capacity of 56 passengers—22 inside and 34 outside. Each car has two motors of the 25 A type, designed to give a tractive effort of not less than 1,000lb. when running at 10 miles per hour. The controllers, like the motors, are of the well-known "Short" design, and are of the D.B.I. solenoid blow-out type, with rheostatic brake, capable of controlling the car in any emergency.

Turning to the permanent way, the district is peculiarly suited to electric tramways, owing to its remarkable flatness. The gauge is 4ft. 8½in. No curves are less than 40ft. radius. The whole of the track (Figs. 11 and 12) is laid with 87lb. rails, double-bonded throughout, with 0000 S.W.G. Neptune bonds. Messrs. Askham Bros. and Wilson's cast-steel points are used throughout. The double track is laid upon a continuous bed of cement concrete, 6in. thick, and paved throughout to a distance of 18in. outside the rails with granite setts, while in the single track the rails are laid on a continuous bed of concrete 18in. wide by 9in.

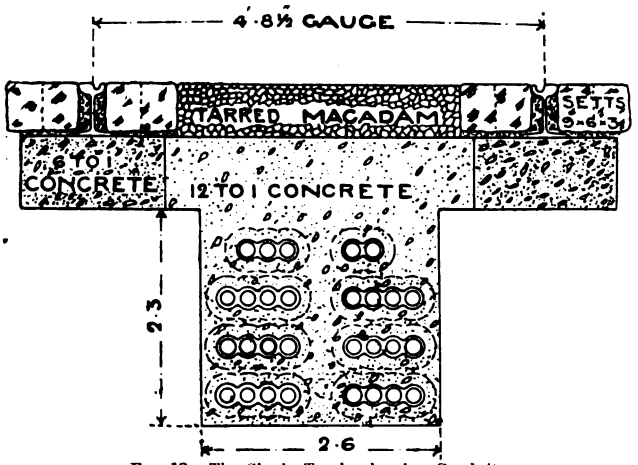

FIG. 12.—The Single Track, showing Conduits.

thick, the surface being paved with granite setts 9in. on each side of the rails, and the centre filled in with tarred macadam.

THE SOUTHEND TRAMWAYS.

The opening of the electric tramways at Southend on Thursday of last week was a matter of great congratulation in the locality, as the tramways are looked upon both as a convenience to the inhabitants, and as an additional attraction to the thousands of visitors who flock to Southend when the weather is fine. The growth of the town, and of the neighbouring town of Leigh, which is connected to Southend by these tramways, has been phenomenal. With the building areas extending inland for miles the need for these tramways is at once apparent, and they are sure to be a remunerative undertaking to the Corporation. At the banquet held at the Victoria Hotel immediately after the opening ceremony, some figures were given by the local agent of the principal contractors (Messrs. Dutilh, Smith, McMillan, and Co.) as to this increase in population, and especially as to the increase since their staff had been in the neighbourhood. A number of congratulatory speeches were made at this banquet, but the exigencies of the railway service prevented us from hearing the same.

The work on these tramways has been carried out to the designs and under the direction of the borough engineer, Mr. A. Fidler, A.M.I.C.E., while Mr. D. F. Adamson, M.I.E.E., has been responsible for the electrical equipment both in the station and on the tramcars. Both these gentlemen deserve credit for the work done. The point which strikes one when looking into the history of electrical undertakings in Southend is the way in which the committees and the Corporation have delayed commencing work, and have fluctuated in their ideas as to what should be done. For instance, the tramway station opened last week is also to serve as a generating station for the electric lighting of the borough, and yet up to the present practically no work has been done for the electric lighting, although the expenditure of £40,000 has been sanctioned. The electric lighting provisional order was obtained by the Council in 1891, and beyond treating with company promoters, and obtaining consulting engineer's reports, nothing was done until 1898. In the spring of that year a borough electrical engineer was appointed, who drew his salary regularly for three years without being allowed by the Corporation to do more than prepare estimates, plans, and specifications. When this gentleman obtained a position where there was more possibility of carrying out work, Mr. Adamson was selected to take his place, and he naturally prepared new specifications and plans for the electrical equipment. It was about this time that work was really commenced on the tramways, and since then Mr. Fidler and Mr. Adamson have pushed matters forward as quickly as possible. The electric lighting question in Southend raised considerable agitation in 1899, when the committee agreed

MR. D. F. ADAMSON, M.I.E.E., ELECTRICAL ENGINEER TO THE CORPORATION OF SOUTHEND.

to hand over their order to Mr. A. H. Gibbings. After a resolution to this effect standing on the minutes for about three months it was rescinded, and we believe that the ratepayers in certain streets may now expect to get a supply from the Corporation station by Christmas. They will in the meantime have the enjoyment of seeing sidewalks, which were opened in order to lay down tramway cables, again opened out to receive electric lighting cables. In fact, the Corporation of Southend cannot be congratulated on its business capabilities.

When the tenders for the tramway equipment were opened, it was found that the firm of Dutilh, Smith, McMillan, and Co.'s tender for the whole of the equipment was slightly below the sum of the individual lowest tenders for the various sections of the work. A contract for £91,876 was accordingly entered into with them, out of which about £11,000 was considered to belong to the electric lighting department. The above firm have employed a number of well-known firms as sub-contractors in carrying out the work. The buildings, which were designed by Mr. Fidler, contain all the offices required for both the electric lighting and tramway undertaking, and also a spacious car-shed, engine-house, and boiler room. In Figs. 1 and 2 we give a cross-section and also an elevation of these buildings, while Fig. 3 is a view of the car-shed. The details of the chimney shaft, which is 9ft. internal diameter and 150ft. high, are shown in Fig. 4. As will be seen, this shaft is lined with firebrick for the first 25ft. In Fig. 5 we give another view of the

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exterior of these works, and regret that the contractor's plant in the foreground rather interferes with the appearance of the building.

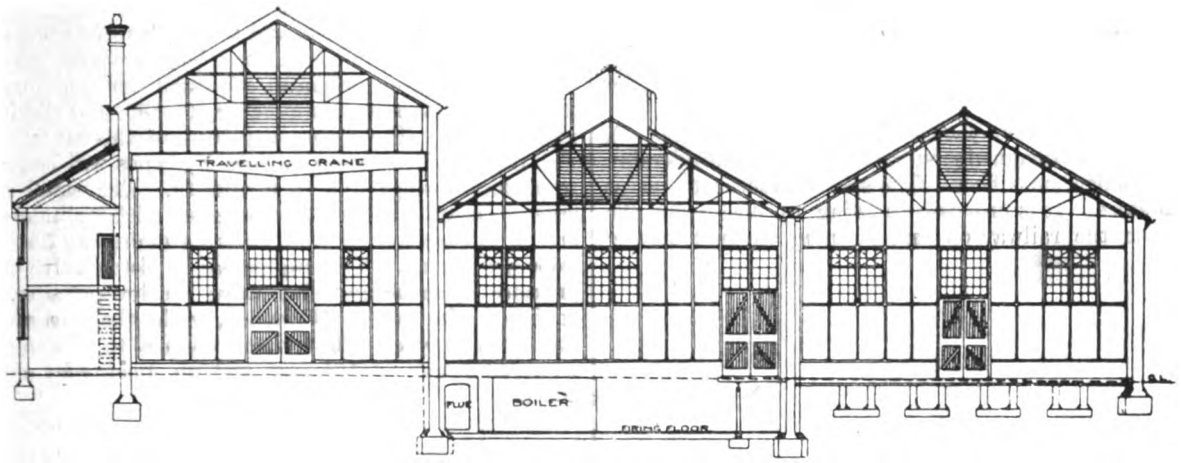

FIG. 1.—Cross-Section of the Southend Electricity Works and Car-Shed.

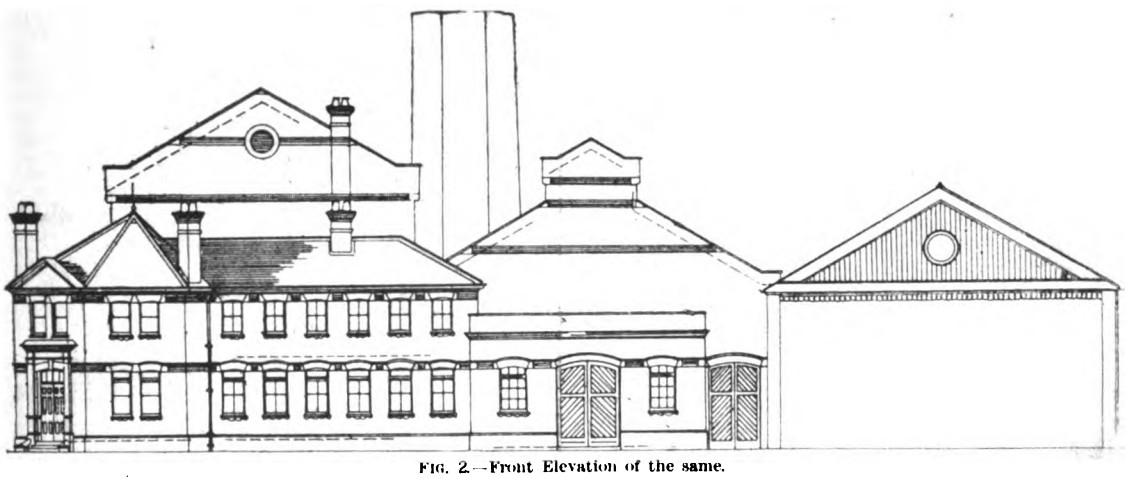

FIG. 2.—Front Elevation of the same.

The boiler-house plant (Fig. 6) consists of three Economic boilers supplied by Messrs. Davey, Paxman, and Co., of Colchester. Each of these is 14ft. long and 8ft. in diameter, with two flues, each 2ft. 8in. in internal diameter. They are constructed for a working pressure of 150lb., and can each evaporate 6,000lb. of water per hour with cold feed. The total heating surface of each of these boilers is about 1,180 square feet, and the grate area 31 square feet. The fittings for their boilers included the following: two sets of Hopkinson's absolute gunmetal water-gauges; one brass water-level pointer; one 10in. dial Hopkinson's steam-pressure gauge, with siphon and tap; one Hopkinson's duplex safety valve,

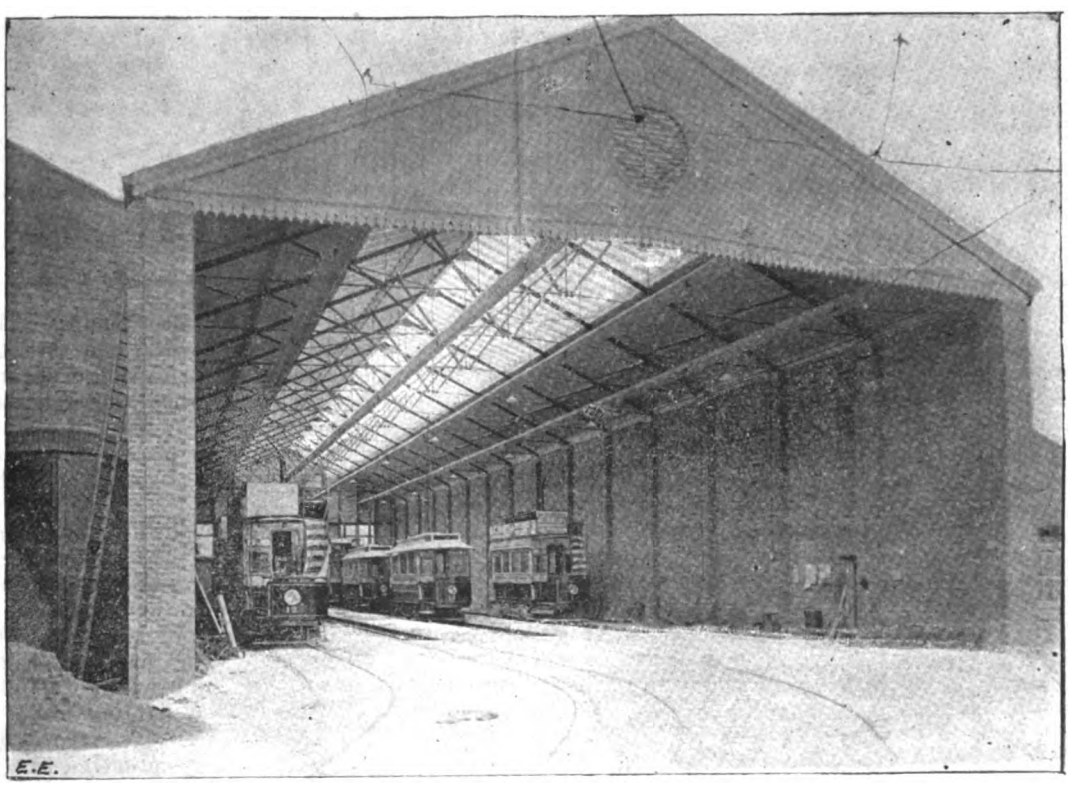

FIG. 3. The Southend Car-Shed.

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with spring and dead weight; two 7in. Hopkinson's steam stop-valve, with cast-iron body, gunmetal valve, and seat, with external screw, cross-bar, and pillar bolts; two 2in. Hopkinson's accessible check-feed valve and cock combined, with internal perforated distributing pipe; one Hopkinson's parallel slide gunmetal blow-off cock; one 2½in. Hopkinson's isolating valve for blow-off cock, and one 7in. ditto for steam-pipe.

As will be seen from the section of the works (Fig. 1), the coal is to be brought in on rails elevated considerably above the boiler-house floor. The space underneath serves as a coal store. It is proposed to bring up coal from the sea or from the railway on cars running on the tramway

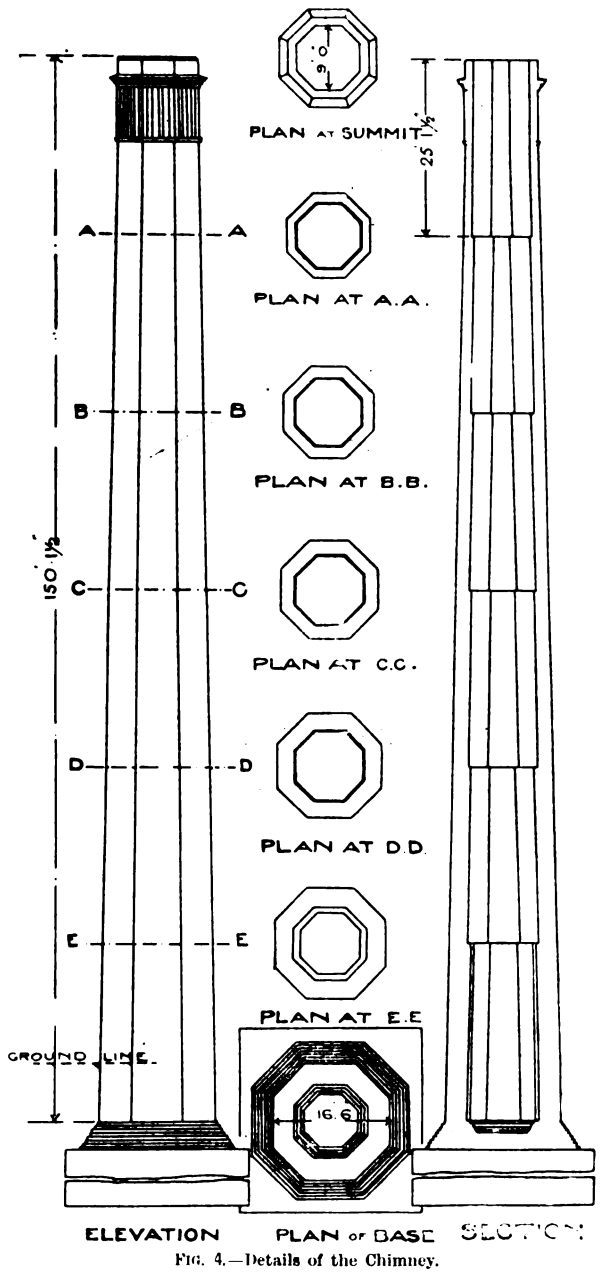

Fig. 4.—Details of the Chimney.

track and propelled by electric motor. These cars will then tip directly into coal bunkers and stores. The range of steam-pipes is duplicated throughout, and is provided with isolating valves, steam separators, and steam-traps. Steam recording pressure gauges are fitted in the engineers' office, and, besides these, two specially large gauges are fitted on the wall of the engine-room, which can be seen from any position in the same.

The engine-house is 84ft. long by 46ft. wide and 35ft. high, and is equipped with a 20-ton overhead travelling crane by the Chatteris Engineering Company. The generating plant, which was supplied by Messrs. Bow, McLachlan, and Co., of Thistle Works, Paisley, consists of two 200-kw. sets and one of 125 kw. The particulars of the two large generators are as follows: The engines (Fig. 7) are of the vertical Corliss type, with cylinders 14½in. by 31in. diameter by 24in. stroke. They run at 110 revolutions per minute, and with a steam pressure of 150lb. per square inch develop 322 i.h.p. A reheater is fitted between the high-pressure and low-pressure cylinders. A Tate's electric safety governor and stop motion and a Lumb's speed regulator are also fitted to these engines. The six-pole generators coupled to these engines are each for an output of 200 kw., the terminal volts being 500-550, and the full-load amperes 364. The emergency load of this set is 300 kw. Full details of these engines and dynamos will be gathered from the drawings Figs. 8, 9, and 10. The small set consists of compound enclosed engine, with cylinders 9½in. and 21in. diameter by 10in. stroke, running at 360 revolutions per minute. This engine has a piston valve on high-pressure cylinder and flat valve on low-pressure. It is equipped with forced lubrication, while the governor is of the flywheel type. The dynamo coupled to this engine has a normal output of 125 kw., and an emergency output of 200 kw.

The condensing plant supplied is of the Wheeler-Voltz type, and is arranged as a combined heater and condenser. It is placed at one end of the boiler-house, and is divided off by a glazed partition which keeps out dust and dirt

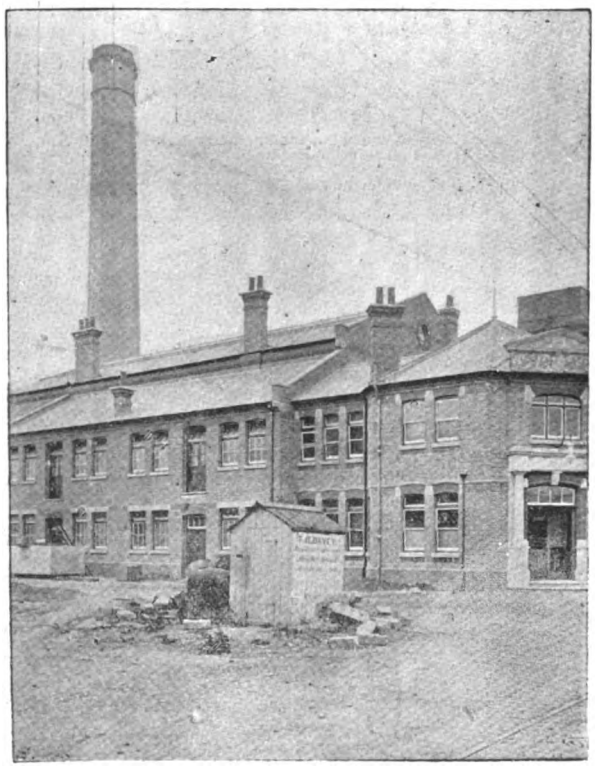

Fig. 5.—Outside View of the Southend Electricity Works.

from this plant and the feed pumps. The following apparatus is all in position—viz.: two three-throw Blake-Knowles pumps, electric driven (capable of dealing with 1,250 gallons per hour each), two small motor-driven centrifugal pumps for emptying sumps. A Barnard cooling tower and auxiliary feed-water tanks are placed over the accumulator-room, the fans for which are driven by an 18-h.p. motor in the pump-room.

The switchboards were supplied by the British Thomson-Houston Company, Limited. The general arrangement of the same was the idea of Mr. Adamson, the engineer, and so is not British Thomson-Houston standard, although all the instruments are of standard types. The board is constructed of white marble and measures 34ft. 8in. long, consisting of 20 panels, each 90in. high and 2in. thick, all in one piece as follows: seven lighting feeder panels, four generator panels, one Board of Trade panel, four traction feeder panels, four pumping station feeder panels. All circuits are equipped with British Thomson-Houston circuit breakers and quick-break switches, and British Thomson-Houston wattmeters are supplied on all generator and lighting feeder circuits, there being 18 wattmeters in all. All ammeters and voltmeters are Weston illuminated dial, the main voltmeters being mounted on swinging brackets

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at either end of the board. The traction feeders are also equipped with magnetic blow-out lightning arresters.

The whole of the cables for the tramway feeders were supplied and laid by the Callender Cable and Construction Company, Limited. The cables are of that firm's standard types, and they are laid in Sykes's stoneware ducts on the solid system. As mentioned above, the cables are laid under the footways.

lightning arresters are used in the feeder boxes, with the usual switches and telephone circuits. The whole of this work was carried out by Messrs. Lowdon and Co., of Dundee.

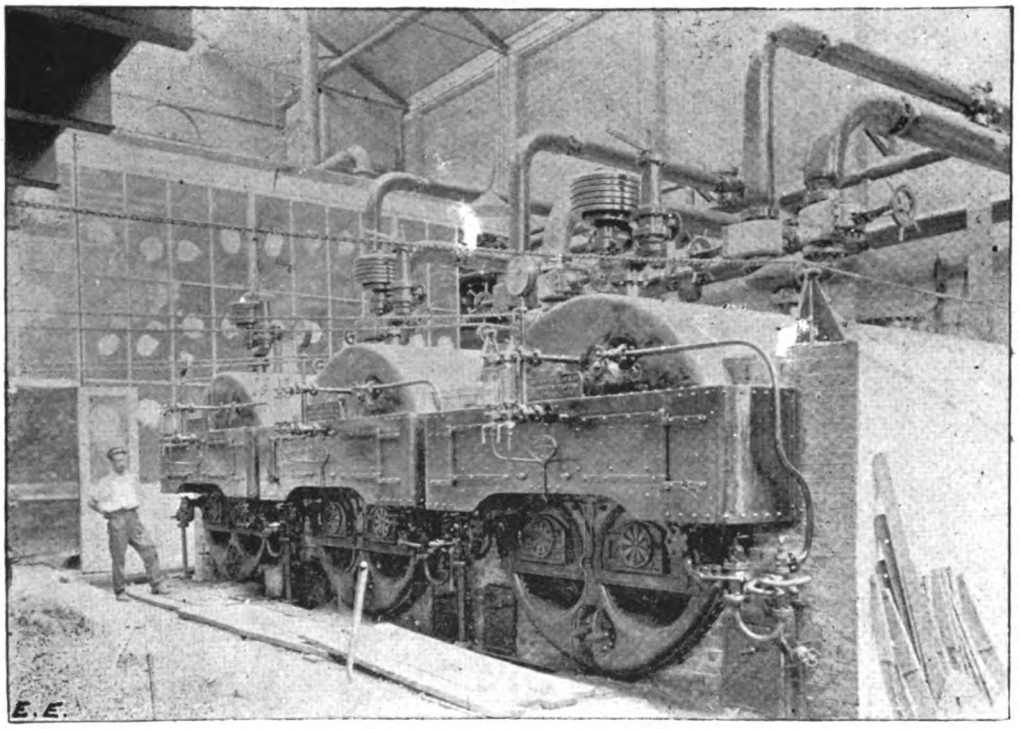

FIG. 6.—View of the Davey-Paxman Economic Boilers at Southend. The glazed partition at the end of the boiler-house divides off the pump and condenser rooms.

The tramcars at present supplied are 14 in number, of which 10 are double-decked, to carry 38 passengers, with Brill extension trucks; two are double-decked bogie cars for 58 passengers, with maximum bogie trucks; and two

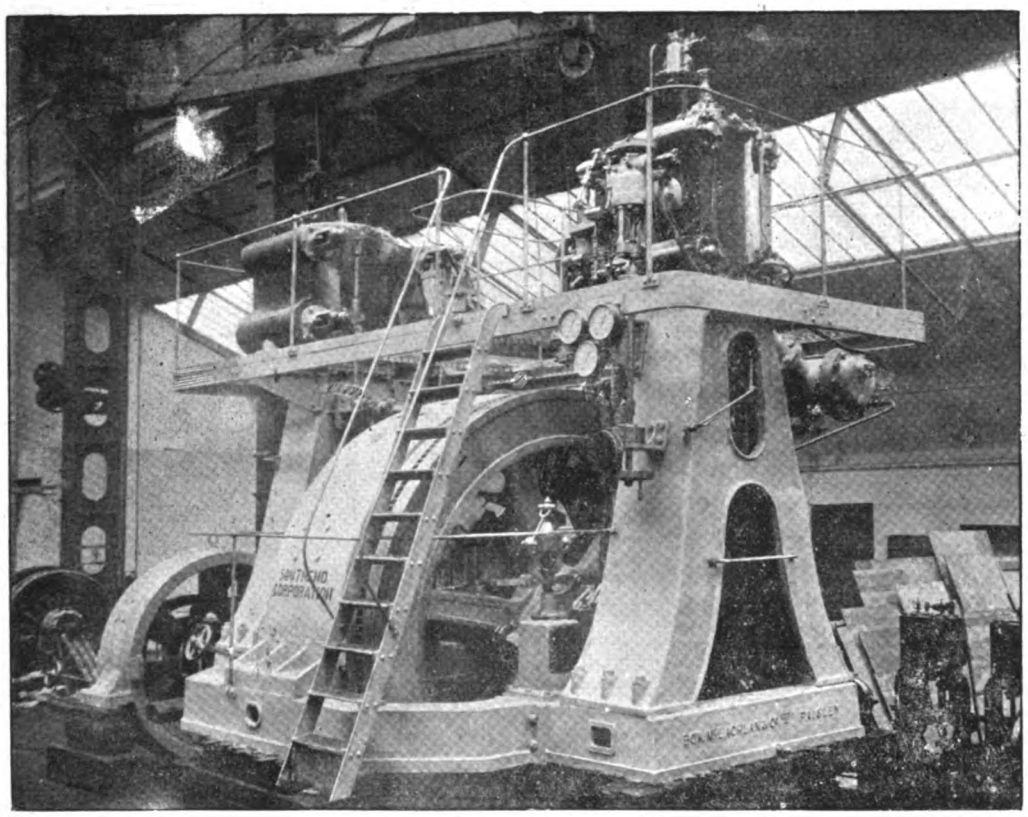

FIG. 7.—One of the 300-kw. Southend Steam-Dynamos, made by Messrs. Bow, MacLachlan, and Co.

The overhead equipment is arranged on the side-pole system, with swivelling trolleys. The two trolley wires are of 000 B. & S. wire gauge, doubly insulated with ambroin insulators, and bow spring suspensions. Garton single-deckers, to carry 28 passengers. The electrical equipments, consisting of motors, series-parallel controllers, rheostatic brakes, and hand brakes, were supplied by the British Thomson-Houston Company. The trolley standards

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are fitted with internal springs. The car bodies were all built by the Brush Electrical Engineering Company.

The tramway track is a single line throughout, laid with 90lb. girder rails. Short lengths of inverted rails are used as soleplates at the joints. Double bonding is used throughout. The total length of the track is eight miles, of which 7¾ miles are now open for traffic. The longest run is from Southchurch to Leigh, a distance of 4½ miles.

Coming now to the prospects of the undertaking, the receipts for the first few days of working, with only six cars on the line, exceed all expectations, and much better results are likely to be attained as soon as a full service is given. The electric trams on the Southend Pier are to be worked from the main supply station next year, and already several pumping plants for sea-water, etc., are arranged for electrical works. Besides this, the Reno elevator, to be opened next week to carry passengers up the cliffs, will take the necessary power required from the electricity department of the Corporation. We gather that arc lighting is proposed for the front, which will require some 45 lamps. These would be supplied off the three-wire distributors. In conclusion, we have to thank the Southend engineers for information given, and to wish the combined undertaking every success.

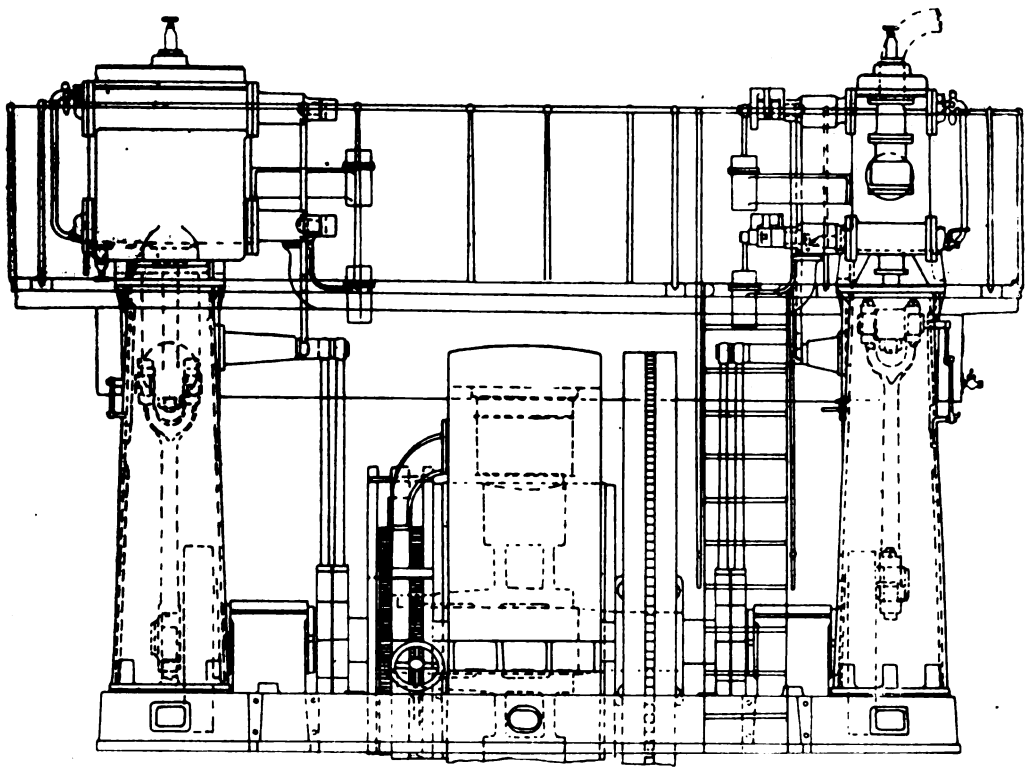

FIG. 8.—Elevation of the Large Southend Steam-Dynamos.

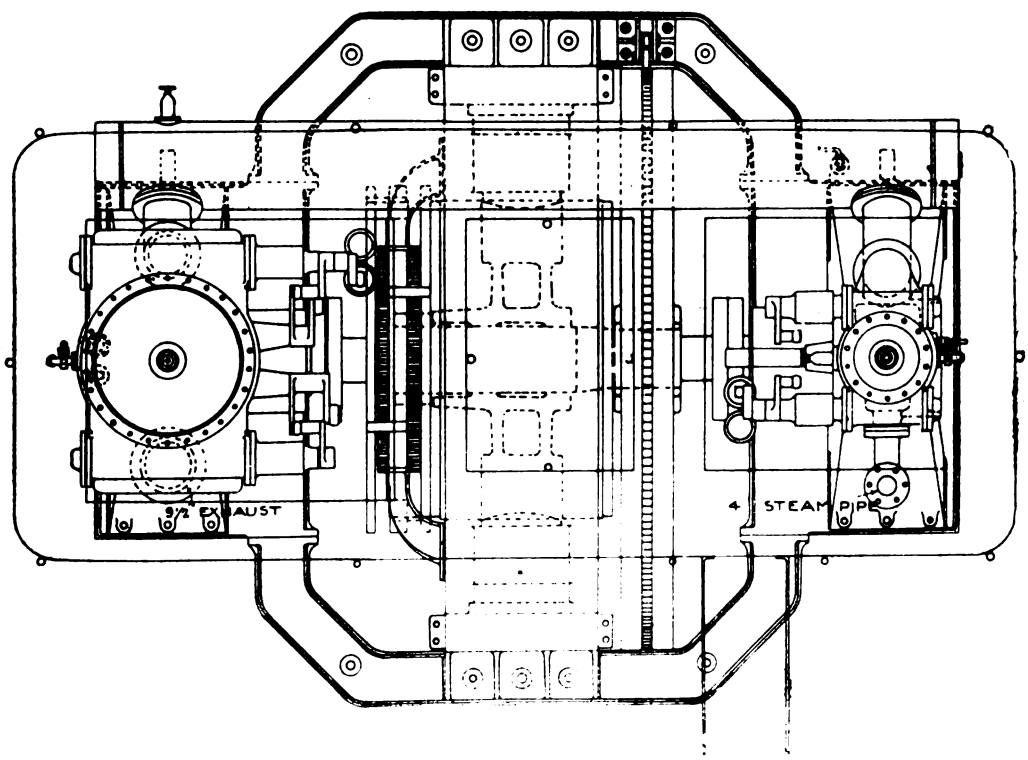

FIG. 9.—Plan of the Large Southend Steam-Dynamos.

COMPARISON OF TELEGRAPH SYSTEMS.

A recent issue of the *Elektrotechnische Zeitschrift* contains an editorial review of six different systems of high-speed telegraphy. A comparison was made regarding the number of attendants required, and the number of words which can be transmitted per minute. With the Morse system, two attendants transmit 15 words

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per minute; with the Hughes simplex system, four attendants 25 words; with the Hughes duplex system, six attendants 50 words; with the Baudot quadruple system, eight attendants 120 words; with the Baudot sixfold system, 12 attendants 180 words; with the Rowland eightfold system, 12 attendants 320 words. These systems were also compared under consideration of the question whether they enable one to send messages over the line in opposite directions. The Baudot system is much in use in France, and is also used in Vienna, London, and Berlin for telegraphy with Paris. With the Rowland system experiments are being made at present. The article states that there is no great need for the new systems in Germany, as the telegraph service has not increased excessively, and it is doubtful whether these systems will be introduced there, as the companies owning the patents generally demand exhorbitant prices.

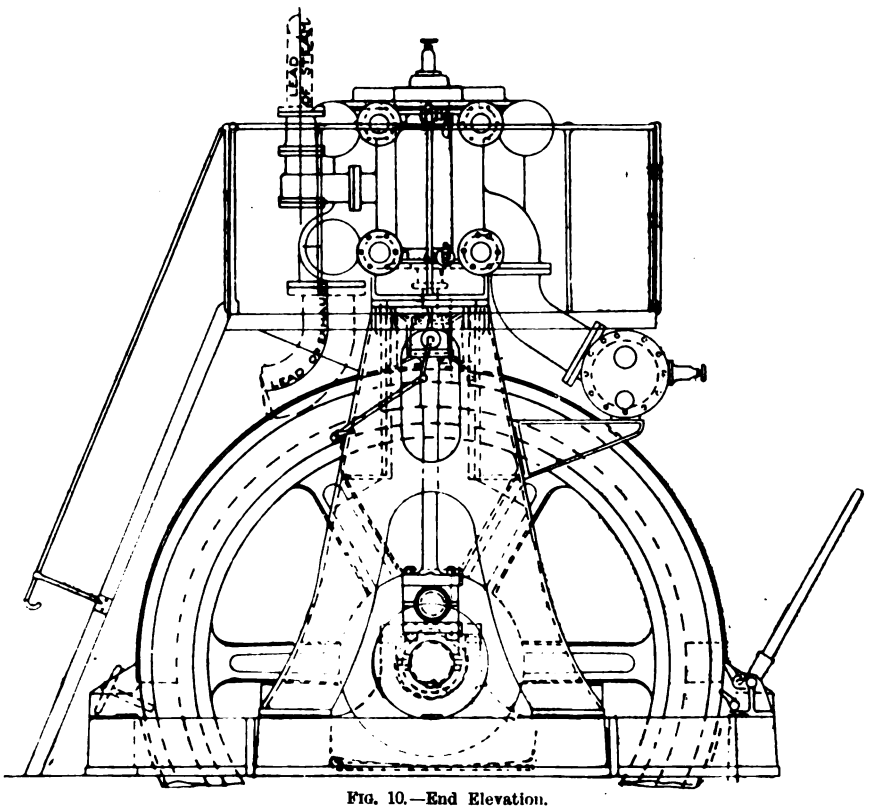

FIG. 10.—End Elevation.

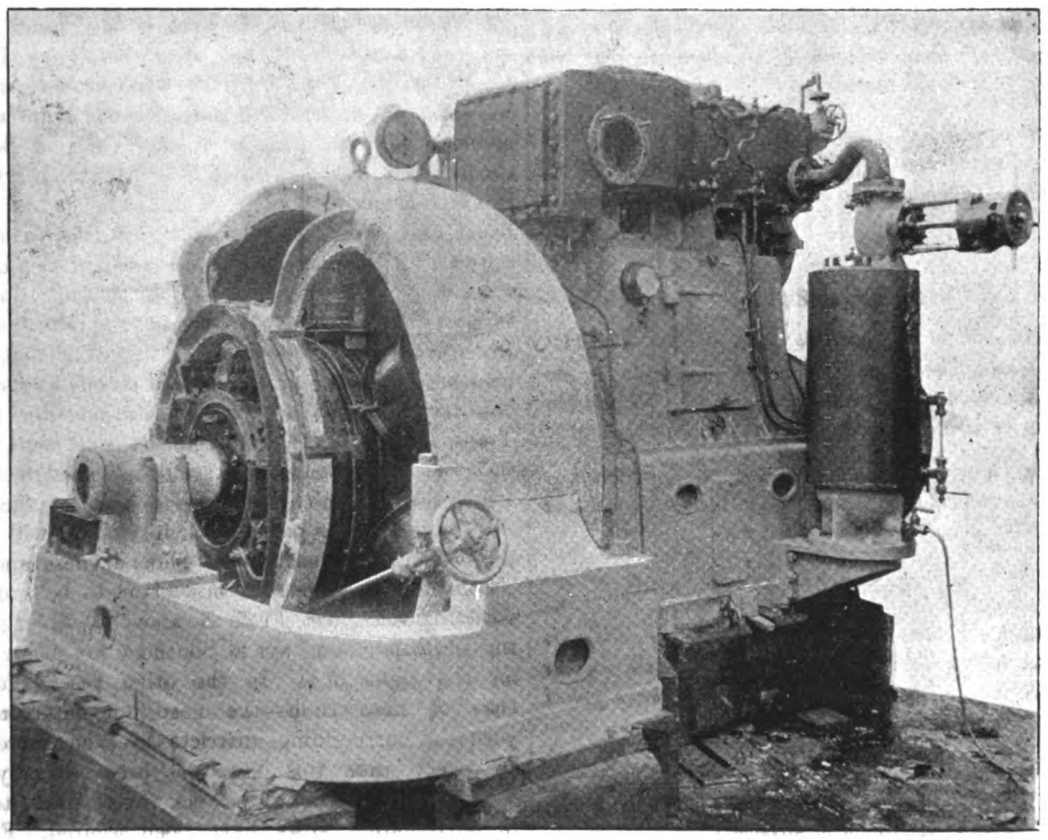

FIG. 11.—The 125-kw. Bow-MacLachlan Steam-Dynamo.

Price List.—Messrs. Atkinson, Schmahl, and Co., of Newcastle-on-Tyne, have sent us their latest price-list, which deals chiefly with main switches. These are now being supplied by the firm in a large number of types, and, we understand, are commanding a ready sale both in this country and abroad.

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MUNICIPAL ELECTRIC TRAMWAYS.

Last week there were opened two new electric tramways owned by municipal authorities in or near London. We refer respectively to the East Ham electric tramways and the Southend electric tramways. The first question which arises in one's mind when considering these undertakings is their relation to the surrounding districts. To quote the opinions as publicly expressed of tramway company promoters, an electric tramway designed to serve a borough area only, and not adapted for serving the surrounding district, is absolutely detrimental to the borough in question. These promoters always hold out as the great advantage which the municipalities will derive from acceding to their demands for running powers that they only are able to give the through communications, which are the essential factors in the success of tramway undertakings. There is a certain amount of truth in the arguments in question, and we know of councils which would prefer to hamper the undertakings of their neighbouring councils rather than to work with them in any way whatever. Even when the opposition between the neighbouring authorities is not so keen as that, there is often a marked disinclination to come to terms over any joint undertaking. It frequently happens that this disinclination on the part of a small authority is due to a fear that the predominating partner in a great undertaking would not treat them fairly in the matter of service or in the division of profits. While these interurban jealousies have done much to asist tramway promoters in getting through Parliament authority to construct large systems of tramways, it is pleasing to find that there are districts in which the public good is put before the brotherly hate of one's next-door neighbour. When the two new tramway undertakings which were opened last week are judged on the above lines, we are pleased to believe that neither of them will be found wanting. In each case the success of the undertaking must necessarily be largely due to connections with outside areas. Thus, at Southend the Corporation succeeded in getting parliamentary powers to run a tramway through to Leigh, some three miles away from the town. In the first instance, when the light railway order was under consideration, the Leigh authorities objected on the ground that the introduction of the tramway would cause their streets to appear unduly narrow. In fact, the authorities at Leigh suggested that this should be overcome by widening the said streets at the cost of the Southend Corporation. After arbitration before the Board of Trade a more reasonable solution was come to, and the tramway connection is now an established fact. Schemes are on foot by which similar extensions of these Southend tramways to other places in their vicinity will be made in the near future, such as to Shoeburyness and Rochford. Parliamentary powers are now about to be sought for constructing these lines. From the above it will be gathered that the municipal tramways at Southend are being engineered on the right line. In the other case before us—*i.e.*, that of East Ham—the need for intercommunication with the surrounding districts is even more necessary. In every case this has not been actually arranged, but already running powers over lines to be built in surrounding areas have been secured. For instance, the tramways at Ilford are to be worked in conjunction with East Ham tramways now opened, and in the near future more connections are likely to be secured. It is also to be presumed that eventually the London County Council will connect up to these suburban lines in the East-end of London. Of the two arrangements of obtaining intercommunication between adjoining districts, we think that the predominating partner plan adopted

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at Southend is likely to give the most smooth results in working. One controlling authority is always better than two for such undertaking, but we are pleased to see that the local authorities in the East of London are co-operating over this great question of rapid and cheap transit.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

GILBERT'S SELF-DRIVING WEIGHT OSCILLATING MOTOR.

SIR,—You have been wrongly informed. The twisted parts are not yet straightened, consequently this experimental model is not in working order.—Yours, etc.,

ARTHUR E. GILBERT.

[Our information was to the effect that the damaged parts had been straightened by the model makers, and returned to Mr. Gilbert. Apart from any dispute on this point, we must adhere to our statement that unless Mr. Gilbert can get the model to go for an hour without the application of external force, this correspondence must cease.—ED. *E. E.*]

SOME NOTES ON THE DESIGN OF MOTOR-STARTING SWITCHES.

BY F. W. DAVIES.

There is hardly any part of an electric motor equipment that comes in for such adverse criticism from mankind in general, and from non-manufacturing electrical engineers in particular, as does the average motor-starting switch. How often it occurs that a burnt-out resistance in the starting switch is responsible for the alleged breakdown of a motor. And this mishap, be it remembered, serves to still further confirm "the man in the street" in his idea that "electricity is in its infancy." Notwithstanding the fact that there are several good makes of motor-starting switches on the market, it cannot be denied but that they leave much to be desired.

The starting switch seems to have received but scanty attention at the hands of electrical designers, and, comparatively speaking, but little has been written on the subject. It is one of the few electrical subjects that one can write upon without much fear of having been preceded along the same lines by someone else. Who is there that has had much experience with starting switches, that does not wish for a design of switch that shall approximate, at any rate, to the low price and simplicity of construction of, say, an ordinary knife switch? Although to design such a switch—one that cannot under any circumstances be burnt out—is impracticable, still it is possible to design one in which the liability to burn out—and the time, trouble, and expense of replacing the resistances when they do burn out—shall be a minimum, and which shall be of simple construction withal. In consideration of this, it may be worth our while to devote a little time and thought to the subject.

Let us examine the design of the average motor-starting switch with a view to finding out in what way, if at all, its construction can be simplified or improved. It should be understood that in what follows the ordinary continuous-current type of starting switch with metallic resistances is referred to, although some of the remarks and suggestions apply also to the starting switches for alternate-current motors. It is proposed in this article to give one or two notes, and to offer, as the results of the thought and experience of the writer, a few simple suggestions with reference to starting-switch design which may, perhaps, be of some service, although not by any means meeting the requirements of the case adequately.

Here it may be convenient to form a rough classification of the various types of motor-starting switches. There are several ways of doing this. Broadly speaking, they may be divided into two classes—those used for continuous-current motors, and those used for alternate-current motors, it being the intention here, as before mentioned, to deal only with the former class. Each of these classes again may be subdivided into the liquid resistance and the metallic resistance types. The latter is in most common use, owing to its relatively small size, cleanliness, and the ease with which it can be adapted to awkward positions—the disadvantages attending the use of liquid starters in this respect being very obvious. The varieties of construction of the metallic resistance type of starters are very numerous, but they may conveniently be regarded as belonging to one or other of two classes, which we may term the open and the embedded types respectively, according to the manner in which the resistance material is disposed. As is often the case, the two types merge one into the other, and there are some designs which cannot, strictly speaking, be placed under either one of these heads. But for our purpose the above classification will suffice. In the open type, the resistance material—which may either be circular in section, or in the form of tape—is exposed to the air, being stretched between porcelain insulators, or supported in some other convenient manner. In the embedded type, the resistances are supported by an iron grid and embedded in enamel or cement, or, as is sometimes done, buried in silver sand. The embedded type of switch is generally the most solid and compact in construction, but the open type affords greater facilities for replacing a burnt-out section of the resistance.

It will readily be seen that there are many points to be considered in the design of a starting switch. The principal requirements of a good motor-starting switch are as follows: (1) It should be free from unnecessary elaboration of detail,

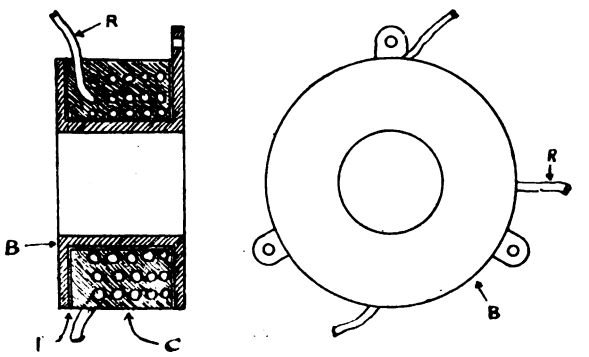

FIG. 1.—B, cast-iron bobbin; I, asbestos insulation; R, resistance wire; C, fireproof cement.

and as simple in its construction as possible consistent with efficient working; the fewer parts there are, the less is the likelihood of its getting out of order. (2) It should be so constructed that it will be impossible for the motor windings to get injured by an excess of current due to a rise in the supply voltage, or to any other cause; this, by the way, is usually provided against by means of a special automatic cut-out on the switch itself. (3) The resistances should be so constructed and arranged as to be easy to replace when, from any cause, they burn out. (4) The switch should be small and compact, and, as far as possible, of pleasing appearance.

To what extent any of the above requirements is to be considered in relation to the others is a matter for the individual designer to decide. Consider the design of the average starting switch. The most notable feature about it is, perhaps, its large size. This is on account of the space required for the resistances, which, besides detracting from its general appearance, adds to the cost of the switch. Manifestly, then, any arrangement of the resistances that will economise space, and at the same time be easily adapted to the processes of manufacture, will be of advantage here. Fig. 1 shows a method of disposing the resistances that is at once compact and cheap. A cast-iron bobbin is insulated with asbestos, and upon this the resistance wire or tape, as the case may be, is wound. The spaces between the adjacent turns in each layer are filled up with some good fireproof cement, and each layer on its completion receives a coating of the same material, in order to insulate it from the succeeding layer. The whole presents a neat and solid appearance, and for ordinary use is practically indestructible. The bobbin is secured to the inside of the switch-case

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by means of small lugs provided on it for that purpose. Instead of the metal bobbin, an earthenware cylinder might be employed. It would be treated with fireproof cement, as above described, but would have to be fixed with clips instead of lugs, as in the case of the metal bobbin. The advantage in using the earthenware cylinder would be that a somewhat more reliable insulation would be obtained, although the former method will be found to be quite satisfactory in this respect, besides being stronger mechanically. With this arrangement of the resistances it is a very simple matter to replace them with a new set, should any of the sections get burnt out. By this arrangement, or some modification of it, the size and cost of the switch may be somewhat reduced.

Then as to the switch contacts, these are generally made either round or sector shaped. Except in switches having a large number of contacts—which in consequence have to be arranged very close to one another, that is, with a small pitch—the former shape is preferable, for the reason that the machining of the contacts is a much simpler matter than in the case of sector-shaped contacts. It is a common and good practice to arrange the contacts in two sets, placed diametrically opposite, and staggered in respect to one another. The chief advantage gained by doing this is that, owing to there being two switch brushes in parallel, double the contact area is obtained that there would be in the case where the contacts are arranged all in one set and the current collected through only one brush. The arrangement is shown diagrammatically in Fig. 2. It is usual to

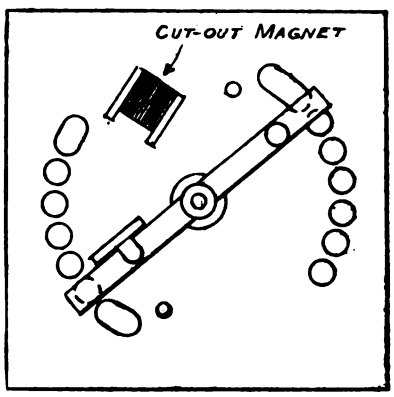

FIG. 2.—(Shunt Bar not shown).

provide a small electromagnet on the switch, which is excited by being connected up in the shunt circuit of the motor. By means of this magnet the switch arm is held in the "on" position. Should the shunt circuit of the motor by any mishap get broken, or should the supply current fail, the magnet ceases to hold its armature; and the switch arm, which, when the motor is at rest, is normally kept in the "off" position by means of a spring, immediately flies back to the "off" position. As will readily be seen, this device forms no safeguard against an excessive current in the motor armature, caused by an overload on the motor, or by an accidental rise in the supply voltage. For this reason many starting switches are provided with another magnet which is inserted in the circuit of the motor armature. The function of this magnet is to short-circuit the winding of the shunt magnet hereinbefore mentioned, upon the armature current exceeding a certain predetermined limit. The result of this is that the switch arm is released as before, thus cutting off the supply of the current and preventing any damage being done to the winding of the motor armature. Instead of using this second magnet, the writer would propose to wind a few turns of wire on magnet No. 1, in addition to the shunt winding. These additional turns should be connected up in series with the motor armature, but in such a manner as to oppose the magnetising action of the shunt winding—in other words, let the magnet be wound differentially. In this case the result of any undue increase in the armature current would be to demagnetise the magnet, and consequently the switch arm would be released just as before; the difference in the two methods being, that whereas in the usual method the magnet which is connected up in series with the shunt winding of the motor is demagnetised by short-circuiting its magnetising coil, in the method proposed it would be demagnetised by the effect of the shunt coil being neutralised by the series coil. The disadvantage attending the use of the differential winding would be this: a large and sudden increase in the current flowing through the series coils of the switch magnet would not release the switch arm, as the magnet would be demagnetised and then remagnetised in the opposite direction before its armature could be released. To overcome this the core of the switch magnet should be provided with a copper sheathing, the eddy currents in which (caused by an increase of the current in the series coil) would effectually prevent any rapid reversal of the magnetism. A diagram of the connections for this arrangement is shown in Fig. 3.

Motor-starting switches are usually rectangular in shape. A circular design would probably be more compact, and would present a more pleasing appearance. Moreover, a circular design would be especially economical in regard to space, in the event of the arrangement shown in Fig. 1 being adopted.

Now as to the shunt bar—this is sometimes made to

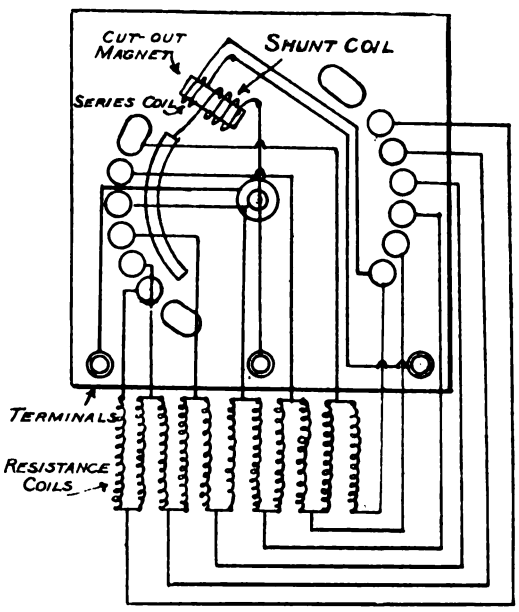

FIG. 3.—Diagram of Connections (Switch Arm omitted).

project a little beyond the first contact, with the idea of the motor magnet being excited before the armature is switched on. This is bad practice, as the high E.M.F. induced on breaking the shunt circuit is liable to damage the insulation, besides burning the shunt bar and brush of the switch. It is better to make the shunt bar of such a length that the shunt and armature circuits are made and broken at the same instant, and to permanently connect the shunt bar to the first contact (see Fig. 4). By this

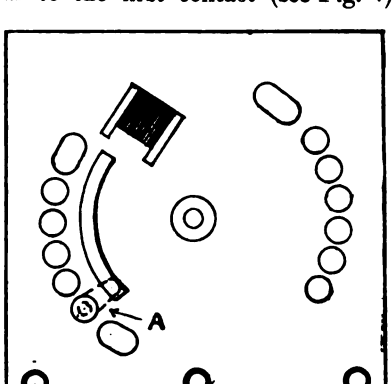

FIG. 4.—A, copper connecting strap, inside switch (Switch Arm omitted)

means the E.M.F. induced on breaking the shunt circuit will be dissipated by being discharged through the low resistance of the armature.

In conclusion, it is well to remember that, more often than not, motor-starting switches are operated by men who may be good mechanics, but whose knowledge of electrotechnics is limited; and that, therefore, the *sine qui non* of a starting switch is simplicity of design.

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PERMANENT WAY FOR ELECTRIC TRAMWAYS.*

BY W. HOWARD-SMITH, A.M.I.C.E.

(Continued from page 94.)

Welded Joints.

With the endeavour to make rails practically continuous, several methods of welding have been tried. These are either mechanical, as the "Falk cast weld"; electrical, as the "Lorain"; or chemical, as the "Goldschmidt." The "cast weld" joint is formed by pouring a mass of molten iron round the rail ends. It has been largely used abroad, and in this country a number have been laid. Their cost is approximately about £1 each. The following information, of practical value when using this joint, is extracted from the *Street Railway Journal* of March last: "Trouble was at first experienced from broken cast weld joints. The work of welding being done in the daytime, the heat caused by the molten metal, combined with that of the sun, expanded the rails, when the rails cooled at night some of the welds broke, the openings being over an inch in some cases. A plan was then adopted of skipping every fourth joint. Then on some cold night, when maximum contraction had taken place, these remaining joints were cast, result being then quite satisfactory. It is well known that when cast iron is subject to a severe tensile strain it is more readily broken than when under a compressive strain. Under the earlier conditions the cast iron in the welds was under tension due to the contraction of the rails at night, and received a sharp blow from the passing cars. Under the later conditions the iron was almost always under compression." Further interesting information with reference to this joint may be obtained from the December, 1900, issue of the same journal.

Electric welding has not as yet realised the high expectations formed of it. Many thousands of pounds have been expended in trying to perfect this system—the apparatus for use in the street is said to alone cost about £10,000—but so far it has not been tried in this country. The Goldschmidt process of chemical welding has been very recently introduced. It is effected by the combustion of a substance termed "thermite," composed of a mixture of aluminium and oxide of iron in the proportions of about 1 to 3, by which a sufficiently high temperature is obtained to effect the welding operation. Time taken to make a joint is about an hour, and cost stated to be from 25s. to 30s. each. This process is said to have been tried with satisfactory results on the Continent, but has not yet been used in England. The conditions under which tramways are constructed in this country largely militate against the extended use of welded joints. Welded joints are, perhaps, least satisfactory on curves. When rails have been welded together there will be much difficulty in breaking them up into convenient lengths for removal when track requires renewal; no doubt the rails will have to be cut, entailing some cost.

Vibration.

Vibration is exceedingly great with electric traction, and its effects as detrimental to the permanent way. (This fact has recently received much prominence through the published statements of the experience on the Central London Railway.) In locating a track, beyond conforming to the road surface, but little regard is usually paid to grading or cross levels. Consequent upon the camber of roadway these are often unequal, and on curves it frequently happens that, owing to the exigencies of the situation, the outer rail instead of having super-elevation is lower than the inner. Thus, with cars run at high speeds over necessarily uneven rails laid in winding roadways, oscillation is naturally set up. An exemplification of this may be witnessed by watching the swaying of the upper deck lamp of an approaching car. Experiments made with a whitewashed rail surface showed that wheel flanges usually strike with some force the tread and guard alternately, the wider the groove the greater the impact, and with a bad track the damaging effect is, of course, increased.

Springing, etc., of Rails.

When rails are simply laid on a concrete underbed, the passage at high speeds of heavy rolling loads along their surface tends to set up vertical undulating or wavelike motions, which are carried on from rail to rail. Were the latter not embedded in the paving, this motion would become very apparent. In addition to being a cause of rails springing, hog-backing, and creeping, this wave motion, combined with the lateral rocking or tilting motion from vibration, loosens the rail in its surroundings, and frequently has the serious effect of raising the paving next abutting to the rails, sometimes to the extent of an inch or more; and although the rail may return to its bed, or is forced down by the passage of cars, the side friction on the paving keeps it lifted ofttimes to such an extent as not only to be a menace to vehicular traffic, but to come in contact with wheel tyres and life-saving guards. This phenomenon of rising setts has been but little experienced on horse or cable tramways, due to the cars being much lighter and run at slower speeds, and being centrally guided there is little of the enormous vibration experienced from electric cars. Another effect of the vertical and lateral motions referred to, is to cause a series of concussions between rail base and concrete, which damage the latter, and not only loosen the joint fastenings, but cause the rail to ultimately become loose throughout its length. So essential is it found to counteract this springing, etc., of rails, with its very harmful effects, that various devices are now employed to hold down the rails to the concrete underbed.

The city engineer of Liverpool, Mr. J. A. Brodie, M.I.C.E., than whom perhaps no one in this country has had better experience upon this subject, says he considers it advisable, and essential in some cases, that the rails shall be held down, and he has designed an ingenious arrangement for the purpose, which has also the advantage of permitting the rails to be tightened down at any time without necessitating interference with the paving alongside the rail (Drawing No. 12). To quote from his patent specification: "This system, consisting of two iron castings and one steel bolt, may be shortly described as follows. The lower casting, marked C on the drawing, is in the form of a bracket or anchor let into the concrete, its top surface being 'flush' with the upper surface of the concrete and underside of the flange of the rail, the side of the slot in bracket for the bolt being just clear of the rail flange. This slot runs the full length of the upper surface of the casting to allow for sliding the upper casting to work in with the rows of granite setts. The upper casting, marked D on the drawing, is hollow and in the form of a stone paving sett, the width being the standard of the setts used in Liverpool; the lower part of this sett has an internal flange which rests on the rail flange, and is held by a 1in. steel bolt, the head being in the slot and the bolt passing up the middle of the cast-iron sett and the nut screwed home in the recess with a box spanner. These fastenings are placed on alternate sides of the rail at intervals of about 10ft. The method of fixing is as follows: after the rail is in position, the bracket is fixed and held up in position by the bolt, and set while the concrete is packed round it, and finally, when the concrete is set and the paving completed, the nut is screwed home." Sometimes bolts and large washer plates have been used for anchoring down, and Mr. Kinnear Clark, in his book on "Tramways," speaking of the Liverpool horse tramway system as constructed under Mr. Deacon, says "much of the excellence of this system is fairly due to the first-rate material and workmanship, and especially to the binding of the rails by bolts to the foundations of concrete."

Gauge.

The greatest care is indispensable in laying and maintaining the rails to perfect gauge. If the gauge be strained, the wheel flanges bind against the sides of rail groove, and frictional resistance is greatly augmented, resulting in the flanges being broken or ground away, or their thickness reduced. The surrounding paving, if of stone, no doubt affords material assistance in keeping rails to gauge, but should only be accepted as an auxiliary. A very slight inaccuracy of gauge, especially if at points or crossings, will probably mean much expense in repairs to cars, motor gearing, etc., apart from the added wear on track. An extract from a recent report of the engineer upon the Bolton tramways bears upon this point: "The variations existing in gauge are disastrous to the cars, oil grooves are 'hammered' out of place as a result of jolting and twisting, coils of motors are shifted and worn through the insulation, axles have been found to give way through the crystallisation of the steel, wheels have been worn and loosened, and the cars themselves wrenched." The running of tramway cars tends somewhat to spread the gauge. Wood paving is also found to give much trouble from expansion. The tiebars usually used are ofttimes insufficient to resist this. Instances have occurred where rails otherwise well laid, and having tiebars at usual intervals, have had gauge spread over an inch within three months of being laid, all tiebars being burst. Of course, tracks had to be relaid.

Cutting Rails.

Rails cut at works invariably have a slight vertical taper back from head; care should be taken that this is not excessive. When rails are cut on the site a proper revolving circular saw, as of the Burton-Griffiths type, should be used. Cold sates and hack saws are often used, but they only cut nicks into the surface, after which rail is snapped off, leaving a jagged edge, which makes a badly fitting joint, and their use is to be deprecated.

Bolt Holes in Rails.

Fishbolt holes in rails are usually $\frac{1}{16}$in. larger, and in fishplates $\frac{1}{8}$in. larger, than the bolts. Bond holes should be $\frac{1}{16}$in. less than diameter of bond, being enlarged to proper size on ground immediately before insertion of bond pin. Holes for fishbolts, bonds and joint-plates should be drilled; but slots, $2\frac{1}{4}$in. by 1in., for tiebars may be punched, all burrs being properly cleaned off. When holes are drilled on the site, a suitable revolving track drill should be used; ratchet drills are sometimes employed, but the work costs more and is less expeditious.

Fishplates.

Fishplates should be of somewhat softer and tougher steel than that used for rails, containing not more than

	Per cent.
Carbon	·15
Manganese	·04 to ·06
Phosphorus	·10
Sulphur	·10

They should be rolled true to template and properly fit the rails; the bolt holes should be punched cold, any fishplate showing signs of cracking at holes being rejected. Tests should be: tensile, 25 to 30 tons per square inch; elastic limit, not less than one-half the ultimate strength; elongation, not less than 25 per cent. measured in 8in.; bending, flat on itself without fracture.

Fishbolts.

Fishbolts should be 1in. diameter, having lock nuts of an effective pattern, otherwise nuts are liable to work loose under constant tremor and vibration of rail. With cup heads, a square shoulder $\frac{1}{8}$in. deep is necessary.

Drain Rails.

Drain rails of cast steel are often laid at the bottom of gradients as a provision for carrying surface water to sewer. While it is necessary to provide for draining the track, drain rails are not to be commended, as the interposition of a different metal leads to unequal wear, and their short length (some 6ft. or 8ft.) necessitates joints close together. It is preferable to cut away the rail guard for a short distance and

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insert a drain-box or special gully. Drawing No. 13 shows such a device.

Tiebars.

Tiebars should be of wrought iron not thicker than ⅜in., or will cause very wide joints in paving. They should not be less than 2½in. deep, when sufficient metal is provided for swaging down to form ½in. threaded end, otherwise end is bent over and a very weak place results. Tiebars having one end slotted are preferable to those with both ends threaded, as it is advisable to have as few screw-nuts as possible—they invariably work loose. The usual distance apart for tiebars is 8ft. on the straight, and 6ft. on curves less than 75ft. radius, but at joints they are placed about 2ft. from rail end. Tiebars are useful in keeping rails in position, but sole reliance should not be placed in them to hold rails to proper gauge under stress of working.

Curves.

Rails should be bent to the required radius by the use of an hydraulic rail bender or suitable jim-crow, of a form to bend by gripping the web and not the head or base. The latter is a very usual but much to be deprecated method, as it tends to distort the rail and to sometimes leave an initial spring which afterwards causes angles to be formed at the joints. Springing in of rails, or bending with hammers, should be prohibited. An investigation made by the author into the question of permissible minimum working radii showed that 30in. diameter wheels on a 6ft. 6in. rigid wheel base with ¾in. flange, running in a 1⅛in. rail groove, commence to bind against both sides of groove at 66ft. radius; this binding increasing as the radius diminishes, both groove and flange suffering. (Drawing No. 14 and cartoon.) Much care is necessary in laying out curves of small radii; it has not unfrequently happened that curves have proved unworkable, and have had to be taken up and relaid before cars could be run round. Sweeter running and added life may be obtained by laying curves in the form of a parabola or spiral, with easy transition curves from the straight. Contrary to railway practice, gauge of rails on curves should not be widened. Rails on curves, being particularly liable to spring from underbed and to spread gauge, should be anchored down intermediately between joints. In order to provide against fouling through the swing of overhanging ends of single-truck cars, it is important that the widths between double-line tracks or curves of small radii should be widened out.

Points.

Great care is necessary in the design, manufacture, and laying of points. Methods thought suitable and sufficient for horse and steam tramways have not proved successful for electric traction; something much more perfect and of greater stability is demanded. When a car is deflected from a straight line, it should be in such a manner that little inconvenience is experienced. With bad points, or even good ones badly laid, the force of impact is frequently such as to cause a sudden and severe jerk, to the discomfort and possible injury to passengers. Cars are also liable to jump the points and become derailed if not accurate. It is very desirable to avoid laying points so as to turn out towards the inside of a curve, which involves an increased angle of deflection with consequent jerk. This impact is very detrimental to the life of the points themselves as well as to the cars and motors. Facing points are required to work automatically, so as to be always open for the run-in. When both arms of points are straight, a length of 7ft. 6in. is sufficient, but it is preferable to curve one if not both arms to the required radii when longer points are necessitated. Special short points with curved arms are usually requisite for turnouts to car-sheds or short crossings. With curved arms care must be taken that tongues are not made too thin. The question of which form of point is preferable can only be properly decided in the light of experience, after a study of the circumstances and necessities of the position to be occupied and probable wear. On open or dummy points or mates (as also on crossings) the groove is frequently raised so that wheel flange may ride thereon—this is to save cutting away of tread by wheel tyre; care must, however, be taken that wheel flange does not receive a sudden impact, therefore groove must be raised gradually. Before laying, points and crossings should have the core hollows filled in solid with cement or bitumen concrete. Certain parts of points and crossings being subject to severe shocks wear rapidly; frequently these are made of harder metal, as manganese steel, in a form to be renewable. The author has seen points worn out after three months' wear through being of an unsuitable pattern and badly laid; being replaced by suitable points, properly laid, the latter have been in two years and are far from worn out yet.

Crossings.

Crossings built from spliced pieces of the rail used have been much employed, but are now generally giving place to cast crossings. The angle of crossings should not exceed 1 in 9, while built-up crossings should not be used if angle is more acute than 1 in 6, and much care is requisite with these in cutting the rails to proper splays, and also in securely fastening the several parts together, special fish and joint plates being necessary. Heel pieces of cast steel are occasionally used to fill in the angles at junctions of lead: they should have a chequered top to prevent horses slipping on the metal surface.

Passing-Places on Single Lines.

Distance apart is governed by the frequency and speed of service; four per mile is a usual provision for a 10-minute service. Their location depends upon road widths and suitability of surroundings, but they should be sightable from one to the other. Their length is governed by the number of cars to be accommodated; it should at least be sufficient to admit two cars passing clear of those on second track. The plan of a passing-place usually conforms to one of three methods: No. 1, the diamond; No. 2, the throw-over; and No. 3, the side turnout (Diagram No. 5); but there may be modifications of each of these. With No. 1 the angles of divergence of both arms of points are equal, both at the run-in and run-out. No. 2 gives a straight run-in—a great desideratum—but a full angle of divergence at the run-out. No 3 is the least desirable form, as it gives the maximum angle of divergence both at the run-in and run-out. The general plan of No. 1 is to be preferred, as it is more symmetrical and offers less interference with road traffic, but the angle of divergence at the run-in is undesirable. The author has adopted a method, No. 4, whereby, while the diamond plan is retained, the advantage of a straight run-in is also secured; this is attained by laying the frog slightly out of the centre, the particular distance being dependent upon the angle of crossing, etc. He has found this method very successful in avoiding the jerk and jolt frequently experienced when cars pass through points; it is shown in detail in Drawing No. 16. A survey of the sites of all passing places should be plotted to a large scale and the exact angles and leads laid out thereon, as sweetness of running may be greatly assisted by the judicious use of a suitable angle of crossing. It may happen, especially when a passing-place is situate on a curve, that while an angle of 1 in 4 will be most suitable at one end, 1 in 8 will be best at the other; the great importance of this detail is frequently overlooked. For those passing-places situate on a straight, a "standard" angle of crossing can be decided upon. The views of engineers as to the best angle to adopt in such cases appear to vary considerably, some using 1 in 4½, while others prefer 1 in 7. The author has found 1 in 5½ a good angle for town lines, while 1 in 7 is better suited for suburban lines, where the speeds are likely to be faster. Generally speaking, the more obtuse the angle the greater the jerk likely to be experienced by car when turning into or out of a turn-out, while an acute angle means longer leads and consequent increased cost. Frequently a "standard" angle of crossing has on many lines been made to do duty under all circumstances, whether laid on a straight or on a curve. This practice is not to be commended; it will often be found that by a variation in the angle of crossing, so as to suit the particular position, much easier running may be secured.

The author has prepared the table in appendix to show the proper lengths of leads and other data for the design and construction of diamond passing-places with crossings of various angles. No advantage is gained by extending the length or increasing the radii of curve leads beyond the dimensions here given. The distance of 7ft. 9in. between centres of tracks allows for an over-all dimension of car of 6ft. 6in., practically a maximum width; and for 1ft. 3in. between passing cars, the Board of Trade requirement.

Concrete Foundation.

Concrete for underbed is usually composed of 1 part of cement (it is seldom that lime can be used with advantage) to 6 of aggregate, though occasionally 8 or 9 of aggregate are used; but so much depends upon its character that it may well happen that 9 to 1 with a good aggregate will produce better concrete than 6 to 1 with an indifferent one. The author's practice is to use 6 to 1 under the rails, with a further slight addition of cement at each joint, while 8 to 1 is used under paving. Where paving is of wood, this is floated over with a layer about 1in. thick of 3 to 1. Depth usually is 6in. below base of rail, and from 4in. to 6in. below paving. Old macadam is often utilised for the purpose of aggregate, and there is no objection to this provided it is thoroughly screened and all dirt eliminated; but in wet weather this is difficult, as mud adheres to the stones. Of course, concrete should be well mixed and the cement thoroughly incorporated. In laying concrete one of two methods is usually employed. The first is: after the excavation has been made, to lay in the concrete to a height sufficient to bring the surface to approximate to a level as near as practicable about 1in. below base of rail, pegs being previously driven to indicate this. After the concrete is set the platelaying gang lay the rails to their proper positions and levels, supporting them at intervals with thin packings. When this work is approved, then part of the concreting gang pack in the inch space under base of rail with fine granite or stone chippings and cement, 2 to 1, mixed dry, forcing same into space by means of beater picks. The webs of rails are then parged, the sand bed spread, and paving proceeded with. The second method is, after the excavating gang have completed their work, for the platelaying gang to lay in the rails to their proper alignment and levels, temporarily supporting them at intervals on concrete bolsters, bricks, or wood blocks. When the platelaying has been approved, the concreting gang throw in the concrete to the requisite level, men being told off with strong spades to make solid the concrete under the rail base; the parging and paving are then proceeded with as before. This, termed the "pudding" method, has several practical advantages over that first described; better work results, because the platelayers, in walking over the concrete underbed while laying the rails, in manner first described, are apt to deposit thereon particles or even a layer of dirt or clay, which prevents the dry cement packing adhering to the concrete surface. Less cost, inasmuch as one operation suffices to complete the whole of the concreting, and a more perfect bed for rail base is obtained. Further, it is not practicable under first method to lay the concrete so that its surface shall always be 1in., neither more nor less, below base of rail. With the best work this will vary longitudinally from, say, 2in. to perhaps ¼in. or even less, when it is difficult, if not impossible, to force in the dry packing, and if this is too thin there is a danger of it being disintegrated and crushed to powder under the effect of heavy rolling loads. A further contingency is that, through careless workmanship, the packing may be done at the outer edges and not extend through full width of rail base, thus leaving rail with a hollow bed, probably to be afterwards filled with surface water. By the first method, the concrete surface being finished off 1in. below rail, means with, say, a 6½in. rail, a depth from rail surface of 7½in., which necessitates either laying a second layer of concrete, a very thick sand bed, or unusually deep setts. By the "pudding" method the surface of concrete can be brought at one operation to whatever level may

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be desired. Having given extended trial to both, there is no question in the author's view as to which is the better method.

PARGING.

The hollow on each side of rail web should be filled with a "parging," composed of one part of cement to four of sand, laid to present a sound vertical surface to pave against. Sometimes special shaped creosoted wood boards are used instead of this cement plaster.

PAVING.

The materials used for tramway paving should be as imperishable as possible. Judged by the periods usually allowed by the Local Government Board for repayment of loans, the life of soft wood on busy roads is estimated at six years, hard wood at 10 years, and granite and similar stones at about 30 years. Granite or other stone setts are most frequently used, of a depth of 5in. or 6in., laid about ½in. above rail surface, on a sand cushion ½in. deep before ramming; with this it is usual to mix dry a proportion of cement, say 1 to 4, which quickly solidifies. By this practice a firmer bed is obtained, and the setts are not so liable to sink under wear, but it makes the paving somewhat more noisy. Wood paving, on account of its noiseless character, is frequently required to be used in the business parts of a town and opposite places of worship, schools, etc., but there are so many attendant disadvantages, especially with soft wood, that a tramway engineer seldom lays it from choice. It should not in any case be laid on gradients steeper than 1 in 18. If wood is used, English beech and Australian Jarrah are probably the best kinds. The principal objections against wood are its liability to expansion and contraction, its tendency to rot, its greasiness at times, necessitating sanding, and its unreliability; blocks vary very much in character, one sample will expand considerably while another will contract to a like extent, apparently little care is exercised in selecting trees at maturity, or in seasoning planks, and, again, blocks may be from heartwood or from outer or sapwood. Great care should be exercised to exclude sappy or shaky blocks. Wood paving contracts greatly under the effects of extreme cold as well as of excessive dryness.

(To be continued.)

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

397. Explain a method of connecting a voltmeter at a central station so that it will indicate the average voltage at a distant group of feeding points on a direct-current system.—J. C. R.

398. Describe in detail the principle and method of making the cross-connections which are provided sometimes on multipolar parallel-wound armatures, presumably for the purpose of equalising the currents in the various circuits of the armature winding. Also state in what types and sizes of machines it is necessary to provide these cross-connections.—F. W. D.

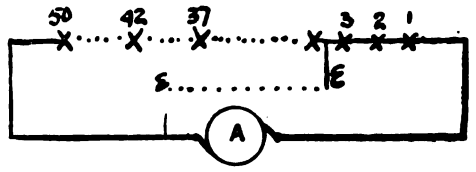
ANSWERS.

Question No. 390.—A Thomson-Houston series circuit is burning with full load of 50 arc lamps, when earth faults suddenly develop—one on the positive main at the third lamp (counting from positive of dynamo), the other on negative main close to dynamo (after No. 50 lamp). The faults are very pronounced, but lamps Nos. 37 and 42 continue to burn, all the others, with exception of Nos. 1, 2, and 3, being out. Why should lamps Nos. 37 and 42 continue to burn?

Best Answer to No. 390 (*awarded* 10*s.*).—There are two possible explanations of this phenomenon. Since there is a bad earth after No. 3 and after No. 50, the total current which comes through the first three lamps will divide into two circuits after the third lamp, part going through the earth to the negative pole of the dynamo, and part going through the lamp circuit. The current that goes through the lamp circuit might possibly be insufficient to operate the lamps from Nos. 4 to 50, with the exception of Nos 37 and 42, which may operate with a less voltage than any of the others. When the 50 lamps are burning in the circuit, the terminal voltage of the machine is probably about 2,500 volts, but when the earth develops, and there is only the equivalent of four or five lamps in the circuit, the current will be about 50 per cent. greater and the terminal voltage will only be 300 or 400. Hence it would be quite possible for the potential difference between the two partial earths to operate two of the lamps in the lamp circuit connecting the two earths.

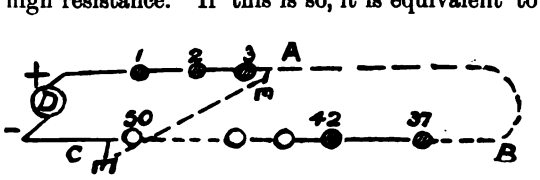
The other explanation is possible, but it is improbable. There might be partial earths on both sides of Nos. 37 and 42. The current leaving by the earth after No. 3 might get by a water-pipe or similar good conductor to the partial earth before No. 37, part of it might then go through No. 37, lighting it, and leaving to earth, again enter further down the street at No. 42, finally leaving it to get to the negative pole of the dynamo. By breaking the circuit at No. 4 lamp it would be easy to test in practice which conjecture was the correct one.—J. C. R.

Answer to No. 390 (*awarded* 5*s.*).—The arc circuit with arc lighter, A, and earth faults at E E, as described in the question, are shown in the sketch. It will be observed that



there are two circuits back to the arc lighter, one *viâ* the earth and the other *viâ* the lamps. Now, the resistance of the arc lamps when the arcs are not struck would be very small, and when alight would be about 4·5 ohms per 10-ampere arc. The resistance of the earth path might be anything from nine or ten ohms upwards, therefore the circuit *viâ* the lamps would be the easiest until the arcs began to light up. As soon as the lamps began to light the resistance would be increased, and more current would be forced back *viâ* the earth path. It is well known that when arc lamps are lit in series they do not all light simultaneously when the arc lighter is run up, but follow one after the other, and if the machine cannot take the full load, some of the lamps will not light at all. The conclusion I come to, therefore, is that the earth faults were fairly high resistance, and that a good portion of the current was flowing through the lamps which went out, which was sufficient to strike the arcs of lamps 37 and 42, but as soon as any further lamp commenced to strike the arc, the resistance of lamp circuit would be increased, and more of the current would be forced back to the dynamo *viâ* the earth. Lamps 1, 2, and 3 would be burning very bright and 37 and 42 dull, because all the current would have to flow through 1, 2, and 3 to supply current to the earth, and 37 and 42 in parallel. It is only by chance that 37 an 42 kept alight, and probably if the same incident occurred again two different lamps would remain alight.—C. L. E. S.

Answer to No. 390 (*awarded* 5*s.*).—The fact of the two lamps, Nos. 37 and 42, remaining lighted seems to point to the fact that one at any rate of the earth faults is of fairly high resistance. If this is so, it is equivalent to the



circuit becoming branched at A, part of the current passing through A B C, the remainder direct from A to C, and the strength of the current passing through A B C—that is, through the lamps—will be governed by the ratio of the resistances of the two circuits. The question omits to say whether the lamps 37 and 42 burn with apparently full brilliancy, or whether they just manage to strike the arc. The current in the lamp circuit will naturally be much below normal, and possibly these two lamps are in better condition as regards contacts and regulation than the others, thus enabling them to work with the smaller current. An ammeter placed in the circuit anywhere between lamps 4 and 50, and the reading compared with one taken with the instrument close to the dynamo, would

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give some idea of the magnitude of the fault, and also would show if sufficient current was passing to account for the lamps 37 and 42 striking up in the manner pointed out.—F. T. CALLIE.

Answer to No. 390 (*awarded* 5*s.*).—Arc lamps which are intended to burn in series are adjusted together, and should all practically strike at the same moment. Any lamp which is not adjusted exactly like the others will strike too soon or too late, as the case might be. This adjustment is rather a delicate process when large installations like 50 in series are used, and when a series plant is being started it is quite usual to find some lamps struck a few seconds before many of the others give any sign, but as the dynamo gets up speed, these lamps strike, and give quite as good effect as the ones which light up earlier. In the question the earth fault, after the third lamp, makes two paths, through the lamps being one path and the earth being the other. The resistance of a lamp with carbons touching is very low—lower, in fact, than the earth, so a considerable current would flow through this circuit if all the carbons would remain touching, but Nos. 37 and 42 strike with less current than the others, and in this way through an additional resistance in the circuit. Thus these lamps will continue to burn, and at the same time higher the resistance of the lamp circuit above the earth, and so prevent the extra striking current being supplied to the other lamps. If these lamps are moved to other positions, it will be found that they will still light, so this question is simply answered by the fact that the lamps continue to burn through bad regulation—*i.e.*, they have a lower striking current than the others.—F. M. M.

Question No. 391.—In an overhead three-motor electric travelling crane describe and illustrate the best method of connecting the motors to the reversing controllers.

Best Answer to No. 391 (*awarded* 10*s.*).—In a three-motor electric travelling crane the cage for the attendant may either travel with the crab or be fixed at the end of the main girders. The question does not state which method is intended, so we will assume the latter, as it is more complicated than the former. Usually two motors, those for hoisting and cross-traversing, are carried on the crab, the motor for travelling being fixed on the end girders. The controller for travelling is connected to its motor by ordinary vulcanised cable fixed in casing, tubing, etc., no sliding connection being required. The controllers for hoisting and cross traversing require sliding or flexible connections. With two series-wound motors the least number of cables required is seven—viz., two armature leads and one series lead for each motor and one negative main lead common to both motors. If an automatic brake is fitted on the hoisting gear it is usually put in series with the field coil of the hoisting motor, no extra leads being required. If, however, a shunt brake coil is used (and this is, in many respects, more satisfactory), an extra lead is required.

Seven separate leads necessitate seven separate sliding or flexible connections, and there are several methods of doing this: (1) Flexible cables may be used hanging down below the girders, and if the span is short and the gantry rails are high above the floor, this method is the simplest. By fixing the cables side by side on a flat cotton rope, so that they form one band, friction of the cables against one another is avoided, and a fairly durable connection made. (2) By using flexible cables wound on a drum carried by the end carriage, and fitted with a spring or weight to wind the cable up again as the crab approaches, the pull of the crab unwinding the cable when cross-traversing in the other direction. This method is expensive and cumbersome, and the writer knows but one case in which it was tried. (3) By means of naked copper wires strung between brackets on the two end carriages, from which the current is collected by rubbing pieces carried by the crab. This method is very satisfactory, is generally adopted, and we proceed to describe it.

Most modern electric travelling cranes are of fair span say, 30ft. to 50ft. and fish-bellied girders are used. In this case there is generally ample room to carry the wires below the upper flange of the girders without risking accidental earths by touching the falling block or ropes or the stiffeners of the girder webs. The wires are generally carried four on one side and three on the other. The advantage of this position for the wires is that the crab, the upper flanges of the girders, and the platforms are free from live metal, and the gear can be oiled and examined without risk of a shock.

In some cases the headroom from the gantry rails to the roof principals is so low that the crab has to be suspended between the main girders, and there is seldom enough room to carry the bare wires there as well. Two alternatives offer—to carry the wires at the side of the crab and make the platform wide enough to allow of this without danger,

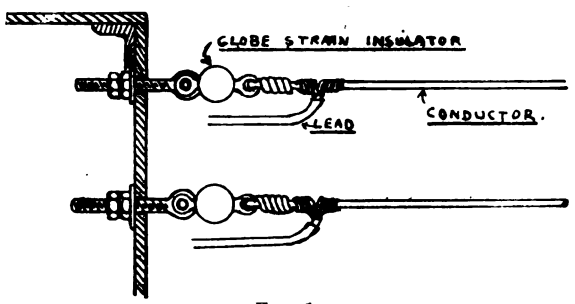

FIG. 1.

or to carry the wires over the crab. As the headroom is limited, if the wires are carried over the crab, it is necessary to place them side by side, and the seven wires will require about 32in. in width. It is seldom possible to get so much space as this between the gear wheels, and the wires cannot be placed above the gear wheels, as usually the highest points of the wheels are only just clear of the roof principals.

The conductors should be made of hard-drawn trolley wire, as soft copper wire wears away rapidly and stretches so much that frequent adjustments are necessary. Each wire should be anchored at one end by an eyebolt, and at the other end by a stretching screw, by means of which the tension on the wire can be adjusted to ensure equal sag of all the wires. At each end the connection should be made by what is known in traction work as a globe strain insulator, consisting of an insulating ball (of Hecla or Aetna compound), into which are moulded two metal eyes for connecting to the wire and anchor. The insulation resistance between these two eyes is almost infinity, and the breaking strength far in excess of any stress that is likely to occur in practice. Fig. 1 shows this method. The only objection to this plan of anchoring the conductors is that about 8in. at each end are taken up by the insulators and fixings. If space be too valuable to allow of this, eyebolts should be used at each end, passing through fibre or vulcanite bushes let into the side plates of the end carriages. These are not nearly so strong as the globe insulators, and it is difficult to avoid leakage due to the accumulation of dirt and

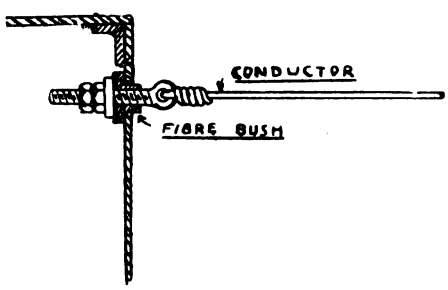

FIG. 2

moisture on the small collets, etc. Fig. 2 shows this method.

Earthenware or porcelain grooved insulators should be fixed at two points in the length of the main girders to take up the sag of the wires. These must be carefully set so that the collectors may clear them vertically by about 1in., and as a certain clearance is required for safety between the collector and the bottom of the insulator above it, the centres of the wires should be not less than 7in. apart.

However carefully the wires are strung and the collectors fixed, there is always a certain amount of sparking, due to

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surging of the crab when starting and stopping. The collectors, therefore, require renewal at intervals, and the simplest form is the most satisfactory. A strip of copper bent into a U-shape, having the edges rounded and curved and secured to an insulating bracket on the crab by two bolts, one of which serves to connect the motor lead to the strip, is the most common form. The bolt holes in the strip are usually made oval, to allow the strip to be raised or lowered slightly to suit the conductors. Each collector should be set at such a level that it raises its conductor about ¼in. above the centre of the eyebolt on the end carriage. This ensures sufficient pressure between the collector and the conductor to make good contact at all points without putting undue stress on the conductor. Fig. 3 shows the collector and its attachment.

If the conductors have to be carried above the crab, a good collector, which the writer has used with success, consists of an ordinary street car trolley wheel with graphite bushing, mounted on a short rocking arm, and pressed up against the trolley wire by a spring. In this case the trolley wires were strained tight, and the clearance from the centre of the wires to the highest metal of the crab was only 2in. This clearance was found to be ample, though for extra security a sheet of asbestos was placed on the crab. The wear of the trolley wheel and wires was practically nil.—W. ACRE.

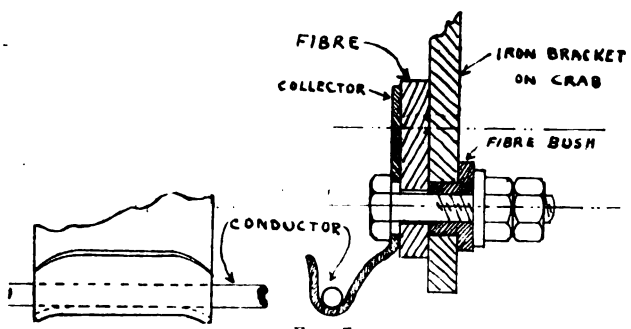

FIG. 3.

Answer to No. 391 (*awarded* 5*s.*).—Assuming that the motors are to be operated with continuous current, the main trolley wires will consist of either two or three copper wires strung longitudinally along the wall of the shop where the crane is to be operated. Of course, if an earth return system is used, the crane rails will serve as the (−) or return, and only one copper or (+) trolley wire will be employed. The current feeding the crane motors will be collected from the main trolley wires by means of sliding gunmetal slippers fixed on to a suitable arm on the crane.

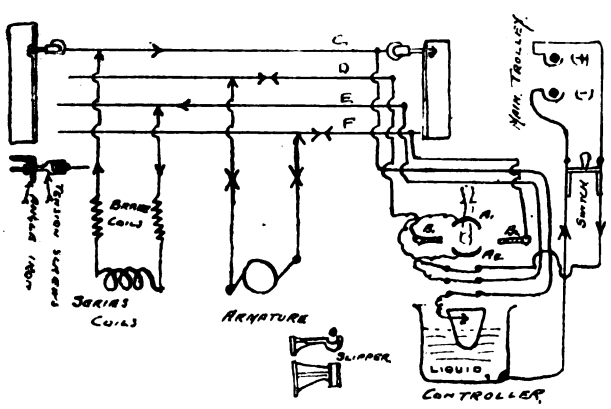

FIG. 1

Fig. 1 is a diagrammatic sketch of the trolley, and connections for the hoisting and lowering motors fixed on the crane crab, C, D, E, and F, represent the copper trolley wires strung taut along the crane girders, parallel to the direction of motion of the crab. Fig. 2 is an end view, and shows four wires strung on each side of the crane girders; the sliding slippers are fixed on to an oak batten, which is bolted on to the crab frame, and ordinary insulated cables are led to the motors. Following up the connections in Fig. 1, A_1 and A_2 are insulated gunmetal segments; B_1 and B_2 represent stationary copper brushes, which forms connection with either of the segments, A_1 or A_2, depending upon the direction in which the handle is moved, either to the right or the left. At the same time as the handle is moved, and with it the commutator or segments, the plate, P, is immersed in the liquid, thus cutting out the resistance in series with the motors, or *vice versâ*. In circuit with the series coils of the hoisting motor it is usual to insert a magnetic brake coil, which when energised attracts an iron shoe, thus releasing the brake strap. Immediately the current is switched off the iron shoe is released from the magnet, and in this way puts on the brake and brings the load quickly to rest. Tracing up the connection in Fig. 1, it will be noticed that the current is always flowing in the same direction through the series coils, and that the reversals take place through the motor's armature, depending upon which segment, A_1 or A_2, is in contact with the brushes, B. The connections for the transverse motion motor is identical to that shown in Fig. 1, with this exception, however, that there is no brake coils.

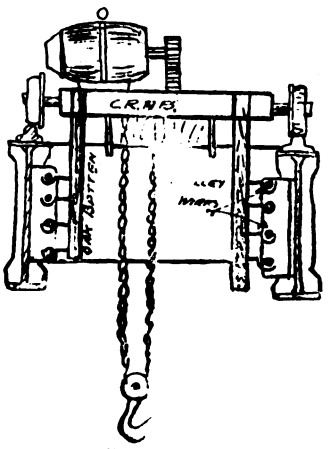

FIG. 2.

The connections for the longitudinal motor will also be similar to Fig. 1, with this difference, that instead of bare copper wires, as indicated by C, D, E, and F, these will consist of ordinary insulated cables run in gas-tubing. Some makers only use seven wires, instead of eight, as is shown in Fig. 3; the only difference, however, is that one wire, C, serves as a common return for the raising and transverse motors series coils. If a three-wire system is installed in the works, have the motors wound for the voltage across the outers, thus driving the motors at their maximum speed for dealing with light loads. When connected across the inners, the motors will run at about half the above speed for dealing with the heavy loads.—R. N. F.

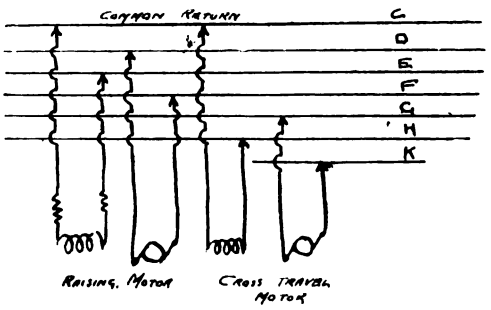

FIG. 3.

Question No. 392.—A so-called differential booster in series with and charging a battery in a traction station is supposed, when a heavy discharge takes place, to boost up that discharge to line. Is this taking place when the motor ammeter and the booster voltmeter drop to zero? If not, what is the booster doing, and what are likely to be its defects?

Best Answer to No. 392 (*awarded* 10*s.*).—A copy of the connections of the differential boosters which is referred to in this question would have been of great assistance in giving a correct answer, but since these are not given we must conjecture to some extent what they will be.

Fig. 1 indicates an arrangement of traction connections in which a differential booster is used to work both ways. The series coils, S_1 S_2, of the generators and the series

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coil, S_3, of the booster are all in parallel, and on the booster, B, there are two field windings; one, B_{sh}, a shunt winding, which tends constantly to generate in the armature of the booster an E.M.F. opposed to that of the battery, B_1, and the other a series winding, S_3, which tends to reverse the polarity of the booster. If the load be light the shunt winding is in excess and the booster helps the main dynamos, G_1 G_2, to charge the battery, B_1. At a certain medium load the booster will be idle, but at heavy loads its polarity is reversed—the series coil, S_3, predominating—and the booster helps the battery to discharge. Since the booster reverses its polarity it is evident that a voltmeter reading from zero up to a maximum in one sense will not do to take its voltage with, but a voltmeter with a scale as shown in Fig. 2, and reading both ways from zero, should

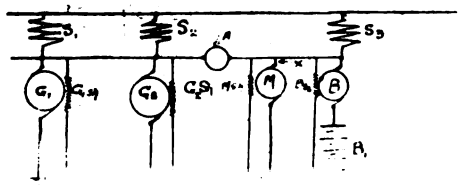


FIG. 1.—S_1 S_2, Generator Series Coils; S_3, Booster Series Coil; G_1 G_2, Generators; G_1sh G_2sh, Generator Shunts; M, Booster Motor; B, Booster; Msh, Booster Motor Shunt; Bsh, Booster Shunt; B_1, Battery; A, Ammeter, wrong position; X, correct position for Motor Ammeter.

be used. It is also stated that the motor ammeter at times reads zero. The booster motor could not very well receive current in two directions, so I am afraid there must be something wrong with the ammeter connections. For instance, if the ammeter were placed at A in Fig. 1, then when the generators, G_1, G_2, were lightly loaded, current would flow through the ammeter, A, to the motor, M; but if the generators were heavily loaded the current for the motor might all come from the battery, B_1, and booster, B, and would not go through the ammeter at all, in which case, of course, the motor ammeter would register zero. The correct position for the motor ammeter would be at X in Fig. 1.

It is probable that when the booster voltmeter drops to zero the booster is discharging, or helping to discharge, the battery to line; but to ascertain whether the machine is doing its proper duty or not, an ampere-hour meter should be connected in circuit, so as to see whether the battery tends over a whole day's working to charge or discharge. Two meters with poles reading in opposite directions only are sometimes used, and their readings compared at the end of the day's run. This arrangement gives the work done by the battery during the day, as well as indicating the state of the battery at the end of the day. In series with the booster shunt field coils, B_{sh}, a variable resistance

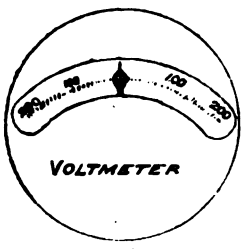
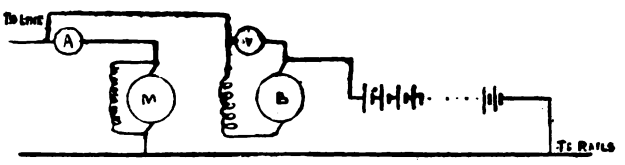


FIG. 2.

should be connected. If the battery tends on the whole to discharge, strengthen the shunt fields of the booster by taking out some of the variable resistance. If it tends to overcharge, weaken the shunt field of the booster by putting in more of the variable resistance. Probably a variable resistance in the booster shunt, together with an ampere-hour meter (if such are not connected), with proper attention to the same, are all that is required for successful working in the case in question.

With an arrangement like the above it is not necessary to shift the regulating cell switch at all, the regulation being done by the booster shunt variable resistance; hence all irregular charge and discharge of the regulating cells is saved, and the regulating cells are very seldom or never short-circuited between the contacts of the regulating cell switch, which is another good point of this system.—S. L.

Answer to No. 392 (*awarded* 5*s.*).—The sketch represents the arrangement described in the question, where M is the motor, A the motor ammeter, B the booster, V the booster voltmeter. (Everything else has been left out.) I do not see how the motor ammeter can ever read zero while the set is running. It will be seen by the sketch that the motor is shunt wound, and will always take some current to run the set light. The booster is series wound. What takes place is this: If the line voltage is exactly equal to the battery volts no current will flow through the booster to the battery; it will therefore not be excited, and the booster voltmeter will read zero, while the motor ammeter will register the current required to run the set light. This is the nearest approach to the conditions of the question. If the line volts drop, current will flow from the battery, which will excite the field of the booster and boost up the battery discharge to line. On the other hand, if the line volts rise, current will flow into the battery, which will excite the booster in the reverse direction, and will boost up the battery charge. The motor will



take current in proportion to the boost. It may be mentioned that the object of the booster is to get a greater amount of work out of the battery and an evener load on the generators. The boosting up in either direction exaggerates the fluctuations at the battery terminals, and therefore much greater charges and discharges result. It also follows that a much steadier pressure is obtained, and the generators get something approaching a steady load.—C. L. E. S.

NEW COMPANIES.

The following new companies have been registered since our last issue:

Birmingham Motor Manufacturing and Supply Company, Limited.—Capital, £5,000. Object: to manufacture, etc., motors, cycles, cars, carriages, etc., and to carry on the business of electricians, engineers, wire-drawers, etc.

Power-Gas Corporation, Limited.—Capital, £350,000. Object: to acquire any patents and rights relating to the production of fuel, gas, sulphate of ammonia, and other by-products, to adopt certain agreements with Dr. L. Mond, and with E. J. Duff and the United Alkali Company, Limited, and to produce gas, etc., and to carry on the business of chemical manufacturers, electricians, mechanical engineers, suppliers of electricity, etc.

Du Bois Company, Limited.—Capital, £200,000. Object: to acquire the business of the British and Foreign Du Bois Company Limited, and the United Enterprises, Limited, and to carry on the business of plumbers, mechanical engineers, electricians, fitters, etc.

Thomas Howden and Sons, Limited.—Capital, £5,000. Object: to acquire the business carried on by Thomas Howden and Sons at the Union Foundry, Wakefield, to adopt agreements with A. Macredie and J. E. Tomlinson, and to carry on the business of engineers, engine and boiler makers, machinery and implement makers, makers of electrical machinery, plant, and appliances, etc.

APPOINTMENTS VACANT.

Resident Electrical Engineer and Manager, Finchley Urban District Council, £300 per annum, Aug. 19. Full particulars in our advertisement columns.

Demonstrator in Electrical Engineering. — South-Western Polytechnic, Chelsea, £120 per annum, Aug. 6. Details in our advertisement columns.

Shift Engineer, Battersea Borough Council central station, £104 per annum. Full particulars appear in our advertisement columns.

BEDFORD ELECTRIC LIGHTING ACCOUNTS.

The accounts of the Bedford electricity works for the year ending Dec. 31, 1900, have just been published, and give the total expenditure on capital account to date as £77,768. An abstract of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., is given herewith.

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Dr.	Revenue Account.	£	s.	d.
Coal or other fuel		4,061	7	4
Oil, waste, water, and engine-room stores		431	3	7
Wages at generating stations		790	8	0
Repairs and maintenance of buildings and plant		512	7	11
Wages and other remuneration to linesmen, etc.		120	0	0
Repairs, maintenance, and renewals of mains		104	18	0
Repairs, etc., at distributing stations		28	14	8
Repairs and renewals of lamps		146	14	1
Rents payable and rates and taxes		203	14	0
Management expenses		778	8	5
Special charges		64	18	2
		7,242	14	2
Amount carried to net revenue account		3,537	4	11
		£10,779	19	1

Cr.	£	s.	d.
Discount forfeited, less bad debts written off	26	15	9
Sale of current per meter at 4½d. per B.T.U.	6,342	10	3
Sale under contracts	1,369	3	9
Public lighting	2,743	17	1
Rental of meters and other apparatus	251	19	9
Sale of incandescent lamps	4	12	3
Contribution to Rucker's defence fund returned	11	15	0
Contribution for cost of lamp columns damaged	4	6	8
Power used for pumping water	15	0	0
Miscellaneous	9	18	7
	£10,779	19	1

General Balance-Sheet.

Dr.	Liabilities.	£	s.	d.
Capital account—amount received		64,327	1	5
Sundry creditors		1,372	16	1
Due to treasurer, less cash in hand		17,010	4	2
		£82,710	1	8

Cr.	Assets.	£	s.	d
Capital account—amount expended for works		77,768	18	9
Stores on hand		610	8	0
Sundry debtors for current supplied		3,297	0	7
Other debtors		121	15	0
Balance at debit of net revenue account		911	19	4
		£82,710	1	8

Statement of Electricity Generated, Sold, etc.

Quantity generated in Board of Trade units			848,489
Quantity sold	Public lamps	207,772	
	By contract	109,535	655,574
	Private consumers by meter	338,267	
Quantity used on works			49,275
Total quantity accounted for			704,849
Quantity not accounted for			143,640
Number of public lamps			530
Total maximum supply demanded (kilowatts)			550

COMPANIES' MEETINGS AND REPORTS.

WEST AFRICAN TELEGRAPH.

On the 18th inst. the ordinary general meeting of the shareholders was held at Winchester House, under the presidency of the Marquis of Tweeddale.

The **Chairman**, having referred to several items in the report (which appeared in our issue of the 12th inst.), said the principal increase in the gross revenue (£81,568, or £4,560 in excess of that of 1899) was due to the operation of the joint purse with the Eastern and South African Company, and there was also an advance owing to a reduction in the amount paid by this Company for the hire of cables belonging to other companies through the Dakar cable not being in working order. He moved that the report and statement of accounts be approved.

Sir Henry C. Mance seconded the motion, which was carried *nem. con.*

The **Chairman** then proposed a resolution authorising the directors 'to negotiate and carry out the sale or disposition of the concession now held by the Company from the French Government, and of all or any of the cables or other property now belonging to the Company in connection therewith, upon such terms and conditions and in such manner as the directors may think fit." He explained that it was now proposed that the Company should surrender the concession and hand over the following cables, which connected the French colonies—the Dakar-Conakry cable, the Grand Bassam-Kotonou cable, and the Kotonou-Gaboon cable, touching *en route* at San Thomé. The Portuguese station at Bissau, which was at present connected with the Dakar-Conakry cable would be disconnected and would be connected with Bathurst direct by a new cable, the latter station being cut out of the Dakar-Conakry station. The French Government would have connection with the existing cables at Conakry, the Sierra Leone-Conakry cable remaining in the possession of the West African Telegraph Company. The Grand Bassam-Kotonou cable, which now touched *en route* at Accra, would be disconnected at the latter place and the cable joined through. The French Government were to have the option of continuing the connection at San Thomé. Under this arrangement that Government are to pay £112,000 on the cancellation of the concession, and a further £32,000 as and when the cables were handed over. These sums, together with the moneys in the reserve, would be sufficient to pay off all the outstanding debentures, which it was intended at once to proceed to do. He need hardly tell them that this arrangement had not been arrived at without a considerable amount of negotiation and trouble. He was glad, however, to say that the matter was now thoroughly completed, and, looking at the proposal from all points of view, it was entirely in the interests of the Company.

Mr. J. Denison-Pender seconded the motion, which was carried unanimously.

ELECTRIC AND GENERAL INVESTMENT.

Mr. George Herring presided over the annual meeting of the shareholders in this Company at Winchester House on the 18th inst.

The **Chairman**, in moving the adoption of the report, said the business done by the Company in the past year had not been as good as in the previous year. Their profits were derived from making issues principally of electrical undertakings, and he was glad to say that these had always been on a sound basis. In the directors' report reference was made to the reports of the trustees for the founders' shares and for the ordinary shares reserve funds. For the reasons stated in those reports the trustees did not propose to make any distribution for the past year in respect of these funds; the trustees considered that these securities held were worth a great deal more than they were now quoted at on the market. Referring to the item of "investments at cost" in the balance-sheet, he stated that, although many of them had undoubtedly declined in value, yet they would nevertheless realise their cost price, and, he hoped, more. The preference shares represented a new entry in the balance-sheet. To pay the dividend on them would require £6,000 a year, which had to be made up, but the possession of the £100,000 represented by them was an advantage, and it would also save them a considerable sum—certainly three-fourths of the £6,000. In previous years they had borrowed from their bankers, paying interest, of course, but the preference capital now rendered this unnecessary.

Mr. J. B. Braithwaite, jun., seconded the motion, which was carried.

A resolution was then adopted for the payment of a dividend on the ordinary shares of 3s. a share, making, with the interim dividend, 5s. a share for the year ended May 31 last, and a bonus of 2s. a share; and the payment of a dividend of £50 per founder's share for the year.

The proceedings closed.

GLOBE TELEGRAPH AND TRUST.

The directors' report for the year ended 18th inst. states that the net revenue, after deduction of expenses, amounts to £197,136, and makes, with the balance of £982 brought forward, a total of £198,119. From this amount there has been distributed £131,035 in interim dividends, leaving an available balance of £67,084. The directors recommend a final dividend for the year of 3s. per share on the preference shares, and of 4s. 6d. per share on the ordinary shares, making, with previous distributions, a total dividend for the year of 6 per cent. upon the preference and 5¼ per cent. net (against 5¼ per cent. for the preceding year) upon the ordinary shares, leaving a balance of £1,102 to be carried forward. During the year the 6 per cent. debentures of the London Platino-Brazilian Telegraph Company held by this Company have been sold at a premium to meet, in part, the cost of the new shares of the Eastern Extension, Australasia, and China Telegraph Company, Limited, referred to in the last report. At a drawing of the Submarine Cable Trust certificates, which took place in April last, nine certificates in that trust held by this Company were drawn for payment at £120, the Company retaining the coupons of reversion belonging thereto. The directors much regret that, owing to his official duties, the Right Hon. St. John Brodrick, M.P., resigned his position on the Board. The vacancy thus occasioned has been filled up by the appointment of Sir John Wolfe Barry, K.C.B.

BRITISH THOMSON-HOUSTON.

The annual general meeting of the shareholders in this Company was held at the offices, 83, Cannon-street, E.C., on Monday afternoon, Mr. E. A. Lazurus presiding.

On the motion of the **Chairman**, the directors' report (which appeared in our last issue) was unanimously adopted without discussion.

DIRECT UNITED STATES CABLE.

In their report for the year ended 18th inst. the directors state that the half-year's revenue, after deducting out-payments, amounted to £50,650, as compared with £52,204 for the corresponding period of 1900, showing a difference of £1,554 against the half-year under review. The working and other exposes for the same period, including income tax, but exclusive of cost of cable repairs, amounted to £21,125, leaving a balance of £29,525 as the net profit, making, with £5,255 brought forward, a total of £34,781. For the corresponding period of 1900 the working expenses and other payments amounted to £20,506. Three quarterly interim dividends of 3s. each per share, amounting to £27,319, have been declared and paid during the financial year, and a final dividend of 3s. per share is now proposed, together with a bonus of 1s. per share, making, with the three interim dividends, 3¼ per cent. for the year. After transferring £10,000 to the reserve fund account, the balance of £3,532 on the revenue account is proposed to be carried forward. The reserve fund account has been

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debited with £19,414 for cost of cable repairs, and after being credited with interest on the investments and amount transferred from revenue account, now amounts to £430,997, taking the investments at cost price.

GENERAL ELECTRIC.

In their report to be submitted at the first ordinary general meeting of the shareholders, to be held at the Cannon-street Hotel, E.C., on July 30 at 12 noon, the directors state that the net trading profits and income from investments, etc., amount to £75,766. 8s. 6d. After deducting interest on balance of purchase money up to date of payment thereof, and on payments in advance of calls on preference shares, income tax, depreciation, and debenture interest, amounting to £21,347. 13s. 10d., there remains an available balance of £54,418. 14s. 8d., which the directors recommend should be appropriated as follows: dividend on preference shares at 5 per cent. to March 31, 1901, paid June 30, 1901, £5,778. 3s. 5d.; managing directors' and employés' bonus, £4,864. 1s. 1d.; dividend on ordinary shares at 10 per cent. to March 31, 1901, £25,692; reserve account, £18,084. 10s. 2d. Since the formation of the Company the directors have acquired an additional 63 acres of land at Witton and Erdington, adjoining the property previously bought, for the purpose of erecting modern engineering, electro-chemical, and other works. The directors are hurrying on as much as possible the completion of the new works at Witton, so as to be able to start manufacturing there before the end of the present year—a matter of great importance, considering the overcrowded state of their present works at Manchester and Birmingham. The Board have during the past year appointed Mr. Max Railing, manager of an important department, as an additional director. Mr. Railing offers himself for re-election. The Board recommend for election two additional directors—namely, Mr. Henry Bevis, manager in the firm since 1889, and Mr. Tom Hawkins, the present chief engineer at Manchester. The 692 ordinary shares issued since the formation of the Company have all been allotted at par; as to seven of such shares to the subscribers of the memorandum of association, and as to the remaining 685 to members of the staff. The auditors, being eligible, offer themselves for re-election.

Abstract of Profit and Loss Account, April 1, 1900, to March 31, 1901.

Dr.	£	s.	d.
Interest on balance of purchase money	5,237	8	3
Debenture interest	3,801	5	9
Income tax	3,246	15	10
Depreciation	9,062	4	0
Balance for appropriation carried down	54,418	14	8
	£75,766	8	6
Dividend on preference shares at 5 per cent.	5,778	3	5
Managing directors' and employés bonus	4,864	1	1
Dividend on ordinary shares at 10 per cent.	25,692	0	0
Reserve account	18,084	10	2
	£54,418	14	8

Cr.	£	s.	d.
Profits from trading accounts	70,091	12	1
Income from investments	5,670	17	11
Transfer fees	3	18	6
	£75,766	8	6
Balance for appropriation brought down	£54,418	14	8
	£54,418	14	8

CROMPTON AND CO.

Directors: John Trotter, Esq., (chairman); Lieut.-Colonel R. E. B. Crompton (managing director); Ivor Bevan, Esq.; Bernard Gibson, Esq.; Carleton F. Tufnell, Esq.; Francis R. Reeves (general manager).

Thirteenth report of the directors (with abstract of accounts) to be presented at the annual general meeting of the shareholders at Winchester House, E.C., on Aug. 1, 1901, at 12 noon:

The directors beg to submit the annual statement of accounts and balance-sheet made up to March 31 last, from which it will be seen that the net profit for the year is £27,100. 12s. 7d. After providing for debenture interest, the payment of interim dividend, and other items set out in the net revenue account, there remains, with the sum brought forward from last year, a balance of £17,926. 9s. 1d. The directors propose to set aside a sum of £2,500 as a provision for doubtful debts, to place £5,000 to the reserve fund, to pay a final dividend of 9 per cent. per annum for the half-year, free of income tax, making, with the interim dividend paid in January last, 8 per cent. for the year, and to carry forward the balance, £3,143. 18s. 1d. With the above addition the reserve fund will now amount to £17,906. 6s. 6d., and the directors propose to write off from this fund the sum of £5,648. 6s. 10d. from patents account, which will then stand at the nominal figure of £10. The directors offered 46,000 shares for subscription in March last at the price of 5s. per share premium. Thirty-one thousand shares were applied for, when the directors closed the list and proceeded to allotment. The whole of the premiums on these shares, less the cost of issue, has been placed to reserve fund and invested outside the business. The order-book continues very full, and the prospects for the future are satisfactory. In consequence of the growth of the business and the small accommodation at Mansion House-buildings, the registered offices of the Company have been removed to larger premises at Salisbury House, London-wall. The building of the new arc lamp, instrument, and switchboard shops at the site of the new works is well advanced. The extensions to the works offices are approaching completion. A new generating station and offices have been erected for the Chelmsford Electric Lighting Company, and the whole of the plant and machinery has been overhauled, and, where necessary, renewed. The cost of these repairs and renewals has been charged to the lighting company's revenue, notwithstanding which fact, and the high price of coal last year, the profits of that company show a satisfactory increase. Mr. Ivor Bevan has been elected by the Board a director of the Company. His election requires confirmation by the shareholders. In accordance with the articles of association, Mr Bernard Gibson retires from the board of directors by rotation, but offers himself for re-election. The auditors, Messrs. J. H. Duncan and Co., also offer themselves for re-election.

Liabilities and Assets.

Dr. Capital and Liabilities.	£	s.	d.
Authorised issue, 100,000 shares at £3 each	300,000	0	0
Issued—54,000 shares, £3 per share, paid up	162,000	0	0
31,000 shares, £1 per share, called up, £31,000; less calls in arrears, £371. 5s.	30,628	15	0
Payments in full	2,602	0	0
	195,230	15	0
5 per cent. first mortgage debentures	100,000	0	0
Sundry creditors	67,041	18	3
Debenture interest accrued	1,187	10	0
Doubtful debts and contingencies account	591	10	9
Unclaimed dividends	98	16	2
Reserve fund	12,906	6	6
Contingency fund	5,000	0	0
Revenue account balance	17,926	9	1
	£399,983	5	9

Cr. Property and Assets.	£	s.	d.
Freehold land and premises	41,768	10	9
Plant, tools, furniture, and fixtures	68,987	18	4
Stock-in-trade and work in progress	141,232	1	1
Trade debtors	80,569	19	9
Chelmsford Electric Lighting Company investments	43,406	12	8
Investments in other companies	1,659	10	0
Cash at bankers and in office	6,700	6	4
Patents account	5,658	6	10
Goodwill	10,000	0	0
	£399,983	5	9

Dr. Profit and Loss Account.	£	s.	d.
Trading expenses (steam and electric power, etc.)	23,769	0	4
Administration and office expenses, rents, etc.	12,825	7	1
Repairs to buildings, plant, and machinery	1,005	6	11
Depreciation of plant and machinery, etc.	3,933	12	5
Net profit to revenue account	27,100	12	7
	£68,633	19	4

Cr.	£	s.	d.
Gross profit from trading account, pupils' premiums, and dividends on investments	68,633	19	4
	£68,633	19	4

Dr. Revenue Account.	£	s.	d.
Interest on debentures	5,000	0	0
Interest on temporary advances	736	15	1
Directors', managing directors', trustees', and auditors' fees	1,997	0	0
Income tax, £320. 13s. 7d.; interim dividend paid Jan. 15, 1901, £4,849. 13s. 9d.; balance, £17,926. 9s. 1d.	23,096	16	5
	£30,830	11	6

Cr.	£	s.	d.
Balance from last year	3,729	18	11
Net profit from profit and loss account	27,100	12	7
	£30,830	11	6

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Blackburn.—The Town Council invite tenders for steam dynamos Tenders by July 29. Tenders in our advertisement columns.

Vienna.—The K. K. fur Austro-Hungarian State Railways require tenders for a number of indiarubber articles. Tenders by Aug. 3.

Farnworth.—The Urban District Council invite tenders for a car shed traverser. Tenders by Aug. 12. Details in our advertisement columns.

Sunderland.—The Corporation require tenders for erection and completion of proposed electric tramcar sheds, Hylton-road. Tenders by Aug. 2.

Paris.—Tenders are invited for 21 double telephone cables, silk and cotton insulated, by the Post Office Department, 103, Rue de Grenelle. Tenders by Aug. 12.

Cardiff.—The Corporation invite tenders for main switchboard with instruments complete. Tenders by Aug. 6. Details in ou advertisement columns.

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Bradford.—The Corporation invite tenders for the supply and delivery of 100 electric tramcars. Tenders by July 31. Details in our advertisement columns.

Kearsley.—The Urban District Council invite tenders for tramway poles, bases, section boxes, overhead line, etc Tenders by Aug. 1. Details in our advertisement columns.

Hapton (near Padiham, Lancs.).—Tenders are required for lighting the Hapton township with electricity from Sept. 1, 1901, to April 30, 1902. Tenders by July 31.

Amsterdam.—The Corporation invite tenders for tramcars for electric traction with overhead wire (perhaps 140). Tenders by Sept. 2. Details in our advertisement columns.

Cardiff.—The Corporation invite tenders for double-deck bogie cars, double-deck four-wheel cars, and single-deck bogie cars. Tenders by Aug. 6. Details in our advertisement columns.

Keighley.—Tenders are invited for electric light installation at the parish church, Keighley. Specifications, etc., can be obtained from Messrs. Gibbings and Baker, Old Bank-chambers, Bradford.

Bury (Lancs.).—Tenders are invited for the work required in the extension of the engine and boiler houses and other contingent works at the electricity works, Rochdale-road. Tenders by July 30.

Manchester.—The Electricity Committee invite tenders for 70 feeder and section pillars. Specifications, etc., may be obtained from Mr. F. E. Hughes, Town Hall, Manchester. Tenders by Aug. 7.

Gravesend.—The Town Council invite tenders for boiler-house and engine-house plant, switchboard, mains, meters, crane, dust destructor, etc. Tenders by July 30. Details in our advertisement columns.

Dundee.—The Gas Commissioners invite tenders for surface condensers, electrically-driven pumps, cooling towers, feed-water heaters, etc. Tenders by August 5. Details in our advertisement columns.

Parc Gwyllt (Glam.).—Tenders are invited for lighting by electricity of Parc Gwyllt Asylum, near Bridgend. Tenders, endorsed "Electricity," to be sent to Mr. Hugh W. Davies, clerk of asylums, Bridgend, by 12 noon on 29th inst.

Brecon.—The Committee of the Talgarth Joint Asylum invite tenders for the electric lighting of the asylum. Particulars can be obtained from the architects, Messrs. Giles, Gough, and Trollope, 28, Craven-street, Strand. Tenders by Aug. 5.

Farnham.—The Urban District Council are desirous of contracting with a responsible firm for the supply of electricity under the requirements of their Electric Lighting Order, 1900, in their area. Proposals by Aug. 27. Details in our advertisement columns.

Amsterdam.—The Municipality invite tenders for 5,000,000 kilos of tramway rails, with plates, bolts, etc. Specification, 2s. 7d. Tenders by Sept. 2. Information is given at the office of the Director of Municipal Street Railways, Nieuwe Achtergracht, 164.

Gateshead.—The Gateshead Co-operative Society invite tenders for the installation of electric lighting at their Askew-road branch, the generating plant excluded. Specifications, etc., can be seen by applying to the Electrical Engineer, Jackson-street. Tenders by July 29.

Belfast.—The Baths and Lodging-House Committee invite tenders for the electric lighting of the new lodging-house, Lower Regent-street. Specification, etc., may be obtained from Mr. V. A. H. M'Cowen, city electrical engineer, East Bridge-street, Belfast. Tenders by July 31.

Newcastle-upon-Tyne.—The Corporation invite tenders for the laying down in Gosforth of about 1,000 yards of double-line tramway, the rails and fastenings and the poles being supplied by the Corporation. Specifications, etc., may be obtained at the office of the City Engineer, Town Hall, Newcastle. Tenders by July 29.

Liverpool.—The Directors of the South Lancashire Electric Traction and Power Company, Limited, invite tenders for the construction of about 30 miles of tramways. Specification, etc., may be obtained from the office of the consulting engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster. Tenders by Aug. 2.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection of steel poles, bases, section boxes, overhead line, and accessories for the equipment of approximately five miles of tramways (specification No. 3); and also for the supply, delivery, and laying of feeder cables and pilots (specification No. 4). Tenders by Aug. 1. Details in our advertisement columns.

Worcester.—The Corporation invite tenders for water-tube boilers, economisers, steam and feed pipes, pumps, steam dynamos, motor-alternator, booster, Korting condensers, electric pumps, cast-iron suction, delivery, and exhaust pipes, tank, switchboard, overhead travelling crane, and accumulators, for the new electricity works. Tenders by Aug. 23. Details in our advertisement columns.

RESULTS OF TENDERS.

Yarmouth.—The Electric Lighting Committee have accepted the tender of R. Eastoe, at the sum of £1,167, for additions to the generating station at the electric lighting works.

Farnworth.—The District Council have accepted the tender of the British Insulated Wire Company, to the specification of Lacey, Clirehugh, and Sillar, for the overhead equipment of the tramway extensions.

West Ham.—The Council have accepted the tender of S. Z. de Ferranti, at £14,240, for the supply of three 500-kw. continuous-current tramway generators. The dynamos will be of D. Bruce Peebles and Co.'s manufacture.

Battersea.—The following tenders are recommended for acceptance for the execution of the waterworks required at the central electric generating station for condensing purposes from the River Thames as per Specifications Nos. 11 and 12, the estimated cost of the work being £7,500: Mather and Platt, Limited, electric pumps, pipework, etc., for condensing water (Specification No. 11), £2,163; Fraser and Fraser, Limited, river work, pipes, and pits for condensing water supply (Specification No. 12, with slight modification), £7,000; Babcock and Wilcox, Limited, chequer plating for covering in the chases in the boiler-house floor in front of the position of the boilers, £110. The work of providing water-circulating pipes to engines, etc., which were omitted from the general specifications, is to be executed by the Works Department at an estimated cost of £45.

Ipswich.—The Electric Lighting Committee have received the following tenders for the supply of four boilers for the electric lighting and power station:

E. Danks and Co., Oldbury (accepted)	£5,020
Fraser and Fraser, Bromley-by-Bow	5,800
J. Fraser and Son, Millwall	5,840
Wallsend Slipway Engineering Company, Newcastle-on-Tyne	6,000
J. P. Phibbs, 26, Basinghall-street, E.C.	6,587
R. Stephenson and Co., Newcastle-on-Tyne	6,880
Richardsons, Westgarth, and Co., Limited, Middlesbrough	8,600

Tonbridge.—The Council have accepted the following tenders:

Holdsworth and Sons, boiler-house plant	£1,120	0	0
Johnson and Phillips, engine-house plant, with Alley and Maclellan engines	1,871	0	0
Johnson and Phillips, condensing apparatus and pipework	1,136	0	0
H. Morris and Bastert, overhead crane	111	11	2
Veritys, Limited, switchboard	921	2	0
Veritys, Limited, accumulators	1,539	16	0
Western Electric Company electricity supply mains	4,002	17	0
Improved Electric Glow Lamp Company, Limited, public arc lighting	444	6	0
Chamberlain and Hookham, house meters	162	0	0
Improved Electric Glow Lamp Company, Limited, public incandescent lighting	331	9	6

Dublin.—The Council have accepted the following tenders:

Alley and Maclellan, condensers	£3,030	0	0
Babcock and Wilcox, Limited, pipework	4,805	0	0
D. Stewart and Co., Limited, feed pumps	395	0	0
J. Musgrave and Sons, Limited, superheaters (Part 1).	832	0	0
Babcock and Wilcox, Limited, superheaters (Part 2)	705	0	0
Graham, Morton, and Co., Limited, coaling plant	5,475	0	0
Carrick and Ritchie, crane	670	0	0
Easterbrook, Allcard, and Co., workshop equipment	795	0	0
S. Z. de Ferranti, Limited, main switchboards and sub-station switch gear	10,304	0	0
British Westinghouse Electric and Manufacturing Company, Limited, transformers	6,320	0	0
Veritys, Limited, arc lamps	6,198	12	0
Veritys, Limited, arc lamp pillars	6,042	15	0
Witting Bros., Limited, motors and generator	3,970	0	0
Electrical Power Storage Syndicate, Limited, accumulators	751	13	6
British Westinghouse Electric and Manufacturing Company, Limited, meters	4,670	0	0
W. Coates and Son, Limited, works wiring	967	0	6

BUSINESS NOTES.

TRACTION.

Sunderland.—Another section of the Corporation electric tramways has been opened for traffic.

Southport.—The formal opening of the Cambridge-road electric tramway has been fixed for the 1st prox.

Wolverhampton.—Work has been commenced in Lichfield-street in connection with the new tramway scheme.

Derby.—A public meeting has decided to canvass the town with reference to Sunday traffic on the local tramways.

Haslingden.—A conference between the representatives of the Haslingden and Accrington Corporations is to be held on the question of tramways.

Moss Side.—The Urban District Council have conditionally arranged with the Manchester Corporation for the reconstruction of the tramways to proceed.

Central London Railway.—In the House of Commons on Wednesday, the Central London Railway (No. 2) Bill was considered and ordered for third reading.

Birkenhead.—Within the next two or three weeks it is expected at least two, or perhaps three, sections of the new municipal electric tramways will be in operation.

Brighton.—The Corporation have decided to run a Sunday service on the new electric tramways when completed. The fare on each route, also, is to be "a penny all the way."

Nottingham.—The formal opening of the Bulwell-to-Nottingham section of the new electric tramway system took place on Tuesday. Work is proceeding rapidly on the Trent section.

Liverpool.—Some delay was caused to the tramway service at the junction of Old Haymarket and Dale-street on Monday, owing to the snapping of the span wire, which fell across the trolley wire.

Chamonix Railway.—The opening of the electric railway from Le Fayet to Chamonix was announced to take place yesterday. This

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new line will shorten the journey from London to Chamonix to about 25 hours.

Ashton.—Steps are being taken to secure a direct service of tramcars, by way of Guide Bridge and Ashton, direct to the Oldham boundary, instead of round by the market, which would necessitate a change of cars.

Bradford.—There is a proposal that the Corporation shall acquire the tramway undertakings of the Bradford and Shelf Tramway Company and the Bradford Tramways and Omnibus Company from February next.

Poole.—The Poole and District Electric Traction Company, Limited, have promised to consider any suggestions the Council may make for minimising the risk to the public at the tramway crossing near North-road, Parkstone.

Oldham.—Major Druitt, of the Board of Trade, has inspected the Hollins-road section of the Corporation electric tramways, this being the fourth section which has been completed. It is 1¾ miles in length, and the fare for the complete journey is 1d.

Dewsbury.—The big electric tramway scheme which the British Electric Traction Company have in hand in the Dewsbury district, including the proposals with regard to Morley, will involve a total expenditure on construction and plant of about £750,000.

Leicester.—On Wednesday evening the Tramways Committee decided to recommend the Council to purchase the present system of tramways from the private company which owns it for £134,000. The electrical equipment of the lines is estimated to cost £350,000.

Perth.—At a special meeting of the Town Council a letter was read from the Perth and District Tramways Company, Limited, stating that the directors are not prepared to entertain the offer of £20,000 by the town for their undertaking. Negotiations will accordingly be dropped.

Mr. Behr's Proposed Monorail.—This week the House of Commons Committee which is considering the Bill to authorise the construction of a high-speed electric railway from Manchester to Liverpool, have been engaged in hearing evidence on behalf of the opposing Cheshire Lines Committee.

Sheffield.—It is intended to present a petition against the proposal to extend the tramway further up Glossop-road than at present. It is hoped that the line to Ranmoor will be opened to the public on Aug. 1. It is definitely decided that there shall be no halfpenny fares from Broomhill to Ranmoor.

Mersey Electrical Railway.—We understand that a contract has been concluded between the Mersey Railway Company, which owns the tunnel railway between Liverpool and Birkenhead, and the British Westinghouse Electrical and Manufacturing Company for the construction of the works for the electrical equipment of the line.

A Lancashire Scheme.—The Committee of the House of Lords over which the Earl of Ribblesdale presides has passed the preamble of the Stalybridge, Hyde, Dukinfield, and Mossley Joint Tramways and Electricity Board Bill. The scheme, which was unopposed in the Commons, provides for the working of a tramway system 25 miles in length.

Manchester and District.—Sir Frederick Bramwell is sitting at the Surveyors' Institution, Westminster, this week, as sole arbitrator to decide the amount to be paid by the Manchester Corporation and the local authorities of the district for the tramway undertaking which has been taken over from the Manchester Carriage and Tramways Company.

Wembley.—A meeting of owners and occupiers has passed the following resolution: "That subject to the roadway being widened throughout to a minimum width of 50ft., the ratepayers, owners, and occupiers present pledge themselves to sign a petition in favour of the introduction of the Middlesex County Council's electric tramways in the Wembley district."

Lowestoft.—The Select Committee of the House of Commons of which Sir Frederick Godson is chairman has passed the preamble of the Bill promoted by the Corporation to authorise them to construct and work electric tramways in the town, make street improvements, and to provide for electric light and other purposes. The borrowing powers are for £60,000.

Leeds.—It is expected that within a week the electric cars will be running on the Cardigan-road route, which has just been completed. In addition to the service to and from City-square to the Cardigan-road terminus, there will be a circular route from City-square to Hyde Park, *via* Burley-road, Cardigan-road, and Victoria-road, and thence to City-square again, *via* Woodhouse-lane.

Cork.—The receipts of the Cork Electric Tramways and Lighting Company for the week ending July 18 stand at £613, as against £489 for the corresponding week last year, showing an increase of £124. The total receipts to July 18 this year are shown at £12,819, the receipts for the corresponding period last year being £11,088. These figures give an increase of £1,731.

Woolwich.—The London County Council have informed the Borough Council of their intention to purchase the undertaking of the Woolwich and South-East London Tramways Company, and that it is probable that the Council will utilise for traffic the tramways in Powis-street. The necessary preliminary arrangements for the transfer, however, will take some considerable time.

Rochford.—The Surveyor has reported to the Urban District Council on the proposals of the promoters of the Southend to Bradwell tramway scheme, and he recommends that the lines should be at the side of the roads in both town and country. He also suggests that the minimum width of all country roads through which the lines go should be 30ft., and that the promoters should build a new bridge at Rochford.

Sedgley.—The District Council have granted the British Electric Traction Company an extension of time for the reconstruction of the Dudley and Wolverhampton tramway. It is stated that the company intend to carry the line to Bilston. The Council have decided to engage an expert to see that the construction of the line is properly carried out, the appointment being left in the hands of the Tramway and Roads Committee.

Liverpool Overhead Railway.—The accounts of this Company for the past half-year show an available balance of £11,722, and the directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares and 2 per cent. per annum on the ordinary shares, against 3 per cent. per annum on the ordinary shares for the corresponding period last year. Balance carried forward, £3.722.

Staines.—The managing director of the London United Tramways Company attended at the last meeting of the Rural District Council and explained the company's proposal to construct light railways in the district. On a show of hands as to whether the Council should support or oppose the scheme, there was an equal division, the chairman being precluded from giving a casting vote by not having voted in the first instance.

Cardiff.—Considerable delay has been caused in the construction of the permanent way at Cardiff owing to the supply of rails running short. The Cathedral-road to Clarence Bridge and the Albany-road and Castle-road sections, however, are nearly finished. As to the purchase of the existing tramways, the engineer to the tramways company and the borough engineer have agreed as to quantities, etc., and are now making out independent price-lists.

Chiswick.—At the last meeting of the District Council the question of the noise of the electric trams was discussed. The Clerk stated that the draft regulations sent down by the Board of Trade were hardly sufficient. Additions had been suggested, but at present no reply had been received. The clerk was instructed to communicate with the Board of Trade and Scotland-yard with regard to the practice of trams stopping abreast of each other, which is considered a source of great danger.

British Electric Traction Co.—Messrs. J. S. Morgan and Co. and the Electric and General Investment Company, Limited, having exercised the option granted to them by the British Electric Traction Company, Limited, to call for allotment of the whole of the unissued share capital of the Company—namely, 37,926 ordinary shares of £10 each and 10,000 preference shares of £10 each—have offered for sale 17,926 ordinary shares, being the balance remaining unsold, at the price of £14 per share.

Doncaster.—The Corporation have received the sanction of the Board of Trade to a double line of tramways to the racecourse, and to an extension of the borrowing powers from £70,000 to £75,000. A temporary shed is to be erected for the Bentley electric cars at Marshgate. On the question of the type of overhead equipment to be adopted, it is recommended that on the south road side poles with brackets on each side of the road be adopted. With regard to the remainder of the system, it is recommended that the bracket arm be adopted.

Wandsworth.—The Borough Council have approved the route proposed by the London County Council of the tramway extension from Clapham Common to Kingston, through Wandsworth and across Wimbledon Common. Also the construction of the tramway from the existing terminus at Streatham to the county boundary, which will thus eventually join the Croydon municipal tramway system now approaching completion. Both approvals are subject to the settlement of details as to the widening of roads, etc., for a double line of tramways between the two Councils.

Private Bills.—In the House of Lords the following Bills have been read a third time: Glasgow Corporation (Tramways and General) Order Bill; Watford and District Tramways, Metropolitan Railway, and the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board Bill. In the Commons, the Chester Corporation Tramways Bill and the Wigan Corporation Tramways, etc., Bill have been read a third time. In the Commons on Wednesday, the Clydebank Burgh Tramways Order Confirmation Bill was read a third time, and the City and Brixton Railway Bill a second time.

Scarborough.—At a special meeting of the Tramways Sub-Committee on Saturday an engineer representing a firm which would be willing to lay down the proposed tramways in the borough attended, and discussed with the committee whether the Council or the firm, in the event of the Council not laying down tramways, should promote the Bill. The committee were of opinion that it would be the wiser course, in view of the legal expenditure to which the Council is already committed, to allow a company to put down the tramways, but that the Council should be allowed to purchase the undertaking at the end of a certain time.

Bournemouth.—The Corporation have decided to adopt the conduit system of electric traction on the proposed tramways between the Hotel Metropole on the one side and a point near the Pembroke Hotel on the other side, and that in other parts the overhead system be adopted. This resolution is in strict accord with the recommendation of the consulting engineers, Messrs. Lacey, Clirehugh, and Sillar, who, together with the borough engineer, have prepared a report on the subject. In this report the extra cost of equipping the section between the Hotel Metropole and the Pembroke Hotel with the conduit system is estimated at £20,000.

Glasgow.—The work of hanging the overhead wires on the Possilpark route is now about completed, and arrangements are being made to put on electric cars on the Possilpark and Paisley-road Toll routes. With the conversion of this route, the last of the horse cars will

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disappear from Renfield-street. On the agenda paper of the Town Council there is a motion: "That, in view of the now almost annual increase in the police taxes of the city, it be remitted to a special committee to consider and report upon the desirability of allocating a portion of the enormous profits of the tramway department to the relief of the rates, and thus obviate the necessity for continually imposing increased assessments to meet financially unproductive expenditure."

Edinburgh.—The Tramway Sub-Committee have had another meeting with the directors of the tramway company to discuss the differences which have arisen regarding the working of the system. The Board of Trade have notified the Town Council that they are not prepared to give their approval to the service of a notice by the Corporation, under the Portobello and Musselburgh Tramway Order, 1900, upon the promoters of that order, requiring them to transfer to the Corporation the powers granted by the order within the Corporation's jurisdiction unless the Corporation are willing to give an undertaking that they will complete the lines in question and work them within two years from Aug. 6, 1900. The Council have decided to decline to grant such an undertaking.

District Railway.—On Monday the Select Committee of the House of Lords presided over by Lord Ribblesdale sanctioned the Bill, already approved by the Commons, for the electrical equipment of the District Railway on the multiple-motor system. The ultimate adoption of this system, however, is subject, we believe, to agreement with the Metropolitan Railway Company. Mr. Pember, K.C., who appeared for the Company, claimed that the multiple-motor system avoided the vibration which was said to have been experienced on the Central London Railway. The Corporation of London, who originally opposed on the score of vibration and ventilators, were now satisfied on these points, but wished it to be publicly understood that this must not be taken to prejudice their action as to tube railways next year.

East London Railway.—Replying to a question at the half-yearly meeting of the East London Railway Company on Tuesday, the chairman (the Hon. A. E. Gathorne-Hardy) said that the other leasing companies had no wish to interfere with the carrying out of so great an improvement as the electrification of the Metropolitan and Metropolitan District Railways, but they placed themselves in the hands of this Company's able solicitor, with the result that a clause for the protection of this Company's interests had been inserted in the Bill now before Parliament with regard to the electrification of the underground lines. He could not say how the Metropolitan and Metropolitan District Companies when working by electricity would be able to continue carrying traffic over the East London line. All that could be done for the present was to protect the interests of the Company, and this had been done.

Huddersfield.—The financial report on the tramways undertaking for the three months ending June 30 last shows that the expenditure was as follows: Electric, £3,973. 3s. 8d.; and steam, £5,293. 3s. 8d. The receipts were respectively £6,288. 9s. 2d. and £5,176. 17s. 8d.—total £11,465. 6s. 10d. No amount for depreciation is set down, but after allowing for interest on capital outlay and sinking fund (£2,861. 19s. 11d. and £1,317. 17s. 11d. respectively), there remains a net balance (deficiency) of £546. 14s. 5d. on electric and £1,434. 3s. 1d. on steam, a total of £1,980. 17s. 6d. for the three months. A substantial part, if not the whole, of this sum, says a footnote, will be carried to capital account as soon as the pecuniary arrangements have been completed through the Board of Trade. The income for the electric cars worked out as 10·34d. per mile, and on steam power at 13·42d. per mile. The total working expenditure (£13,446. 4s. 4d.) is equal to 13·53d. per mile. For the month of June the receipts were as follows: steam, £1,829. 8s. 1d., or 13·31d. per mile; and electric, £2,226. 6s. 1d., or 10·57d. per mile.

Great Northern and City Railway Co.—The directors, in their report for the half-year ended June 30, give a good account of the progress made in the construction of the line during the six months under review. At Drayton Park 1,200 lineal yards of tunnel have been driven, and only 536 yards remains to connect with Essex-road. At Essex-road the station tunnels and connecting passages for the shafts are completed, and the cross passages between the platforms are in hand. At the Regent's Canal the up and down line tunnels have been driven southwards to a point within 69 yards of the north end of Old-street Station, where the station tunnels are in course of construction. At the Finsbury-pavement terminus the connecting passages are approaching completion, and the driving of the station tunnel is being rapidly proceeded with. Four hundred lineal yards of double tunnel remain to be driven between the terminus and Old-street. Generally the progress made is satisfactory, and it is anticipated that the whole of the tunnelling will be completed by the end of the current year. A contract for the electrical plant and equipment will shortly be placed.

Middlesex Light Railway Schemes.—Mr. Hopwood (Permanent Secretary of the Board of Trade) has heard an appeal of the Finchley Urban District Council against the confirmation of an order of the Light Railway Commissioners giving the county of Middlesex power to make light railways over the Great North road. Counsel for the Finchley Council stated that the Light Railway Commissioners had before them two schemes, one promoted by the Finchley Council and the other by the Middlesex County Council, and, without hearing the Finchley Council, decided that the County Council's scheme should be carried out. He submitted that the Light Railway Commissioners had no power so to decide without hearing the Finchley authorities on the scheme within their own boundaries, and that it was never intended by the Light Railway Act that the Commissioners should have such power of deciding against the local authority through whose district the railway proposed to run. The matter should have gone before Parliament. Mr. Cripps, K.C., for the County Council, said it was within the jurisdiction of the Commissioners, and therefore the Board of Trade should confirm the order. The Permanent Secretary said the matter was very important, and would be fully considered by the Board.

London United Tramways.—On Wednesday the Select Committee of the House of Lords of which the Duke of Northumberland is chairman commenced the consideration of the Bill of the London United Tramways Company, Limited, for power to electrically equip part of their existing system and to make extensions to Barnes and Richmond, and from Hampton Wick to Malden and Coombe, Surbiton, Thames Ditton, and East Molesey. Mr. Balfour Browne, K.C., the counsel for the promoters, pointed out that the whole length of tramways belonging to them or already authorised was 40 miles, of which 16 or 17 were at the present time being worked by electric traction. When the scheme was completed it would extend to 54 miles. Counsel then spoke at length on the opposition of the water companies, who dreaded the effect of electrolysis on their water-mains, and asked for special protection. Mr. Clifton Robinson, managing director and engineer to the company, said the estimated cost of the whole widenings involved in the scheme was £91,700, of which £20,000 was allocated to two bridges, those at Hampton Court and Kingston. The estimate of the permanent-way construction was £169,900. When the company's scheme was complete and in full operation he believed they would carry from 150,000,000 to 200,000,000 passengers a year. The committee adjourned.

London County Council's Bill.—The Select Committee of the House of Lords presided over by Lord Hatherton passed the preamble of the London County Council (Tramways and Street Widenings) Bill on Tuesday, under which power is given to enable the Council to construct new tramways, to reconstruct and alter existing tramways, and to equip them for electrical traction, and to widen streets where necessary. As the result of their deliberations the committee declined to sanction the proposed line from Camberwell-green to Dulwich, the line along Stamford-street across Blackfriars-road and along Southwark-street, and the extension of the line in the Waterloo-road, so as to terminate some 300 yards nearer Waterloo Bridge than is at present the case. They, however, authorised the construction of lines from the existing tramway in the Battersea Park-road to the Albert Bridge; from Lower Tooting along Garratt-lane to Wandsworth, connecting with existing tramways at either end; and from the termination of the existing tramway system at the Archway Tavern, Highgate, to the county boundary, where eventually it is hoped connection will be made with a system of tramways which the Middlesex County Council are authorised to construct. A clause was also inserted reserving to the borough of Battersea, as electrical undertakers in their area, the right to break up the new tramway in Battersea for the purpose of laying electric lines.

More London County Council Schemes.—At their meeting on Tuesday evening the London County Council agreed to give notice to the South London Tramways Company requiring the company to sell to the Council certain portions of their undertaking. The lines in question are about 4¾ miles in length, and are situated in Wandsworth-road, York-road, Queen's-road, Battersea, and Falcon-road. It was also agreed to serve notice on the Woolwich and South-East London Tramways Company requiring them to sell to the Council the whole of their tramways, which are about 4¾ miles in length. In addition to these two schemes, the Council propose to construct the following new tramways: (1) along the Victoria-embankment from a point near Westminster Bridge to a point near Blackfriars Bridge, length 1 mile 3 furlongs—total cost £31,000; (2) along Elgin-avenue, from Edgware-road to the Harrow-road and Paddington Tramways Company's lines in Harrow-road, length 7 furlongs—total cost £35,000; (3) Trafalgar-road, Greenwich (London County Council tramways), *via* Blackwall-lane to a point near the southern approach to the Blackwall Tunnel, length 1 mile 1 furlong—total cost £39,100; (4) Herbert Hospital, Woolwich (proposed London County Council tramways), *via* Wellhall-lane to Eltham, and thence *via* High-street, Eltham, to a point near the Monument at Eltham Park, length 2 miles 1 furlong—total cost £70,300. This last scheme would involve an outlay by the Council of £29,267 on street widenings, which brings the estimated total cost of the four new lines up to £204,667. The Council further decided that its electrical engineer and its tramway manager should proceed to America to obtain the fullest information with respect to underground tramways.

Metropolitan Railway.—In their report for the half-year ended June 30 the directors of the Metropolitan Railway Company, referring to the competition of the Central London Railway, state that "the most effectual remedy will be the substitution of electric for steam traction on the Inner Circle, which will enable the traffic to be worked under greatly improved conditions, and your directors are sparing no efforts towards the adoption of electric working, without a moment's unnecessary delay, upon the most efficient, economical, and advanced system of electric traction which has yet been placed before the public." The directors then go on to review the events of the last few months, stating that up to Feb. 13 last this Company and the Metropolitan District Railway Company were in accord as to the method of electric traction to be adopted—viz., the Ganz system. The report proceeds: "It was therefore a matter of surprise to the directors that the District Company, without consultation with this Board, shortly afterwards announced their determination to electrify their railway upon an entirely different system. To enable this to be carried out the District Company sought parliamentary powers to compel the traffic of other companies passing over the District Railway to be worked by the particular system adopted by that company. The Board considered such enactments prejudicial to the Metropolitan Company's interests, and petitioned against them, with the result that a clause has been inserted in the District Company's Bill to the effect that unless within one month after the passing of the Act the Metropolitan and District Companies shall have agreed to adopt the same system for the working by electrical power of the portions of their respective railways forming part of the Inner Circle Railway, and also the City

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lines and extensions, either company may refer the question to the Board of Trade to appoint a special tribunal to hear evidence and report to the Board of Trade, who are thereupon directed to determine which system of electrical working shall be adopted. The Company's electrical engineer advises that the generating station will be practically the same for any system which may be adopted, and plans are accordingly being prepared of a station to be erected at Neasden, upon a site belonging to the Company, which he reports is well adapted to the purpose."

District Electric Traction Company.—On the 15th inst. the Metropolitan District Electric Traction Company, Limited, was registered with a capital of £1,000,000 in £20 shares. The objects of the new company are these: To adopt and carry into effect certain agreements made or intended to be made between the Metropolitan District Railway Company of the one part, and this Company or persons acting on its behalf of the other part, providing, *inter alia*, for the electrical equipment and traction of the railways of the Metropolitan District Railway Company, or any railways of which the said railway company is part or joint owner, or over which it has running powers, or in which it is interested; to enter into agreements with the Metropolitan District Railway Company and the Brompton and Piccadilly-circus Railway Company, or either of them, for the erection of a generating station or power-house upon lands belonging to them, or either of them, and for the working and use thereof; to construct subways and ducts, to lay down cables and rails, to build sub-stations, to alter existing stations, to execute all necessary works for the conversion of railways and tramways using steam or other form of tractive power into railways or tramways worked by electric power; to acquire from the Metropolitan District Railway Company, or any other corporation or persons, land and premises at Chelsea or elsewhere in the United Kingdom for the erection of generating stations or power-houses; to equip and maintain such generating stations or power-houses; to manufacture rolling stock, engines, trolleys, trucks, electric motors, and machinery; and to carry on the business of electricians, engineers, producers, and suppliers of electricity, contractors, financiers, etc. Among the subscribers are the following: Charles T. Yerkes, New York City, financier; John J. Mitchell, Chicago, gentleman; P. Calbona, New York, lawyer; Brown Bros. and Co., New York, bankers; Simon Borg and Co., New York, bankers; Pemberton and M'Cados, New York, bankers; J. G. White and Co., New York, contractors; Alex. Brown and Sons, Baltimore, bankers; Henry H. Roque, New York, gentleman; J. G. White and Co., New York, contractors; J. W. Brown, Baltimore, agent; Govett, Sons and Co., London, stockbrokers; T. Jefferson, Boston, ex-minister to France; Frederick Ayer, Boston, director; Lee, Higginson, and Co., Boston, brokers; Charles G. Weld, Boston, M.D. There will be no initial public issue. The number of directors is not to be less than three nor more than five. The subscribers are to appoint the first. Qualification, 50 shares. Remuneration as fixed by the Company.

LIGHTING AND GENERAL.

Bath.—The resolution to borrow £12,000, as noticed in our last issue, was confirmed by the Town Council on the 19th inst.

Whitehaven.—An enquiry has been held into the Town Council's application to borrow £1,000 for street-lighting extensions.

Shannon Water and Electric Power Bill.—The House of Commons have agreed to the Lords' amendment to this Bill.

Nottingham.—The electric lighting of the shire hall is completed. The accepted tender was £170 for wiring and £125 for fittings.

Buxton.—An enquiry has been held into the application of the District Council for sanction to borrow £25,000 for electric lighting purposes.

Southampton.—Colonel Coke has held an enquiry into the Council's application for sanction to borrow £4,000 for electric supply extensions.

Hastings.—Colonel A. E. Smith, R.E., has held an enquiry into the Town Council's application for sanction to borrow £14,272 for purposes of electric lighting.

Rochdale.—A meeting of subscribers and intending subscribers to the National Telephone Company was held last week to ventilate complaints, and some of the speakers suggested municipalisation as a remedy.

Stafford.—We understand that Messrs. Rooper and Robins and Messrs. Lea, Son, and Co. have been invited to submit a scheme and estimate for providing and fixing electric alarms in all parts of the workhouse.

West Bromwich.—The Electric Lighting Committee have decided to reduce the charges for electricity to 4d. per unit for the remainder of the summer season, this being a reduction of one-third on the amount now charged.

Chester.—The Lighting Committee have been authorised to have a distributing main laid for incandescent public and private lighting in Stocks-lane at an estimated cost of £309, and to purchase eight enclosed arc lamps for the sum of £52.

Bromley.—The Guardians are still discussing the lighting question. We understand that a scheme for electric lighting has been abandoned, as the installation and plant would cost £2,000, and would involve more skilled labour than they were prepared to employ.

Poplar.—The Borough Council have decided, in response to a number of applications, to put places of worship on a preferential basis in regard to the consumption of electric light, and have agreed to supply them at a round charge of 4½d. per unit, a figure considerably below that charged to tradesmen.

Dublin.—The electric lighting loan of £254,000 having been sanctioned, some tenders were accepted at the last meeting of the City Council—not without discussion. The motion given on p. 105 of our last issue was proposed, but was ruled out of order.

Stepney.—The Borough Council on the 24th inst. accepted tenders for the supply of electric light cables to lay along the Mile End-road, and every effort is to be made to complete the work by the early autumn. When this is done the whole of the route from the West-end to Epping Forest will be lighted by electricity.

Islington.—A number of applications having been received for a supply of electricity to premises in roads mentioned below and to the Baptist chapel in Cross-street, new mains are to be laid as follows: Essex-road, £304; Essex-road and Cross-street, £195; Holloway-road, £440; Caledonian-road, £140—total, £1,079.

Epsom.—The Rural District Council will at their next meeting consider a letter from the Leatherhead and District Electricity Company *re* their intended application to the Board of Trade for a provisional order authorising the company to supply electricity for all public and private purposes throughout the rural district of Epsom.

Ashington.—The Northern Counties Electricity Company have given notice to the Urban Council of their intention to apply for a provisional order for power to supply electricity in the Ashington district. The subject will be dealt with at a meeting of the Council this week, at which representatives of the company will attend.

Long Eaton.—At a special meeting on Monday, the electric lighting tenders for an installation throughout the town were opened, and it was decided to submit the 38 tenders to Mr. Crowther, of Wallasey, the Council's engineer, for report. Mr. Crowther's estimate was £11,500, and the tenders were well within that amount, although Mr. Crowther had advised the Council to borrow £15,000 for the work.

Stock Exchange.—The Stock Exchange Committee have been asked to allow the following securities to be quoted in the official list: Brompton and Kensington Electricity Supply Company, Limited, further issue of 8,000 7 per cent. cumulative preference shares of £5 each, fully paid, Nos. 50,001 to 58,000; County of London and Brush Provincial Electric Lighting Company, Limited, further issue of £100,000 4, per cent. debenture stock.

Hackney.—The Electric Lighting Committee at the Council's meeting last night reported that they had instructed the National Electric Wiring Company to proceed with the work of wiring and fitting a number of premises in the district. With regard to the fee Mr. Alexander Paine, the district surveyor, proposes to charge for excavations made under the electric lighting order, they asked to be empowered to invite representatives from the other metropolitan borough councils to attend a conference to be held at the town hall, Hackney, to consider the matter. A report as to the supply of electricity to the Stoke Newington Borough Council is being prepared.

Battersea.—Application is to be made to the London County Council for sanction to and the advance of the sum of £9,163 to defray the cost of providing, sinking, and excavating suction sumps, etc., and providing electric pumps, pipework, etc., for the condensing of water at the electric lighting station, Lombard-road. Distributing mains, arc light leads, etc., are to be laid in the portion of Bridge-road West from High-street to Lammas Hall, so as to supply electricity to the branch library and premises on the line of route at an estimated cost of £125, and five enclosed arc lamps, weighing machine, stoke-hole, barrows, stores, tools, and special stationery are to be procured for use at the central electric generating station at an estimated cost of £89.

Fulham.—It is proposed that distributing mains for the supply of electric current be laid on both sides of Wandsworth Bridge-road, at an estimated cost of £5,500, and that additional boiler power be provided at an estimated cost of £4,000. During the past fortnight applications equivalent to 1,964 8-c.p. lamps had been received, making a total in all of 19,104 8-c.p. lamps. The last report from the borough electrical engineer states that 1,487 loads of refuse had been destroyed, 299 loads of clinker at 6d. and eight loads at 1s. per load, and 30 loads of fine ash at 8d. per load had been sold, and that 132½ tons of clinker had been barged away. Mr. G. Rowe, at present employed as canvasser, has been permanently appointed as "outside assistant."

Expensive Carbons.—In the Blackpool County Court last week a claim of £6, said to be due for the supplying of an electric arc lamp, was made by Frederick Isaac Burns, electrical engineer, of South Shore, against James Binns, wholesale artificial flower manufacturer, Central Pier. The defendant counterclaimed for £5. 18s., loss sustained by him owing to the lamp not having been fixed and in working order at the proper time. Evidence was given by William Sutcliffe, an assistant in the Corporation electricity works, that the lamp would not work because the carbons were too large and unsuitable. He altered it, and got the pictures to work beautifully. The carbons were only 1d. each, and could be obtained in all sizes. The fixing of the lamp was well done; the reason why Mr. Binns could not get the light was because the carbons were too big. The judge gave a verdict for £5.

Excursion.—On Saturday last the first annual excursion of the employés of the Renewable Electric Lamp Company, Limited, took place. The dinner was served at Stansfield's Restaurant, Southend, to a company of over 100 of the employés and some of the staff. After the usual toasts, "prosperity to the company and long life to the directors" was proposed by Mr. Edwards, one of the travellers, in a speech in which he felicitated the company upon the striking progress the renewable efficient lamp was making. Mr. Hammond, the secretary, replying, alluded to the unavoidable absence of Mr. Kershaw, the managing director, and had every reason to suppose that at the next annual outing the company would be at least three times as numerous as on the present occasion. An enjoyable evening, in which music, recitals, and dancing held their sway, concluded a most enjoyable day.

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Woking.—The Council, after their many bickerings with the electric light company, have finally entered into a contract with the gas company to supply them by Aug. 1. It appears, however, that the Council have omitted to give the requisite three months' notice to the electric light company, and on the first of next month they will probably have two contracts on hand and no light.

Presentation.—Some of the members of the Institution of Junior Engineers have made a presentation to Mr. Edward Goffe, M.I.J.E., "in token of their appreciation of his services during the siege of Kimberley, 1900." As chief draughtsman to the De Beer's Consolidated Mines, Mr. Goffe distinguished himself in connection with the design and construction of the famous Long Cecil gun.

Trowbridge.—The Council have been discussing an offer from Messrs. Crompton and Co. *re* their provisional order, and also the advisability of pumping the sewage by means of electric power. During the discussion in the Council on the matter it was mentioned that a little place like Salisbury made 2½ per cent. the first year, and last year over 5 per cent. profit on their electric light undertaking.

Merthyr.—Mr. T. F. Harvey, surveyor, has reported upon the proposed lighting of the public streets by electricity. He considers that the best plan would be to have partly incandescent lighting and partly arc lamps—the latter at the more important points. Mr. Hume, a director of the Merthyr Electric Lighting and Traction Company, has made certain proposals. The committee have deferred the consideration of the whole matter.

Loftus.—At a special meeting of the District Council on the 19th inst. a request from the Cleveland and South Durham Electric Supply Company for the Council's sanction to make application for a provisional order to supply electrical energy to the district was considered, and after some discussion it was decided that the surveyor (Mr. T. H. Tarbit) enquire into and report to the next meeting as to the advisability of the Council applying for a provisional order on their own account.

Dundee Telephones.—The question of the municipalisation of the telephone in Dundee was considered at a committee meeting of the Town Council on the 19th inst. It was reported that the matter had been investigated in other centres—in Glasgow especially—and that the result of the enquiries made went to show that the Town Council should take up the question of originating a scheme of their own or giving facilities for another company in opposition to the National Company.

New Works.—The European McGuire Manufacturing Company, Limited, of London, has just purchased the Elton Fold Works at Bury, Lancs. This property comprises about five acres, and there is about 25,000 yards of floor space under cover. The company will begin immediately to equip the factory, and inside of three months all orders for trucks will be filled at the factory, and the goods made there. Messrs. Maguire and Baucus, of 5, Warwick-court, High Holborn, W.C., are the selling agents for the output of the factory.

New Issue.—The Aron Electricity Meter, Limited, have just issued £60,000 5 per cent. debentures, part of a total issue of £75,000, at the price of £95 per cent. The proceeds of the present issue will be used to complete new factory buildings at Schweidnitz, new workshops in London, and the erection of new works at Budapest and elsewhere; and also for supplementing and extending the company's means of manufacturing meters and other instruments, for providing additional working capital, and for the repayment of a temporary loan of £20,000.

Ipswich.—The Council intend to apply for sanction to a loan of £58,000 for building the generating station, laying mains and feeders, etc., according to the following estimate of Prof. Kennedy: boilers of marine or water-tube type, £5,000; six engines, dynamos, etc., £13,200; battery of 300 ampere-hours capacity, £900; switchboard with boosters and connection, £2,400; station buildings, £22,000; distributing mains and feeders, £8,400; meters and house service connections, £800; 85 arc lamps and posts, £2,900; engineer's and architect's charges, £2,800—total, £58,400. Tenders are to be obtained for boilers, reference to which is made in another column.

Wireless Telegraphy.—It is understood that the Government contemplates the introduction of a system of wireless telegraphy in the West Indies. It is said that Trinidad and Tobago will be the first to be connected in this manner, and that as soon as the necessary financial arrangements can be made wireless communication will be established between Antigua and Montserrat and between St. Kitts and Nevis. It is reported that the experiments with wireless telegraphy carried out on board the French Mediterranean Fleet have not proved successful. Fourteen ships have been fitted with apparatus, but it is found that messages cannot be sent for more than 30 miles with anything like precision.

Annual Outing.—On Saturday the staff of the British Thomson-Houston Company chartered the "England," and went for a trip from Maidenhead to Henley. An improvised band and vocalists recruited from amongst the members of the staff contributed in no small measure to the pleasure by furnishing music of a popular nature. At the Red Lion, Henley, a bountiful banquet, presided over by the genial managing director, Mr. W. J. Clark, was partaken of, and toasts to the "King," "Ladies," "Managing Director," "The British Thomson-Houston Company," etc., were drunk with enthusiasm. In the cool of the evening the "England" slipped down the river, tea being served on board, arriving at Maidenhead at an hour that many wished could be prolonged indefinitely, so thoroughly enjoyable was the outing.

Bankruptcy.—At the Halifax County Court last week, before Mr. Registrar Stansfeld, Alfred Sharp, electrical engineer, Barnsley, but now residing in lodgings at Lanehead, Brighouse, said that his liabilities amounted to £162. 8s., and he had no assets. He commenced business in May of last year in partnership with John Savage, under the style of Savage and Sharp, electrical engineers. A month later Mr. Savage retired, and was paid £52. The principal cause of his insolvency was losses on contracts due to a singular thing. He had fitted installations in a number of shops at Barnsley for the electric light, and these were going on all right. The Barnsley Corporation then decided on a requirement unknown to the debtor—namely, that "standard" wires instead of single wires should be used, and they did not furnish him with a copy of the new by-law. He carried out another installation contract for six shops, and "single" wires being disallowed he lost £100 by the contract. The examination was closed.—*Bradford Observer.*

Queensland.—Messrs. Trackson Bros., electrical engineers, have been entrusted with the work of installing a complete electrical power and lighting plant for Messrs. Birt and Co.'s extensive meat works in course of erection at Mooraree. The generating plant will consist of a Laurence-Scott 100-kw. dynamo giving 220 volts, coupled direct to a Browett-Lindley 130-h.p. compound engine. Two 10-h.p., three 5-h.p., and four 3-h.p. electrical motors are to be erected in starting the works, and provision has been made for duplicating their number. The whole of the fans are also to be operated by electric motors of from 2 h.p. to 8 h.p. About a mile from the works an electrically-driven pump will deliver 30,000 gallons of water per hour, and which is to be controlled from the works. The lighting of the works will be done by means of 300 60-watt incandescent lamps and six 2,000-c.p. arc lamps. When these works are completed, the *Brisbane Evening Observer* says, they will be the most up-to-date electrically driven and lighted in the Australian States. Mr. Coxon, of Sydney, is the consulting engineer engaged by Messrs. Birt and Co. in connection with the erection and equipment of these important works.

Brighton.—The committee at their last meeting considered the following resolution of the Southwick Urban District Council: "That the request of the Brighton Corporation for permission to construct overhead telephone circuits in this district be granted, provided all wires crossing the tramway be taken underground; that the maximum charge to a subscriber in the district does not exceed £5. 10s. per annum; and also that in no case shall a larger sum be charged in this district than in Brighton." It was resolved that the Southwick Urban District Council and the other local authorities interested be informed that the Council have decided that for the present the charges to subscribers to the municipal telephone exchange, both within and without the county borough of Brighton, situate within one mile of the nearest exchange, shall be as follows: for unlimited service, £5. 10s. per annum; for limited service, £3. 10s. per annum, and toll 1d. per call; but that the Council reserve the right to make a further charge not exceeding a maximum of £1. 5s. per annum for every additional quarter of a mile in the case of subscribers situate more than a mile from the nearest exchange.

Rowley Regis.—The Urban District Council have adopted a report of the Electrical Supply Committee, stating that after much discussion it appeared clear that the Council could not receive a discount from the Midland Electric Corporation. The provision had been inserted by mistake, and was now entirely withdrawn. Each consumer must make his own bargain with the company for discount. The alternative of this plan was for the District Council to seek powers by means of a provisional order to take the current in bulk from the company, lay mains through the district, distribute the current to the consumers, and open and collect accounts. In this case the company would allow a discount on the current taken from them in bulk, but they would not consent to the Council obtaining a provisional order for generating and supplying the current irrespective of the company. The committee did not see their way to recommend the adoption of this alternative scheme. There would be nothing to prevent the Council at a future time seeking powers to buy the cables, etc., so as to adopt this alternative scheme should it be found advisable. With regard to the street lamps, the proposal was to supply lighting at £2. 14s. per lamp for nine months in the year instead of £2. 18s. 6d. each for 12 months, the light to be 25 c.p. At present the gas-lamps in the streets cost £2. 10s. each for seven months in one part of the district and eight months in the other part, the candle-power being not less than 15, with burners each supplying not less than 5ft. per hour.

Woolwich.—The Borough Council on Thursday week considered a notification from the Blackheath and Greenwich District Electric Light Company of their intention to lay extensions of mains in Eltham, and town clerk's report thereon. The Electricity Committee recommended that the Board of Trade and the London County Council be written to, pointing out that the Borough Council have given notice to the company requiring them to sell to this Council so much of their undertaking as is authorised by the Blackheath and Greenwich District Electric Lighting Orders of 1897 and 1899, and such of their works as may, at the date of such notice, be situate within the borough of Woolwich, upon the terms provided in Clause 65 (2) of the Blackheath and Greenwich District Electric Lighting Order, 1897, and urging them to refuse their sanction to an expenditure for which, under the purchase clause, this Council would have to pay 33 per cent. premium the proposed works being obviously started with the intention of making a large profit at the expense of the ratepayers. The Town Clerk reported that this company were also canvassing in Eltham for consumers, and were circulating a form of agreement for free wiring houses with six lights, copy of which he had secured, and advised that a circular letter be printed and sent to residents in Eltham, pointing out that the Council were about to take over the lighting, and urging them not to sign the agreements. It was agreed to distribute a circular in Eltham, drawing attention to the fact that the Borough Council will shortly have power to supply electricity in Eltham, and suggesting that they should not do any wiring until then.

London County Council.—At Tuesday's meeting of the Council it was agreed to lend the Hackney Borough Council £8,000 for the purchase of an electric lighting station and destructor site, and £34,200 for electric light installation and dust destructor; the

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Hammersmith Borough Council £1,900 for the purchase of electric light meters; the Woolwich Borough Council £20,000 and £27,805 for electric light works, street lighting, and meters; the Battersea Borough Council £9,623 for electric light installation, and the Islington Borough Council £2,500 for the same purpose and £2,018 for the purchase of meters. It was decided that application be made in the next session of Parliament for powers to enable the Council to acquire, compulsorily, for purposes connected with the establishment of an electricity generating station at the Greenwich depôt of the London County Council tramways, certain property shown approximately by blue colour on the plan submitted to, and approved by, the Highways Committee on July 11 last. The following report of the General Purposes Committee was adopted: "The Council on July 2 last accepted Sir Alexander Binnie's resignation of his appointment as chief engineer of the Council. Although the resignation will not take effect until the end of the year, we think steps should at once be taken with a view to filling the vacancy. The salary at present attached to the position is £2,000 a year, and we propose that an advertisement should now be issued inviting applications for the appointment at the salary above named. We accordingly recommend that an advertisement be issued inviting applications for the appointment of chief engineer of the Council at a salary of £2,000 a year."

LIGHT RAILWAYS.

The Board of Trade have recently confirmed orders authorising the construction of light railways in the county of Lancaster from Blackpool to Garstang, in the urban district of Barrowford, in the borough of Nelson, and in the borough of Colne, and the urban district of Trawden, all in the county palatine of Lancaster, and in the county of Essex, between Chipping Ongar Station on the Great Eastern Railway and Great Bardfield; authorising the construction of light railways in the county of Nottingham, in the borough of Mansfield and the urban districts of Mansfield, Woodhouse, Sutton-in-Ashfield, and Hucknall-under-Huthwaite; amending the Mid-Suffolk Light Railway Order, 1900; amending the Isle of Thanet Light Railways Order, 1898; authorising the construction of light railways in the West Riding of the county of York, from Rothwell to Hunslet, and the working of the East and West Yorkshire Union Railways as light railways.

Mr. F. J. S. Hopwood, C.B., Permanent Secretary of the Board of Trade, has held an official enquiry in the offices of that Department for the hearing of objections to the confirmation of an order issued by the Light Railway Commissioners authorising the construction of light railways in the city of Bath and district.

The Friern Barnet Urban District Council have informed the Middlesex County Council that the Urban District Council object to the application regarding the proposed light railways.

The Parliamentary Committee of the West Riding County Council have received an application from a company to be incorporated as the Rotherham and Laughton Light Railway Company, with a proposed capital of £90,000, for the construction of light railways in the borough of Rotherham, and of the proposed Shireoaks and Laughton Railway at Laughton-en-le-Morthen. The committee consider the alteration of grade proposed unreasonable, and will oppose it, and request that the parapets of the bridge to carry the road over the railway be made in line with the existing fences. Applications have also been received from the Spen Valley and Morley Light Railways (Extensions) and the Southowram and Elland Light Railway. The committee also report that part of the Shireoaks, Laughton, and Maltby Railway—the length from Laughton to Maltby—has been abandoned, and the Bill as amended has passed the House of Commons.

A public meeting held at Stroud has passed a favourable opinion with regard to the contemplated construction of an electric railway from Stroud to Painswick, to Chalford, to Stonehouse, and to Nailsworth, with a possible extension to Cheltenham.

Steps are being taken with regard to the proposed electric light railway to St. Just.

Mr. Hopwood recently heard objections by the Jarrow Corporation to the confirmation of the order for the making of the light railway in Jarrow and South Shields, about three miles and two furlongs. The order is promoted by the British Electric Traction Company. The Tyne Commissioners have come to an arrangement with the promoters, and have withdrawn their opposition. Finally the promoters were put under terms to submit plans, and in case of dispute the Board of Trade are to arbitrate. Subject to these matters the order will be confirmed.

The Kidderminster and Bewdley light railway order, which has passed the Light Railway Commissioners, has been slightly amended, and will now be confirmed by the Board of Trade.

The Hornsey District Council have decided to oppose the Middlesex County Council's light railway scheme, on the ground that all the proposed lines were local lines, and, if required, should be constructed by the district councils of the various localities. The scheme includes a light railway commencing at the Highgate Archway, and, running in a southerly direction, forms a connection between the North Metropolitan Tramway Company's system and the light railway already authorised in the Archway-road within the parish of Hornsey, and another light railway from Archway-road to Muswell Hill and Wood Green.

Sir Henry Bloomfield has held an enquiry into an application made by the promoters, for whom Mr. F. H. Smith, solicitor, and Mr. J. L. Godden, engineer, appeared, for the confirmation of the order granted by the Light Railway Commissioners, respecting the construction of a light railway from Bury St. Edmunds to Diss. Several minor objections were made which Sir Henry Bloomfield promised to consider and to communicate the decision to the objectors. Mr. Smith, on behalf of the promoters, agreed to a maximum charge of 6d. by passenger train over the entire distance of the railway, which was 27 miles in extent.

The sub-committee of the Light Railways Committee of the Middlesex County Council have considered the following requirements of the Wembly Council: (1) that the road should be widened to a minimum of 60ft., the work of so doing to be carried out by the County Council; (2) that where trees existed they should be left where possible, and a footpath formed at the back; (3) that the conduit rather than the overhead system be adopted. After standing out for a long while for a 45ft. road, the sub-committee have now decided to recommend to the Light Railways and Tramways Committee that a 50ft. road be granted; they also agreed to recommend the committee to adopt the Wembly Council's suggestion as to the trees. The third point was stated to be impossible.

The Lauder light railway line has now been completed and opened for traffic.

The Woodbridge Rural District Council have approved of the intended application to the Light Railway Commissioners to sanction the making of a line from Melton to Bawdsey, but find it necessary to raise formal objection so that they might not lose the opportunity of taking any action that might be considered necessary hereafter.

The Montgomery County Council have decided to advance £6,000 to the Welshpool and Llanfair Light Railway Company, and will also grant a further loan of £1,250 to the Tanat Valley Light Railway Company.

The Middlesex County Council have adopted a minute from their Parliamentary Committee, who reported having made application to the Light Railway Commissioners, in accordance with a resolution of the Council of May 23 last, for light railway orders, including one situate in the parish of Staines, Laleham, Ashford, Littleton, Sunbury, and Hampton, in the county of Middlesex, commencing at a point in Kingston-road, in the parish of Staines, two chains, or thereabouts, in a south-easterly direction from Greenlands-road, being also the commencement of the proposed Staines and Egham Light Railways authorised by the Light Railways Commission, and thence running along Kingston-road, over Ford Bridge, Port-lane, Port-lane Bridge, Thames-street, and terminating in Thames-street at its junction with Church-street, Hampton. This has a length of 6 miles 2 furlongs 2·4 chains, and is estimated to cost £99,206. Another was situate in the parishes of Staines, Stanwell, Heston, and East Bedfont, in the county of Middlesex, commencing at the junction of Kingston-road, High-street, Staines, and London-road, and thence running along London-road and Staines-road to a point within one chain of Baber's Bridge, and thence through fields across the River Crane, continuing through fields in a northerly direction, crossing Green-lane, Beaver's-lane, and Bath-road, and terminating at Hounslow Station, having a mileage of 6 miles 1 furlong 0·70 chain, and costing £94,671. There were other proposals for railways in the parishes of Twickenham, Hampton, Hanworth, and Sunbury, in the county of Middlesex, commencing at the junction of Staines-road with Hampton-road and Heath-road, Twickenham, and running thence along Staines-road, and terminating at its junction with Kingston-road and Vicarage-road, Sunbury, 4 miles 0 furlongs 1·45 chains, cost £63,700; as well as in the parishes of Isleworth, Twickenham, and Hanworth, in the county of Middlesex, commencing at the termination of Railway No. 3 in Staines-road, at the junction of Bath-road and Staines-road, and thence running in a southerly direction along Bell-road, and then in a south-westerly direction along Hanworth-road, and terminating at the intersection of that road with Staines-road by junction with Railway No. 6, length 2 miles 5 furlongs 9 chains, cost £42,946. The committee further reported that objections had been received from certain authorities and persons to some of the proposed lines included in the four orders, and the objections would be duly considered. The London United Tramways Company had deposited orders and made application to the Light Railway Commissioners for powers to construct certain light railways following the same routes as some of the light railways included in the County Council's four orders. The County Council decided: "That it is desirable that all questions relating to any application by the Council, or other bodies or persons, to the Light Railway Commissioners for authorising new light railways in the county of Middlesex, and in particular relating to the application of the Council in May, 1901, in respect of Orders Nos. 1, 2, 3, and 4, and any application competing therewith, should be referrred to the Light Railways and Tramways Committee, except so far as may be necessary to enable the county solicitor to comply with the Standing Orders of the Light Railway Commissioners. That the Light Railways and Tramways Committee be empowered to decide whether any of the lines, or sections of the lines, included in the County Council's Light Railways Orders 1, 2, 3, and 4, shall, or shall not, be proceeded with at present." The same committee reported that application had been made by the London United Tramways Company to the Light Railway Commissioners for an order authorising the construction of various lines, including one 3 miles 6 furlongs and 5 chains in length, commencing at or near the junction of Church-street, Hampton, and Hampton Court-road, by a junction with the company's authorised tramway, and passing thence into and along Thames-street, Portlane Bridge, Port-lane, the roadway on the western side of Kempton Park-road, thence easterly along the road leading thence to Hanworth (otherwise Staines-road), and terminating in Hanworth at a point 32 yards north-eastward from the Brown Bear Inn. Railway No. 2 would pass through or into the parishes of Hampton, Sunbury, and Hanworth. A railway (No. 2A) 0·80 chain in length, wholly in the parish of Hampton, commencing at or near the eastern end of Thames-street, Hampton, by a junction with Railway No. 2, and passing thence into and terminating in Church-street by a junction with the company's authorised tramway at a point seven yards northward from Thames-street. A railway (No. 3) 2 miles 3 furlongs and 6 chains in length, commencing in Hanworth at the termination of railway No. 2, passing thence eastwardly along Staines-road and the

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Green, Twickenham, and terminating therein by a junction with the company's authorised tramway at a point 47 yards eastward from Knowle-road. Railway No. 3 would pass through or into the parishes of Hanworth, Teddington, and Twickenham. Railway No. 4 would pass through or into the parishes of Hanworth, Twickenham, Isleworth, and Heston. Under the circumstances it was referred to the county solicitor to oppose the London United Tramways (Light Railway Extensions) Draft Order, with a view to the protection of the county interests, and that any necessary petitions or other documents, in a form approved of by the Parliamentary Committee or its sub-committee, be sealed with the common seal of the County Council.

When the Bill by the London United Tramways Company for extensions in the neighbourhood of Surbiton, Barnes, and Heston and Isleworth was before the Select Committee of the House of Commons presided over by Sir John Kennaway, Mr. Bigwood, chairman of the Parliamentary Committee of the Middlesex County Council, in opposing the scheme, said the United Tramway Company had been opposed by the County Council so far as their lines in Middlesex were concerned, but they had been defeated; the company had fairly cornered them. The company had obtained profitable lines, and the more profitable they could show the lines to be, the more money they would get out of the Middlesex County Council when they came to take over the undertaking, "and we shall take them over—that is my prophecy." Questioned as to a letter from the solicitor to the London Tramway and Omnibus Company, objecting to certain of the lines in the Middlesex County Council's application to the Light Railway Commissioners, and stating that the company would not work them, the witness said he did not think the communication had been before the Council. It certainly had never been before the Parliamentary Committee. They had not assented to the London County Council's proposal to work with them in London or to allow them to work with the Middlesex County Council in Middlesex; but they would work amicably with the London County Council for interchange of traffic and to assist London's congested population where the difficulty arose.

PROVISIONAL PATENTS, 1901.

JULY 15.

14349. Safety guard for electric cars, motorcars, and such like self-propelled vehicles. Alfred Ernest Percy Hill, 144, Machon Bank, Letheredge, Sheffield.

14367. Improvements in or relating to and in the manufacture of elements for electric storage batteries or accumulators. Job Thomas Niblett, 69, Ivy-road, Cricklewood, London.

14376. Improvements in and connected with electric bell-pushes and light switches and other articles. William Goatley Hicks, 36, Chancery-lane, London.

14404. Improvements in electric switches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (William Peyton Pinckard, United States.) (Complete specification.)

14411. Improvements in and relating to the manufacture of filaments and other conductive bodies for incandescent electric lamps and heaters. William Eberhard Sander, 18, Buckingham-street, Strand, London. (Complete specification.)

14423. A combined telephone, telegraph, electric light, and power system. Alexander McMartin Stark, 5, Corporation-street, Birmingham.

JULY 16.

14429. An improved label for electric cables, pipes, or other cylindrical bodies. Charles Beckingeale, 187, High-street, Cheltenham.

14466. Improvements in electrical storage batteries or accumulators, and in electrolytes for electric batteries. Peter Stiens and Percival John Smith, 65, Chancery-lane, London. (Complete specification.)

14474. Improvements relating to electric batteries. Arthur Edwin Greville, 27, Chancery-lane, London.

14486. Process and apparatus for the manufacture of wrought iron, steel, and cast iron by electric heating. John Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société Electro-Metallurgique Francaise, France.)

14488. Improvements in means for the electric lighting of railway trains, tramcars, and the like. Charles Jacquin, 19, Southampton-buildings, Chancery-lane, London.

14490. Improvements in electric lamp hangers. Henry John Harrison, 53, Chancery-lane, London. (Complete specification.)

14511. Improvements in electric light apparatus for medical purposes. Alfred William Marshall and Maurice Walter Woods, 2, Gray's-inn-road, London.

JULY 17.

14535. Improvements in and relating to electrical instruments for transmitting sounds, writing, and drawings. Edward James Clifford, 12, Addington-street, London.

14551. Improvements in suspension gas-lamps, chandeliers, brackets, electric light fittings, and the like. Frank Howard Barwell, Herbert Barwell, Henry Philip Kimberley, and John Frederick Smith, 128, Colmore-road, Birmingham.

14589. Improvements in lifeguards for electric cars and like vehicles. William Preston, 6, Lord-street, Liverpool.

14562. Improvements in alternating-current electricity meters. Friedrich Ludwig Catenhusen, 15, Tooks-court, Cursitor-street, London. (Complete specification.)

14576. Process and apparatus for utilising the waste heat of metallurgical operations. John Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Soci t· Electro-Metallurgique Francaise, France.)

14579. Improvements in and relating to the transmission of electrical energy. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Nikola Tesla, United States.) (Complete specification.)

JULY 18.

14611. Improvements in tunnel-casings for electrical railways and other purposes. George Herbert Lloyd, Atlas Works, Springhill, Birmingham.

14614. Improvements in trolley heads for electric cars, etc. Joseph Hunter and Ernest Griffiths, 141, Brownlow-hill, Liverpool.

14624. Improvements in moving-coil electrical measuring instruments. August Eckstein and Frank Panter, Peel Works, Adelphi, Salford.

14643. Electric furnace arranged for being oscillated or tipped. John Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société Electro-Metallurgique Francaise, France.)

14656. An improved automatic cut-out device for overhead conductors. Tom Watson Benwick and John Grant, 3, St. Nicholas-buildings, Newcastle-on-Tyne.

14670. Improvements in connection with electric circuits. Albert Harris Howard, 47, Lincoln's-inn-fields, London.

JULY 19.

14733. Improvements in apparatus for lighting gas by electricity. Henry Nehmer and Ferdinand Nehmer, 82, Bunhill-row, London.

14751. A process of electro-metallurgic treatment of ores, of copper, and other metals with depolarised insoluble anodes. Constantin Jean Tossizza, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

JULY 20.

14767. Improvements in tanks, cells, and connecting pipes for electrolysis and like purposes. Arnold Stevenson, 4, Porchester-gardens, London.

14807. Improvements in contact ploughs and conduits for electrically-propelled cars. Albert Neumann Cornett, 322, High Holborn, London.

14813. Improvements in or relating to trolleys and like current collectors for electric railways and tramways. George Arthur Menlove, 6, Lord-street, Liverpool.

14822. An improvement in electrolytic apparatus. John Gustaf Adolf Rhodin, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14825. Electro-metallurgical treatment of zinc, ores, and especially blende. Constantin Jean Tossizza, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14826. Improvements in apparatus for exhausting electric glow lamps. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London (Paul Scharf, Germany.)

14827. A magneto-microphonic electric transmitter. Orazio Lugo and John Arthur Barratt, 1, Temple-gardens, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 10.

1900.

7983. Electrical signalling. Maskelyne.

13401. Electrical converting transformer. Abel. (Soc. Anon. pour la Transmission de la Force par L'électricité.)

13839. Glow bodies for electrolytic incandescent lamps. Drake and Nernst Electric Light, Limited.

14373. Electrical fuse boards. Farrell.

15591. Electrical driving apparatus and electric meters combined therewith. Boult. (Katzenstein.)

15890. Electric cable connectors. Becton and Barr.

16308. Switchboards applicable for electric call apparatus Shore and Heap.

16329. Electrical switches. Berry.

16500. High-voltage electric cut-out. Eckstein and Krause.

16501. Arc-lamp suspension apparatus, applicable also to other purposes. Eckstein and Agnold.

18707. Micro-telephonic apparatus. Lake. (Telephon-Fabrik Actiengesellschaft vorm. J. Berliner.)

19623. Gas-tight fuse and junction-box for electric cables. Kennedy and Reading.

20277. Means for supporting the osmium filaments of electric incandescent lamps. Imray. (Oesterreichische Gasglühlicht-und Electricitats-Gesellschaft.)

1901.

9593. Electric switch for starting motors or like purposes. Siemens Bros. and Co., Limited, and Hird.

11530. Electric glow lamps. Boehm.

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10960. Circuit-closing device for the winding gear of electric clocks and the like. Möller.

12016. Framework for alternating-current electrical machines. Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

12210. Electrostatic separators. Dolbear.

12241. Manufacture of electric illuminating bodies. Boehm.

12498. Static rectifiers and other electrical apparatus for producing or maintaining continuous or unidirectional discharges. Kinraide.

12587. Apparatus for lighting and heating by means of electric lamps. Boyd.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	—	—	—	—	—	—
Birmingham Tramways	July 20	4,902	4,711	+ 190	126,542	— *b*
Blackburn Corporation	,, 19	632	540	+ 92	13,795	12,545*b*
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 20	1,367	1,491	- 124	3,193	3,242
Bolton Corporation	,, 21	1,606	1,534	+ 72	41,234	31,844*b*
Bradford Corporation	,, 14	1,106	523	+ 582	20,345	10,839
Bristol Tramways Company	,, 19	5,097	3,605	+ 1,492	—	—
Carlisle Tramways Company	—	—	—	— *b*	—	—
Central London Railway	,, 20	6,218	—	—	18,442	—
City and South London Railway	,, 21	1,800	1,411	+ 389	5,644	4,294
Cork E. T. and L. Company	,, 18	613	489	+ 124	12,819	11,088*b*
Darwen Corporation	,, 19	221	177	+ 44	5,261	4,333
Dover Corporation	,, 20	279	283	- 3	5,662	5,292*b*
Dublin & Lucan Electric Railway	,, 21	143	126	+ 17	444	367
Dublin U. T., electric cars	,, 19	4,207	3,937	+ 270	—	—
Dublin S. District, Electric	,, 19	1,336	1,301	+ 35	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 20	10,857	7,824	+ 3,033	—	—
Halifax Corporation*	,, 21	2,844	1,748	+ 1,096	—	—
Huddersfield Corporation	,, 20	1,114	729	+ 384	14,775	11,404
Hull Corporation, E. S.	,, 20	1,787	1,378	+ 409	5,289	4,047
Liverpool Corporation	,, 13	10,199	8,630	+ 1,569	241,774	207,098*b*
Liverpool Overhead Railway	,, 21	1,801	1,751	+ 50	5,298	5,193
Oldham-Ashton-Hyde Tramways	—	—	—	—	—	— *b*
Portsmouth Corporation	—	—	—	—	—	—
Potteries Tramways	,, 20	1,026	—	+ 121	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 21	3,756	—	—	—	—
Southampton Corporation	,, 18	972	709	+ 262	—	—
Southport Corporation	—	—	—	—	— *d*	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. *b* From Jan. 1. *d* From April 1 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £18 increase.
Barcelona Ensanche y Gracia, £34 decrease. Barcelona, £371 increase.
Brisbane, £215 increase.
Buenos Ayres and Belgrano Electric, £513 increase.
Calcutta, £155 increase.
Cape Town (month of June), receipts, £13,119; expenditure, £6,380.
Mexico Electric (month of June), receipts, £18,465.
Perth Electric, £181 increase.
Port Elizabeth (month of June), receipts, £2,983; expenditure, £1,800.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅞-⅞
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	9/16-11/16
—— Ordinary, 1-125,000	1 ..	⅞-⅞
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	6-6½ xd
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4½-5
British Electrical Engineering, Ordinary	2 ..	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2½
—— 4½ per cent. Debenture Stock	100 ..	103-108
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	107-111
—— Ordinary	5 ..	14-15
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	3 ..	3¼-4
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	1-1½
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	92-96
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼ xd
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9⅞-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	15½-16¼
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	101-104
Telegraph Construction and Maintenance	12 ..	36-40 xd
—— 5 per cent. Bonds	100 ..	101-104
Telegraph Manufacturing, Ordinary	5 ..	10¼-11½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-⅜
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	95-100
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	11-10
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	7½-8¼
—— 7 per cent. Preference	5 ..	8¼-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7½-8¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand" ,,	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	102-104
Chelsea Electricity Supply	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	107-110
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	12½-13½
—— 5 per cent. Debenture Stock	100 ..	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	100-102
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	103-106
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5½-6 xd
—— 6 per cent. Cum. Pref.	5 ..	5½-6
—— 4½ per cent. First Mort. Deb.	100 ..	102-105 xd
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4½-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7½-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	102-105
Kensington and Knightsbridge and Notting Hill	100 ..	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10½
London Electric, Ordinary	3 ..	1½-1¾
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13-14
—— ,, 85,001-98,769	5 ..	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	108-111
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	94-97
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	14½-15½
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7¼-7⅜
—— £4½ Shares, New	4½ ..	6¼-6⅜
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5½-6½
—— 4 per cent. Debenture Stock	100 ..	99-102 xd
River Plate Electric Light and Traction, Deb.	100 ..	65-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2½-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-10
Westminster, Ordinary	5 ..	11½-12
Electric Railways.—		
Central London, Ordinary	100 ..	90-93
—— 4 per cent. Pref.	100 ..	99-102
—— ,, ,, deferred	100 ..	92-96
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118 xd
City and South London, Consolidated Ordinary	100 ..	53-55
—— Ordinary	10 ..	5¼-5⅜
—— 4 per cent. Debenture Stock	100 ..	112-117
—— 5 per cent. Pref. Stock '91	100 ..	132-137
—— ,, ,, ,, '96	100 ..	122-128
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅜-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-129
Blackpool and Fleetwood Tramroad	10 ..	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2½-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-4⅜
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	101-103
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¾-7
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14½-15½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅝-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	102-105
—— Prov. Cert., all paid	100 ..	96-99
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅝-1¾ xd
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5¼-5⅜
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	98-102
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	105-107
New General Traction, Ordinary	5 ..	3-3½
—— 6 per cent. Cum. Pref.	10 ..	4¼-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	12-13
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	105-108
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	6s. ..	5/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	30 p.c. ..	30 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	3¼-3½
—— 6 per cent. Cum. First Pref.	10 ..	11-13
—— 6 per cent. Cum. Second Pref.	10 ..	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-4⅜
—— 4 per cent. Deb. Stock, Red.	100 ..	95-98
—— 3½ per cent. Deb. Stock, Red.	100 ..	90-93
Oriental Telephone and Electric Company	1 ..	¼-1

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NOTES.

Franklin Institute.—The Franklin Institute *Journal* for July concludes Mr. George W. Colle's paper on "Rotary Transformers: Their History, Theory, and Characteristics," and, among others, contains the following papers: "Electrochemical Action," by Mr. C. J. Reed, and "Thermometer Glass at Higher Temperatures," by Mr. Wm. McClellan.

Foreign Competition.—Considering what has been said and written recently on the subject of foreign competition, our readers may be interested to know that the contract for the large independent condensing plant for the De Beers Consolidated Mines, Limited, Kimberley, has been placed with Messrs. T. Ledward and Co., London, for their patent evaporative condenser. This is only another instance where this system has more than held its own in all points against foreign competition.

Railway Telephones.—The subject of substituting the telephone for the telegraph for the operation of the railroads in the States is being seriously considered by the authorities, and we note that the Lackawanna Railroad Company has made the announcement that in the course of a few months its system will be managed by telephone instead of the telegraph, as at present. It is estimated that the substitution can be made at a saving of about 60 per cent. in the hire of telegraph operators alone. Already the telephone system is in successful operation on one or two of the branch lines, where it will be given a thorough trial before it is brought into general use on the main line from New York to Buffalo.

Mechanical Engineers' Conference.—This week the 1901 summer meeting of the Institution of Mechanical Engineers is being held at Barrow-in-Furness. On Tuesday, the opening day, an official welcome was accorded the delegates at the town hall by the Mayor and the members of the local reception committee. The week's proceedings have taken the form both of business and pleasure, and while several useful and interesting papers have been read on different subjects, the members have found plenty of recreation in visiting many of the engineering works and places of interest in the district. The president this year is Mr. W. H. Maw, in addition to whom some 280 members of the institution are attending the conference.

Enterprise in Hungary.—In view of the prominence which has of late been given to the firm of Ganz and Co., of Budapest, in connection with the projected equipment of the Metropolitan Underground Railways for electric traction, it is interesting to note the proposals of the company in other countries. A message from Budapest states that the firm is now making investigations and preparing plans at the instance of the Minister of Commerce and Finance at Budapest, with a view to the introduction of electrical working on the main lines of railways in Hungary. The investigations in question have been made in regard to the four lines, Budapest-Neuhausel, Galanto-Silein, Salgotarjan-Rutka, and Piszky-Petrozseny. It is stated that as a result of this enquiry it is intended to introduce a system of electrical working of the whole of the traffic on one of these lines by way of experiment without loss of time.

Electric Traction in Italy.—The new electric railway between Milan and Varese, which has already been referred to in this journal, has just been opened for traffic. The line is 40 miles long, and from advices received the intention appears to be to cover this distance in 50 minutes, although a much higher speed is easily attainable. Trial trips have taken place with perfect success, and at 66 miles an hour the carriages are reported to have run quite smoothly. The third-rail system has been adopted on this line. Another dispatch from Italy contains the announcement that the construction has been commenced of an electric tramway from Naples to the cable railway leading to the crater of Vesuvius. It is expected that the new tramway will be ready for public use next spring, when it will take an important place in the interest of visitors to Mount Vesuvius.

State Telephones.—A further question was put in the House of Commons on Friday concerning the expected opening of the Post Office metropolitan telephones in October. Mr. T. Dewar wanted to know in what districts the service would then be commenced, when it was proposed to extend the service to the East-end of London, and whether the Secretary to the Treasury was yet in a position to announce the scale of telephone tariff. Mr. Austen Chamberlain said it was hoped to begin the connection of subscribers in October with the central exchange, which would serve the City and a considerable district to the west; and in the course of the autumn, or early next year, exchanges at Westminster, Kensington, Chiswick, Putney, Wimbledon, Kingston, and Richmond would become available for use. The Postmaster-General was not in a position to name definite dates for the extension of the system to the various districts of East London. The rates of subscription would be announced as soon as subscribers could be invited to join the system.

Submerged Motor for Boats. — The *Western Electrician* for the 13th ult. gives details of a new portable electric motor for propelling small boats. The novel feature about this new device is that the motor itself is under water, while the storage batteries are in such compact form that they may be placed under the seats of an ordinary rowboat. In addition to propelling the boat, the motor takes the place of the rudder, and serves to steer the craft as well. This propeller, as the combination of motor, propeller wheel, and rudder is called, is complete and portable, weighing about 35lb. Using two boxes of cells, the motor drives the boat forward or backward at the fairly moderate speed of four miles an hour, and it will run 20 to 30 miles on one charge. By the addition of more cells, however, it is possible to attain a speed of six miles an hour. One advantage which is claimed for having the motor outside the boat is that there is no strain or vibration, and on this account it is unnecessary to build a boat of any extra strength or weight in order to carry the power. It is further declared by the company owning the patents for the device that the construction is such that the motor works perfectly well when submerged in water.

Propagation of Electric Waves through Water. An interesting paper on this subject by Mr. C. Gutton is abstracted in *Science Abstracts* for July. From this we gather that when the electric and magnetic properties of an insulator only depend upon its dielectric constant, the wave-length of a resonator remains the same when measured first in air and then in the insulating medium in question. This proposition was deduced by Blondlot from considerations of homogeneity, and verified in the cases of castor oil and ice. If the medium is magnetic or conducting, or if it shows considerable absorption for electric waves, its properties are no longer completely defined by its dielectric constant, and the equality of wave-lengths of a resonator in air and in the medium cannot be certain. This is the case with ordinary spring water, which shows a decided conductivity and consequent absorption of electric waves. The author, therefore, measured the wave-lengths of a simple resonator in air and in water, and found that they were practically the same when resonator and wires were either out in the air or immersed in water. He also found

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that the path traversed by the waves during one period of the resonator oscillating in air is 8·3 times smaller in water than in air. This implies that when a resonator is plunged into water its period of oscillation becomes 8·3 times greater than in air.

A Lighting Difficulty.—The question of letting the electric lighting contract for the city of Montreal is, we note, providing plenty of excitement among the city councillors at present. The difficulty, it would appear, all arose out of the fact that the special committee appointed to consider several tenders for the contract reported without recommending the acceptance of any one of the tenders submitted. The Council thereupon rejected the whole of them, and decided to call for new tenders. It is this decision which has apparently caused the trouble, for bribery is alleged as the probable cause of the rejection of the first batch of tenders, but in what connection and to what purpose is not stated in the report we have seen of the proceedings. The present lighting contract, which terminates in two years' time, is at the rate of £24 per arc lamp, or about £30,000 per annum. The new figures submitted for the future contract averaged just over £16 per arc lamp. The lowest tender was from the St. Lawrence Power Company, which is now engaged in developing the water power at Sheik's Island in the St. Lawrence River, near Cornwall, Ont., while at least one other company was willing to deliver both light and power from a water-power station within two years. The decision of the City Council, therefore, in refusing to accept any of the tenders submitted is regarded locally with surprise, if not with a certain amount of dissatisfaction.

Supporting Long Commutators.—It is well known among electrical manufacturers that when commutators reach considerable diameter the length must be restricted in order that the construction may be stable at reasonable speeds. Otherwise the individual parts of the commutator are apt to bend and slacken out from their supports. The pressure required on the end rings of these large commutators, when of considerable length, becomes too great for the ordinary types of insulation to withstand. We notice in the *Electrical World* a description of a commutator design patented by Mr. Henry Geissenhoner on July 9. In it an additional support is secured on the end side in the middle of the commutator bars. This middle support consists of a double cone, which is in one piece with the commutator centre. A number of bolts which pass through the stalk of this cone are used to clamp the end rings at either side. These end rings are also made on the cone principle, and can be tightened up individually. With the design in question the front end ring has to be clamped in first, which draws the centre cone hard up into the middle of the commutator. After the front cone has been secured the back cone can be screwed up, but this tends somewhat to slacken the centre support. From what we know of commutator work we can see that exceedingly accurate workmanship would be required in order to get commercial results with the commutator as designed. Perhaps, after all, it will pay to keep the diameter of the commutator big, and to increase the current capacity by using a number of parallel circuits.

Economy of Copper in Transmission Lines.—*Science Abstracts* for July contains a short summary of a paper on this subject by Mr. Latour, in the course of which he points out that the use of accumulators at the distant end of a line may conduce to economy in the cost of a transmission line in cases where the power is transmitted over comparatively short distances. This is due to the possibility of sending along the transmission line a constant current which is equivalent to the mean amount of current required throughout the day, or, in other words, to the possibility of maintaining a constant load on the running machinery. He shows that if, under the usual conditions, full load is maintained on the line during eight hours of the day, and there is no load during the remaining 16 hours, the loss in the transmission line is three times as great as it would be if, with the use of accumulators, it were possible to maintain a steady load on the line equal to the mean load required. It is pointed out that this requires to be somewhat corrected to allow for the fact that the efficiency of the battery is not 100 per cent.; but even allowing for this, the line loss would be much smaller in the one case than in the other. The matter may be put in another way: it is possible to have much less copper in the line in the one case than in the other, and yet have equal daily loss in the line; and consequently, from the point of view of the author, the use of accumulators may be said to conduce to economy in the cost of copper. No estimate is, however, made of the cost of plant under the two conditions, though it is pointed out that the use of accumulators dispenses with the cost of transformers at the distributing station.

Improved Tramcars.—The 12 new cars which Halifax recently added to its tramway system would appear to have many improvements on the previous consignments. A particularly good feature about them is better lighting on top. Electric glow lamps in smoked shades depend over the passengers' heads from brass brackets, which is certainly a great improvement on the old form of hanging globes from the canopy back and front of the car. Much has also been done, by an arrangement of the windows, in the way of bettering the ventilation of the cars. Another improvement consists of an electric connection with the conductor half-way down the interior of the car for the convenience of the passengers. An electric communication between conductor and driver is also provided. The equipment beneath the car consists of a pair of 35-h.p. Westinghouse motors, which can give 40 h.p. if occasion arises. A speed of eight miles an hour uphill is easily obtained. For emergencies, the patent slipper device of Mr. Spencer (the tramway manager to the Bradford Corporation) is introduced. This is said to be vastly more powerful than those on the older cars, and it also has the advantage of having its supports quite clear of the road, and will not help to clog a car travelling over snow. Another addition to the new cars is Tedswell's lifeguard. In this device there is a swinging ridge of woodwork beneath the front of the car, which, when struck by an object on the line, instantly releases the "gate" of the tray just in the rear in time to pick up the obstruction. On being released, the front end of the tray rests on the rails, which effectually prevents anything from getting underneath the car. We hear that the invention has already done good work in different parts of the country.

Experiments with Sound Signals.—A recent issue of the *Times* records some interesting experiments with sound signals which have been carried on during the past few weeks by a special committee of the Elder Brethren of Trinity House appointed to consider the present position of the subject. St. Catherine's Point, in the Isle of Wight, was selected for the trials. Here there is a lighthouse with a powerful electric arc light, produced by steam power which also serves for compressing air into receivers for sounding a permanent fog signal. At this station the committee, with Lord Rayleigh as scientific adviser, have been engaged particularly in testing the relative merits of sirens as sound-producing instruments as compared with reeds. It is thought to be improbable that the vibrations set up by means of a reed can possibly

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be so powerful as those produced by means of a siren, and it will be interesting to learn the results of the committee's observations on this point. The form of the trumpet or sound projector is also receiving considerable attention, Lord Rayleigh himself having certain theoretical views on the point which he desires to have practically tested. The relative merits of notes of different pitch is another branch of the enquiry which is being followed up by the committee, and the question of the most effective and economical utilisation of power for operating sound signals is also receiving much consideration. The various forms of siren and reed vibrators have come into the trials with the view of deciding which form, size, and description of vibrator is best adapted for producing the sounds; and questions respecting pressure, air consumed, and length of blast are also being dealt with. The investigations ought to yield some interesting results.

The Telephone in War Time.—A good lesson is to be learnt from the operations of the Signal Corps during the recent manœuvres of the National Guard of the State of New York in connection with the stringing and installation of telephone wires in the field under conditions of active military service. The *Electrical Review* of New York gives an interesting account of their proceedings, and the general uses to which the telephone was put. Up to the present the results of target firing have been made known to the firing party by means of a flag signal code, which considerably limited the amount of information received. This year it was determined to bring into operation for this purpose a field telephone line. The line was reeled off at a good speed through bushes, across roads, over walls and fences, etc., and in about two hours some three miles of it were ready for service. The insulation resistance of the line was about zero, and it was trodden into the mud of the roads by the feet of men and horses, run over and cut by wagons and guns, etc. In short, it was subjected to the same usages as in actual warfare. The telephones had very powerful transmitters, operated by four cells of dry battery, and powerful induction coils. The results obtained are said to have been beyond all expectation. Although sometimes it was difficult to ring through the line, communication was generally maintained, and the saving of time was enormous. Whereas the firing of 20 shots and the reports of the results used to take about two hours, this year the time occupied was only 40 minutes. In fact, it is said that the report of the striking of the shot was received in some cases before the detonation of the exploding of the shell at the distant target was heard.

The Electro-Chemical Industry.—At the congress of the Society of Chemical Industry held this year in Glasgow, Mr. J. Wilson Swan delivered an address on "Electro-Chemical Industry," which we hope to print in full at an early date. It may be convenient now, however, to touch on a few points brought out by Mr. Swan in the course of his oration. Having traced the progress of this new branch of applied science from the early laboratory researches of Davy and Faraday down to the position it holds at the present time, he gave particulars of the power at present utilised and products made in the 150 works using electricity for chemical and metallurgical purposes in Europe. In several instances the new methods of manufacture have already supplanted the old, while in others there was keen competition between the chemical and the electrolytic processes. The United Kingdom was severely handicapped as regards these new developments by her lack of water power, but in spite of this many of the new electro-chemical industries could be carried on with steam power. The utilisation of the waste gases of blast furnaces in large gas-engines for the generation of electrical energy would also become a realised fact, and would supply large quantities of cheap power for the industries in question. Although the position of the staple chemical and allied industries in this country had been undermined to some extent by the rapid growth of electro-chemical industries abroad, and although the protective tariffs were being employed to shut out British products, he believed that the future might be faced with some degree of confidence and hope. Mr. Swan then went on to refer to the necessity for the adequate endowment and encouragement of research, not only in the interest of the chemical industry, but in that of the manufacturing industries generally. The fullest measure of assistance was demanded that education and energy could give.

Hub-Motor Omnibuses.—The issue of the *Western Electrician* for the 13th ult. describes and illustrates a very interesting type of electric vehicle known as the hub-motor omnibus, which is about to be put on the roads of Chicago. It will be gathered from the name that in this automobile the hub of each driving wheel contains the propelling motor. Each wheel is a driving wheel, and it is claimed that the combination is efficient and economical in operation. Improvements in battery and the use of solid rubber tyres are also said to add to the efficiency of the hub-motor omnibus. The vehicle has been subjected to tests by a well-known electrical company, and from the records obtained it is credited with an excellent performance. For instance, on a voltage of 63, with a current consumption of 80 to 85 amperes, and a dead-weight of 8½ tons (including eight passengers), the omnibus gave a speed of 6·8 miles an hour. The low voltage was caused by some of the cells being cut out on account of sulphating. Without the battery the vehicle weighs 15,115lb., the testing battery making an additional weight of 2,100lb. Estimating the cost of current at 1½ cents (about ¾d. in English money) per kilowatt-hour with a gas-engine plant of the type that the company will probably instal for its charging stations, it is said that 80 watt-hours per ton-mile (giving a speed of eight to ten miles an hour), with 60 per cent. efficiency of the batteries, will give a cost of 2·2 cents, or just over 1d. per mile for current for the entire vehicle. These figures, however, practically go for nothing, as it is impossible to determine the real value of the vehicle until after an extended test in actual service. From the illustration, however, which appears in our contemporary of one of these self-propelled omnibuses, we must admit that its general build and equipment seem to be far and away superior to anything of the sort we have heard of up to now, but it is impossible to form any accurate opinion as to its performance until it has been in actual operation, say, for 12 months.

The State and Submarine Cables.—This is the subject of a letter which has appeared in the correspondence columns of the *Morning Post* from Mr. Wm. Blanchard. The object of the communication is to express a sincere sympathy with the efforts which are being made by Sir Edward Sassoon to secure to the State the right to purchase the Cape-to-Australia submarine telegraph cable. The writer believes that precedents for this course, relating to concessions which have been granted to submarine cable companies, may be found in the records of several foreign States. About six years ago the Brazilian Parliament decided to acquire by purchase the submarine cables which traversed their territorial limits. This proposal, however, was not then carried out in consequence of the enormous sum it would have added to the national expenditure. Personally, the correspondent is in favour of the State acquiring by purchase some of the more important cable

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sections, especially those which from their location are likely to be useful for military purposes. With regard to the object aimed at by Sir Edward Sassoon, the writer thinks the Colonial Secretary would do well to keep in view the possibilities of the future, and ventures to suggest that immediate steps be taken to safeguard the public interest in such an effective way as to make it impossible for any telegraph cable "combine" hereafter to dictate terms of settlement (in the event of reversion to the State) which shall be burdensome to the taxpayer. Those who are interested in this subject ought not to have forgotten the enormous excess over the original estimate paid by the country for the British inland system of overhead telegraph wires. The late Frank Ives Scudamore assured Parliament that he was prepared to carry out the scheme (which was supported by Mr. Gladstone) at a cost of £2,500,000. Yet the country, on the completion of the transfer to the State in 1870 of the then existing telegraph interests, found itself saddled with a charge amounting to over £7,000,000. "Is not this a lesson and a warning?" asks Mr. Blanchard in conclusion.

Tunnel Lighting.—We hear of a new device for the lighting of railway tunnels by electricity, which is the invention of Mr. F. D. Black, of Gourock. Mr. Black's idea is to suspend a row of lights between the two sets of metals, thus dispensing with the necessity for lights in the carriages of the trains. We cannot agree, however, that this arrangement is at all comparable with the ordinary train lighting. It is far preferable, in our opinion, to have the lights on the train itself, and collect electricity from a third rail. Of course, this involves car-wiring, but this has already been done on many of our railway systems with success, and the result is all that can be wished. With only the tunnel lighted it would be impossible to get a steady and continuous illumination in the carriages, which, we think, would condemn the system at once. Mr. Black's invention also provides for a connection between the switch regulating the lamps and the signal lever worked at the box governing the section of line in question. Thus, it is claimed, when the signalman gave a train the clear signal through a particular section of the tunnel, only the lamps as far as the next signal-box would be lighted. And, of course, when he restored the lever to its normal position, the lights would be automatically extinguished. In addition to other advantages, it is thought that this device would ensure greater safety from accident, as the fact of any particular section of tunnel being illuminated would indicate to the driver that the line was clear. We are afraid, however, that the fact has been overlooked that the illumination would be observed from both ends of the section when, perhaps, only intended for the "up" train. The lighting of the lamps would be no indication of safety, as it must happen at some time or other that an "up" and a "down" train would be passing through the same section at the one time. We do not think, therefore, that any advantage would result in controlling the lamps in conjunction with the signals; in fact, it would probably lead to confusion. Such a device has, we believe, been experimented with in France with but little success.

Energy Consumption on Electric Railways.—The digest of the *Electrical World* for 20th ult. gives a good abstract of a paper by Volkers, in which the author discusses the different factors which require an energy consumption on electric railways—friction, air resistance, grades, and stops. The friction and air resistance he measured together from the decrease of speed, when the current supply was interrupted. The curves of speed were plotted very accurately by means of a Morse telegraph instrument, the current of which was flowing through a contact device mounted on the axle of the car, two contacts being made during each revolution. The author also measured friction and air resistance separately. He found from experiments on a fairly good road with a normal two-axle motorcar with two motors, the value of the friction at 2·76 kg., and for a trailer at 1·09 kg. per ton. On curves the friction is considerably greater. He recommends basing calculations upon the following figures: for the friction of trailers and of that part of motorcars which does not rest upon the driven axles of the motorcars, 1 kg. to 1·3 kg. per ton on clean and nearly straight roads; 1·3 kg. to 2 kg. per ton on moderately clean roads, partly in paved streets and partly on macadamised road; 2 kg. to 5 kg. on dirty roads in the country; for that part of motorcars which rest upon the driven axles, 2·8 kg. to 3·1 kg. per ton on clean and nearly straight roads; 3·1 kg. to 3·8 kg. on moderately clean roads; 3·8 kg. to 6·8 kg. on dirty roads. The air pressure in kilogrammes can be determined as the product of 0·12248, with the square of the wind speed in metres per second and the surface perpendicular to the direction of the wind in square metres. The latter can only be given with difficulty. He has found practical values of this quantity to be seven square metres for normal motorcars and 2·5 for trailers. He then discusses the influence of grades and stops, and the efficiency of motors. The total efficiency is the smaller, the greater that part of the work which is to be done in starting. On level roads, at a high average speed and with many stops this total efficiency is a minimum. The total efficiency of a two-motor car is between the limits 57 and 78 per cent. In the conclusion the author gives two numerical examples to show how to apply his calculations.

Artificial Submarine Cable.—Mr. Augustus Trowbridge describes in the June number of the *Physical Review* a neat form of artificial submarine cable which can be made at a comparatively small cost. The earlier forms of artificial submarine cables involved the use of very large condensers made with tinfoil at great expense, and the author's method is, therefore, to be welcomed as a means of providing artificial submarine cables at a much cheaper rate for technical schools. The essential element in such cables is the appreciable time lag which they must have, and in order to get this they must have both large resistances and large capacity. The author has made use of the great polarisation capacity which a cell consisting of dilute sulphuric acid with platinum plates has when the applied E.M.F. has a value below the maximum polarisation of the cell. The artificial cables are accordingly built up of a series of resistances, between each of which is connected to the earth return one of these cells. These electrolytic capacities consisted in the experiment recorded in the article of short lengths of glass tubing about 1cm. in diameter, with a platinum wire as an electrode sealed in to one end. The tube was filled nearly full of distilled water, and the other electrode, which was a piece of platinum foil about 3mm. wide, was corked in so as to dip about 5mm. into the water. In the cable the author has made he used 39 such cells, arranged in 13 sets of three cells each. The three cells of each set were connected in parallel. Thirteen resistances aggregated about one million ohms. The galvanometer had a figure of merit of 10^{-8} amperes, which made a signal giving a small but very definite throw of the instrument. The author states it will be found convenient to mount the cells on a thin board, in which a triple row of holes are drilled just large enough to allow the wire electrodes to project a few millimetres from the under side, and to have this board rest on another, in which are three troughs filled with mercury to serve as an earth connection for all the wire

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electrodes. In this way, if the board carrying the cells be lifted, all the capacity is at once removed from the system, and a signal is sent along the conductor with no appreciable time lag. In other words, when the board is lifted the submarine cable becomes an overhead land line of the same length as the cable. With the apparatus described above, the time lag when the capacities are in is very appreciable, being in the neighbourhood of six seconds. Of course, the E.M.F. of the battery used must be less than the maximum polarisation of platinum electrodes in water, and therefore a single Daniell or Leclanché cell is suitable.

Influence of Temperature upon the Photo-Electric Effect.—The discharge of negatively-electrified bodies by the impinging of light waves upon them has been studied in various phases by a large number of observers. The results obtained by these have led to the hypothesis that the discharge is due to an ionisation produced at the surface of the body by the rapid absorption of certain of the waves of the impinging light. There is but little known, however, as to the relative parts played in the ionisation by the material of the body and by the gas occluded in it or existing as a layer upon its surface. Mr. John Zeleny contributes an article to the June number of the *Physical Review*, giving the results of some preliminary experiments on the influence of the temperature of a body upon the rate at which electricity is discharged from its surface by ultra-violet light. The experiments showed that temperature has a large influence upon the photo-electric effect. From a platinum wire the negative electricity is at first discharged more slowly as the temperature is increased. The rate of discharge reaches a minimum, however, and then increases as far as the highest temperature used (about 700deg. C.). The rate of the discharge produced by the light also depends upon the immediate previous history of the wire. On coming to certain temperatures from a higher one, the rate of discharge is much greater than if a lower temperature had been used just before. For small ranges, at least, this effect appears to be independent of the electric intensity and of the intensity of the light. After the reduction of temperature the rate of discharge gradually becomes smaller with time, showing that the large conductivity at first is due partly, at least, to the fact that the wire reaches its steady state but slowly. The recovery is much faster at temperatures below a certain point than for those above, the change being fairly abrupt. From an iron wire the rate of discharge also appears to diminish at first with the temperature, but after reaching a minimum it finally becomes a great many times its value at room temperature. Heating the wire does not change the inactivity of the light for discharging positive electricity, even though the wire is raised to a temperature where, due to the heat alone, the positive electricity is being discharged. The fact that after the platinum wire has had its temperature reduced the larger conductivity of the higher temperature persists for a time, there being a gradual recovery, shows that at least most of the variations which have been noticed in the experiments described are due to changes taking place at the metal surface and not in the gas between the electrodes. The comparatively abrupt change in this effect occurring at about 100deg. C. may indicate some molecular alteration of the metal. Any further discussion, the author concludes, had best be delayed until the completion of further experiments.

A Gold Mine Power Transmission Plant.—We have had occasion recently to note the rapid progress which is now being made in the introduction of electric traction into some of the principal cities of New Zealand. We are pleased to see, however, that the enterprise in electrical matters in this colony is not confined to electric traction alone. What we believe to be the first installation of its kind in Sumatra is a water-driven three-phase power transmission plant which has recently been completed by Messrs. Siemens and Halske at the Redjang-Zebong gold mine of Sumatra. From a description of this plant in the *New Zealand Mining and Engineering Journal* we gather that the goldfields in question are particularly suited to the employment of electricity as a motive power, having the advantage of a large water power within a distance of only two miles, where is a fall of 463ft. At first only about 35 cubic feet of water per minute is being made use of, so that, assuming an efficiency of 85 per cent., about 125 h.p. will be available. Pelton wheels were chosen, and these were directly coupled to three-phase generators, this being the natural arrangement in view of the high speed of this class of water-motor. Each of the three generators is rated at 100 kw. for an inductionless load. In erecting the power station considerable difficulty was met with owing to the absence of transport facilities, and accordingly no single piece of machinery was allowed to weigh more than about 1,350lb. This necessitated special design in the case of some of the larger motors and the dynamos. For instance, the stators of the larger machines had to be made in four pieces, and the iron stampings had to be delivered separately and fitted into the castings on the spot. Thus the dynamos could not be wound at Messrs. Siemens and Halske's works, and this had to be done during erection. In order that the winding might be carried out in the easist and quickest possible manner, mica troughs were employed for the insulation, and these were laid directly in the open slots of the cores. Some weeks were occupied in carrying the dynamo shafts from the coast to the works, and on one occasion the journey was stopped by an earthquake, followed by landslips. The tropical rains also played considerable havoc with the contents of the cases, and some of the dynamo windings and instruments suffered damage. Fortunately the possibility of mishaps had been anticipated to a large extent, and plenty of spare parts had been sent out. Once the plant had arrived at the station it took four months to erect it. Extremely high poles are used for carrying the high-pressure transmission line through the jungle in order to avoid interference by the growth of timber. The smaller motors and lighting are provided for on low-pressure circuits through transformers, but some of the larger motors are supplied directly at 2,000 volts. In order to be secure against accidents, the switches, cut-outs, ammeters, and voltmeters are enclosed in metal cases which are earthed. Rubber cable, with extra good insulation, is employed within the buildings and fixed to the wall with iron fastenings, which are earthed at different places. A telephone enables communication to be held between the generating station and the mine. The wire is placed beneath the high-pressure wires on the same posts. In order to guard against injury, should a high-pressure wire fall and come in contact with the telephone line, a telephone set, specially designed for such cases, in employed, in which the mouthpiece and receiver ear-pieces are connected to the instrument by rubber tubes, and are not in metallic connection with it. The electric power is used for hoisting and pumping, for driving the stamp mill, for the pumps, etc., for the cyanide works, for running the repair shop, for lighting, and for operating the air compressor, which furnishes power for the drills. At present compressed-air drills are in use at the mine, but tests are to be made with electrically-driven drills with a view to their adoption. For some months now the whole installation has been working, and is stated to be giving ample satisfaction to the owners of the mine.

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THE TUNBRIDGE WELLS TELEPHONE SYSTEM.

The motto on the coat-of-arms of the Corporation of Tunbridge Wells is "Do Well, Doubt Not," and this has been the spirit shown by the Corporation in their telephone undertaking. When in 1899 Mr. A. R. Bennett reported on the probability of success of such an undertaking in Tunbridge Wells, he estimated that some 300 subscribers might be obtained in the area first exploited. The Telephone Committee had faith in their expert, and provided accordingly. The result is most creditable to both the adviser and those who backed his opinion with public money, as some 330 subscribers are already connected to the exchange. We do not propose here to go into the history of the development of this, the first municipal telephone system in England, as this can be gathered from the speeches which are reported at the end of this article. The first point of interest in the system is the large area—some 180 square miles—over which the Corporation have powers to give telephone connection. This is shown in the accompanying map (Fig. 1), on which most of the places connected are shown. The full list of the towns and villages in which sub-exchanges are to be provided is as follows: Bells Ewe Green, Bidborough, Boar's Head, Brenchley, Capel, Claygate Cross, Cousley Wood, Crowborough, Dunk's Green, Eridge, Five Ashes, Flimwell, Frant, Friar's Gate, Golden Green, Goudhurst, Groombridge, Hadlow, Hadlow Down, Hildenborough, Horsmonden, Jarvis Brook, Kilndown, Kippings Cross, Lamberhurst, Langton, Latingford, Leigh, Mark Cross, Matfield Green, Mayfield, Oxonhoath, Paddock Wood, Pembury, Penshurst, Plaxtol, Romford, Rotherfield, Shipbourne, Southborough, Speldhurst, Ticehurst, Tidebrook, Tonbridge, Tudeley, Withyham, Wadhurst, and Yalding.

The following figures show how the applications range over the district. Thus, while in Tunbridge Wells the total of the applications is now over 300, there are in Tonbridge fully 25 lines arranged to subscribers, in Southborough over 10, Crowborough over 30, Rotherfield 10, Mayfield 20, Wadhurst 30, Ticehurst 15, Frant 15, Pembury 15, Penshurst 15, and a number of other small places which are mentioned above with from 10 to 15 subscribers in each place. The laying of the trunk mains to these outlying places has in several cases inaugurated the telephone convenience, as they were not supplied by the National Telephone Company.

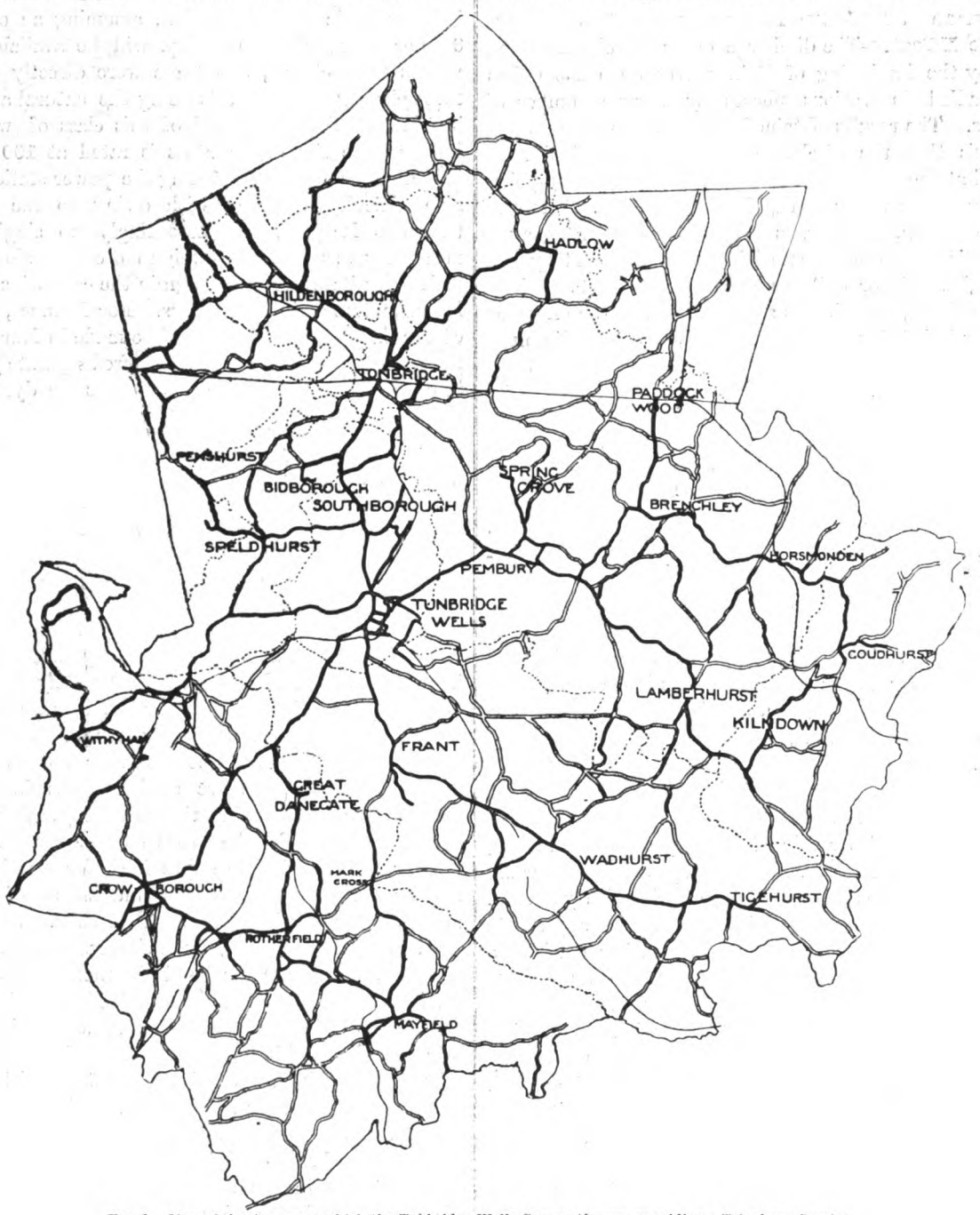

FIG. 1.—Map of the Area over which the Tunbridge Wells Corporation are providing a Telephone Service.

The central exchange is situated at 5, Calverley-parade, which is a most suitable position. The exchange-room, in which all the switching is done, is on the ground floor, which is a novel point in the arrangement of telephone exchanges in this country. Owing to the use of overhead

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wires the switch-rooms have always been at the top of the building, and even at Glasgow this arrangement has been retained. In the switch-room (Fig. 2) is placed the main telephone board, which was manufactured and supplied by the Manufacturing Telegraph Company, of Helsby, who also made the equipments for the local stations. The

MR. C. M. GARDNER, MANAGER OF THE TUNBRIDGE WELLS CORPORATION TELEPHONE DEPARTMENT.

COUNCILLOR NICHOLSON, CHAIRMAN OF THE TUNBRIDGE WELLS TELEPHONE COMMITTEE.

MR. A. R. BENNETT, CONSULTING ENGINEER FOR THE TUNBRIDGE WELLS MUNICIPAL TELEPHONES.

design of the switchboard was got out by Mr. A. R. Bennett, the consulting engineer to the Corporation, and is novel in several respects. Thus, each subscriber's metallic circuit contains an indicator of ordinary construction and a four-point spring jack.

of the second switch remains unpressed, the metallic circuit into which the answering plug has been inserted is directly on to the operator's 'phone. If in this position the finger switch is pressed the operator's 'phone is cut out, and a magnetic generator is brought into circuit, by means of which the operator is enabled to ring the bell of the subscriber into whose jack the answering plug is inserted. The consequence of this arrangement is that the mere insertion of the answering plug puts the operator in communication with the calling subscriber without any further movement. After ascertaining his wishes, she lifts the rear plug from its position

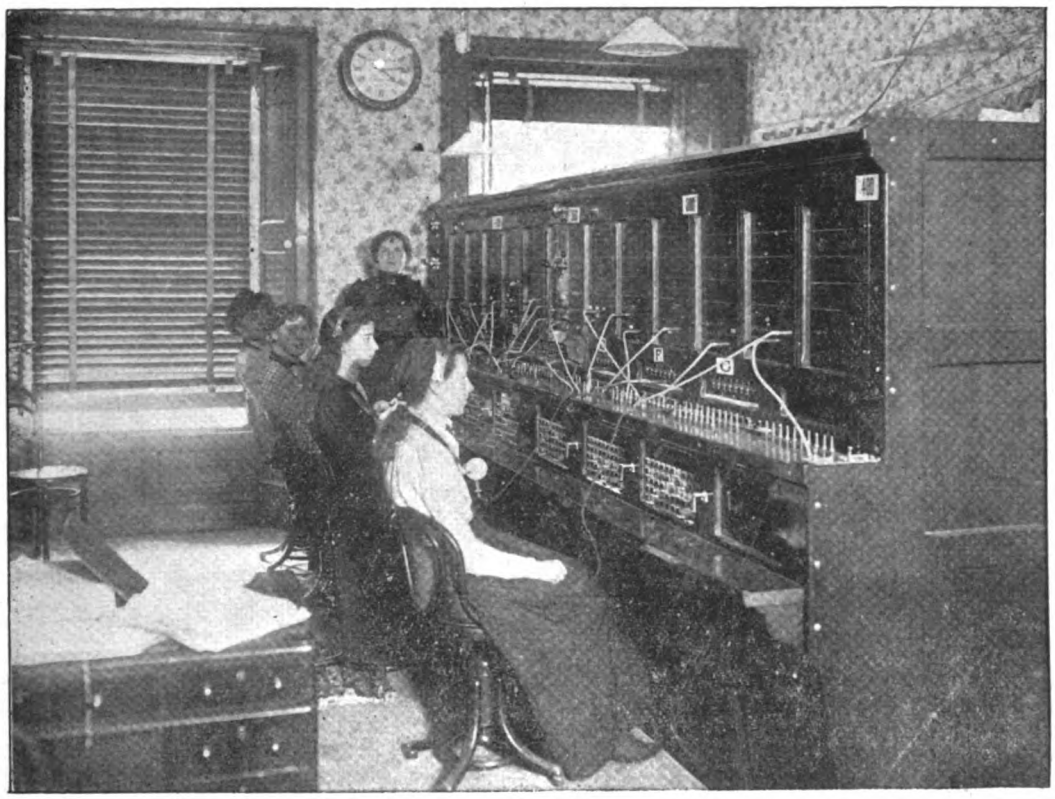

FIG. 2. The Tunbridge Wells Municipal Telephone Switch Room.

When the answering plug is inserted in the spring jack, the line indicator is cut out of circuit, and the metallic loop is in direct communication with the two circuits of the plug. The second, or rear, plug when out of use sits on and presses down a switch, which connects the two conductors of the flexible cord, joining the two plugs to a second switch, which is worked by the operator's finger. When the rear plug is sitting on its switch, and the button and inserts it in the jack of the subscriber called for. The lifting of the rear plug from the switch cuts off the operator's telephone and brings into circuit a ring-off indicator. This indicator is wound so that a current passing through both coils successively will not work it, but if a current enters between the two coils the shutter falls. From a point between the two coils of the indicator a wire is taken which is connected to the pole of a ring-off battery, the

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other pole of which is joined to "earth." Supposing two subscribers are connected, one can ring the other's bell without disturbing the indicator at the exchange, but when the conversation is finished, if one or both of the talkers touch their ring-off buttons, a current flows from the battery, actuates the indicator, and flows over both wires of the metallic loop to "earth" through the subscriber's ring-off key.

FIG. 3.—Commencing a Joint in the large Air-Cored Cable.

FIG. 4.—The Joint nearly completed

This is a great advantage, as when one of the two subscribers wishes to leave his telephone to look up some reference matter for the other, there is no need for that strained listening to prevent cutting off, now common to other systems. The two telephones can be replaced temporarily and attention called by a ringing up when the necessary information to continue the conversation has been obtained. The same saving of time applies when the person answering a call has to get someone else to come to the telephone. Another advantage of the system designed by Mr. Bennett is that the conversation cannot be overheard by the operator. In small places this is quite as important as in large towns, although the value at stake may not be so great. Behind the main switchboard is a terminal board supplied by the International Electric Company. This contains lightning arresters in each line wire, and also heat coils to disconnect the line should any large current pass. The exchange, although only recently opened, was working most smoothly when we inspected it,

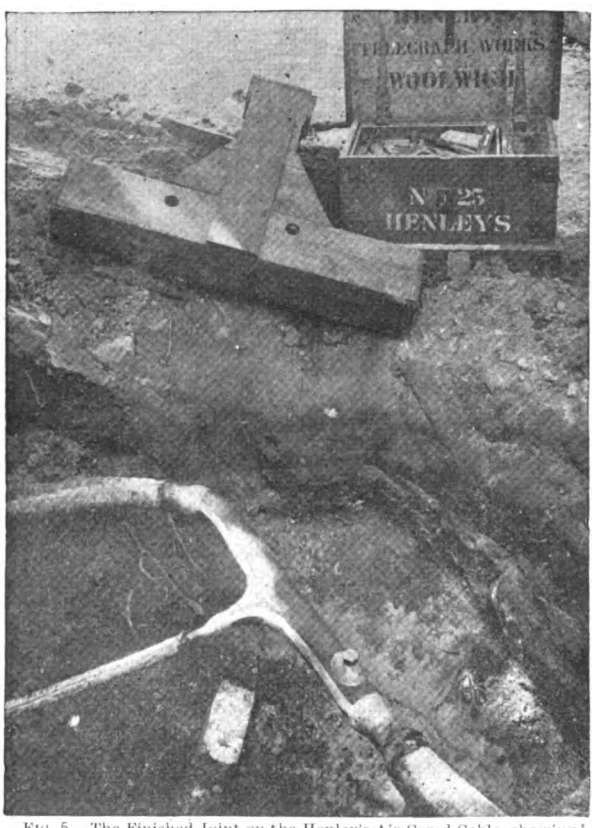

FIG. 5.—The Finished Joint on the Henley's Air-Cored Cable, showing Nipple for Air-Cock.

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and Mr. Gardner speaks favourably of the equipment he is in charge of.

All the conductors leaving the exchange go underground through the town. The cables used are what are known as dry-core cables, and are composed of plain copper, insulated with paper, the cores laid up in pairs, the pairs being cabled up; different coloured paper being employed to distinguish the various pairs. The whole cable is then lead covered with lead having 3 per cent. of tin mixed with it. The lead-covered cable is served with tarred yarn armoured with two coats of steel tape, served over all with tarred yarn, and compounded, so as to be fit for laying direct in the ground.

The size of the conductors are in some cases No. 22 S.W.G., and in others No. 20 S.W.G., the mean inductive capacity in the former case being ·067 microfarad per mile, and in the latter ·075 microfarad. The thickness of the lead covering is ·100in. for the smaller sizes and ·125in. for the larger. The total diameter of the cables varies from 1in. to 3½in., the sizes of the cables varying from a cable containing six pairs of conductors to a cable containing 312 pairs.

The quantity of cable laid up to the present amounts to over 10 miles, containing over 700 miles of single conductor, and this was all manufactured and laid by W. T. Henley's Telegraph Works Company, Limited.

The underground cable going down the High-street contains 312 pairs of wires when it leaves the exchange, and it is gradually reduced in size as smaller cables are tee'd on. This reduction in size involves jointing, which has to be most carefully carried out to insure good insulation and a complete air-tight envelope over the joints.

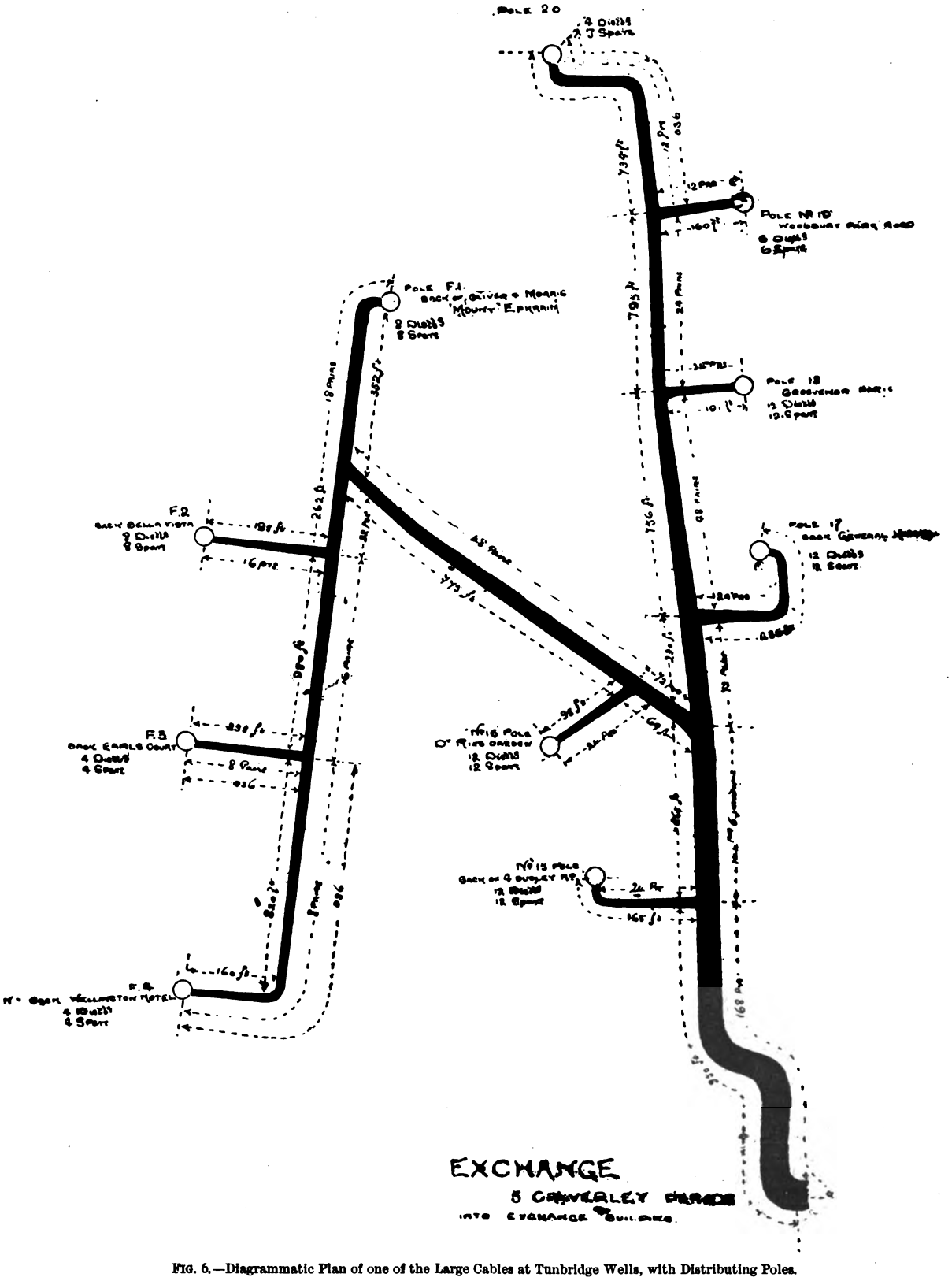

FIG. 6.—Diagrammatic Plan of one of the Large Cables at Tunbridge Wells, with Distributing Poles.

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Figs. 3, 4, and 5 show stages in the jointing of these cables. Where the cables terminate in the exchange, the wires are brought out through a cast-iron cable head, which is filled up with a sealing mixture of bitumen. Below this there is provided an air-cock, to which an air-pump can be fixed. In fact, as soon as possible a small air-pump will be kept always at work trying to force dry air into the cable. The regular reading of the gauge will show the instant any leak occurs in the lead sheathing.

A diagrammatic map showing how one of these main cables leaving the station is split up is given in Fig. 6, while Fig. 7 shows the large cable being placed in position in the trench. The final distribution is done by short overhead spans from distributing poles (Fig. 8). The dry-core cables are taken to the bottom of the distributing poles, and then connected to rubber lead-covered cables which are fixed up the poles. The whole of the trench work, together with the jointing and connecting up of the cables, was also done by the W. T. Henley's Telegraph Works Company, under the local superintendence of Mr. J. Hall.

The telephones themselves were made and supplied by the General Electric Company. These instruments are of the design illustrated in Fig. 9. The generator is of four-magnet type, and the induction coil being wound to the Post Office specification. The hand combination consists of a ring magnet receiver with Hunningscone-Deckert transmitter. The system of wiring is on the well-known bridging system, and the generator is capable of ringing its own bell through a resistance of 25,000 ohms. Each instrument is provided with a special "ringing-off" key, which operates on what is described above as the Bennett clearing system. By using this system subscribers are able to ring through to each other without giving the ring-off signal to the operator at the exchange. The woodwork is of solid walnut throughout, and a most handsome coat-of-arms, not showing in Fig. 9, makes the instrument an ornament wherever erected.

System of Charging.—There are no less than three systems of charging for telephone service. The first, and most popular, is the over-all charge of £5. 17s. 6d. per annum.

FIG. 7.—Placing the 312 Pair Telephone Cable in Trench at Tunbridge Wells.

The alternatives are: £3. 10s. per annum and ½d. for each outward call, or £2. 10s. per annum and 1d. for each outward call. These toll subscribers are entitled to any number of inward calls free. The ½d. and 1d. tolls cover communication with every part of the municipal telephone area to which the Corporation cables for the time being extend.

As will be gathered from the speeches at the opening, the National Company have resolved to fight in the Tunbridge Wells area, and have reduced their charges to £4 per year. The Corporation have replied by a circular showing why their system should be supported, and that the additional advantages should be well worth the £1. 17s. 6d. difference. These advantages include connection to the police, borough fire brigades, cemetery,

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sanatorium, electric lighting, public health, and municipal offices, which are connected with the municipal exchange only. As regards trunk calls, the Corporation are franking all outward calls to the National Telephone Company's subscribers to avoid delays, and corresponding fees have been imposed the opposite way. When, however, the London Post Office exchange is open, connection will be allowed without terminal fee to any of its subscribers.

Coming now to the men who have been chiefly responsible for the work, we would mention first Councillor Nicholson, the chairman of the Telephone Committee. This gentleman is a dogged fighter, and he has had every opportunity for displaying both this and also his organising capabilities in the telephone struggle at Tunbridge Wells. Of Mr. A. R. Bennett, the consulting engineer, whose excellent advice has been faithfully followed, we need only say that the telephone system at Tunbridge Wells is

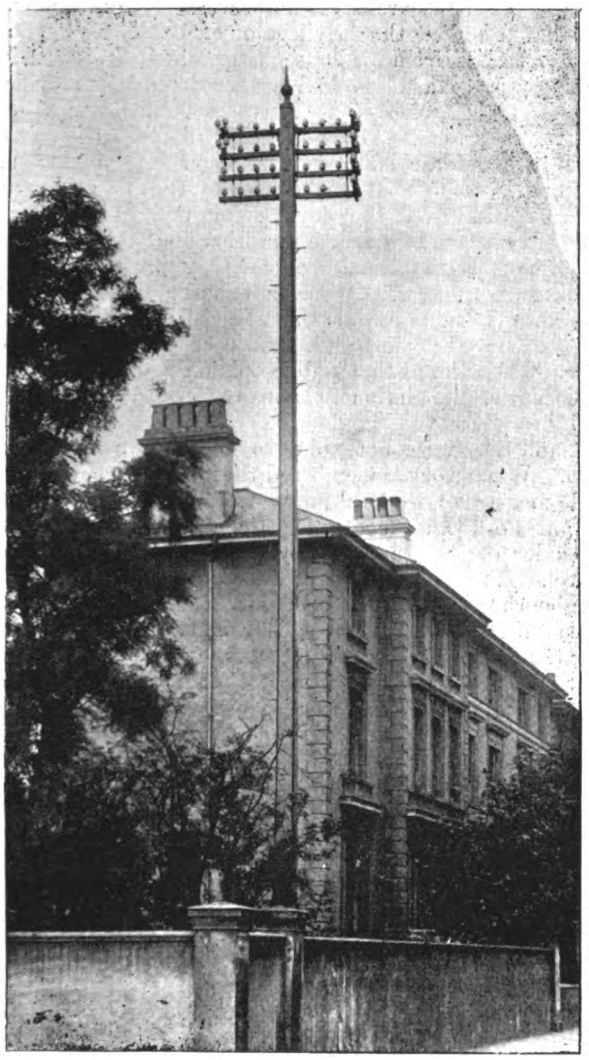

FIG. 8.—A Terminal Distributing Pole.

only the forerunner of many others to be equipped by him in all parts of the country. He, too, has shared in the fight, which for a long time seemed so hopeless, against inefficient telephony in this country. Mr. C. M. Gardner, the engineer and manager of the system, has put his whole energy into making the same a success. Thus in 110 working days he has managed to lay over 10 miles of underground cable, erect over 1,000 poles, and run fully 400 miles of copper and bronze wire, besides equipping the central and local exchanges.

Mr. Gardner has for years been connected with Mr. A. R. Bennett in telephone matters. It follows that during the waiting period after leaving the National Company, he had to seek experience abroad. Thus he has carried out some most important Government contracts in India and in Burma. His practical experience in telephony and general electrical work has been assisted by a good training at the Heriot-Watt College and Edinburgh, where he gained distinction for electrical work. We have to thank all three of the above gentlemen for giving us information and details from which our article is prepared.

The Opening Ceremony.

The opening ceremony on Saturday last was held in the Great Hall, which was well filled by an appreciative audience. The Lord Mayor of London was escorted from the railway station to the hall by a guard of honour of the local fire brigade. The Mayor of Tunbridge Wells (Mr. W. H. Delvis) conducted the Lord Mayor and Lady Mayoress to the platform, when the latter was presented with a handsome bouquet. After a few words of welcome, the telephone system was tested by the Lord Mayor, who carried on congratulatory conversations with the subscribers in neighbouring villages. He then declared the system open, and wished it every success. He did not doubt but that what Tunbridge Wells had done would be copied, and very largely copied, elsewhere.

In the course of the proceedings, Councillor NICHOLSON explained to the Lord Mayor the details of the system. He said that on payment of his yearly rent every telephone subscriber would be entitled to speak without any restriction over the whole local area. Of course, when he wanted

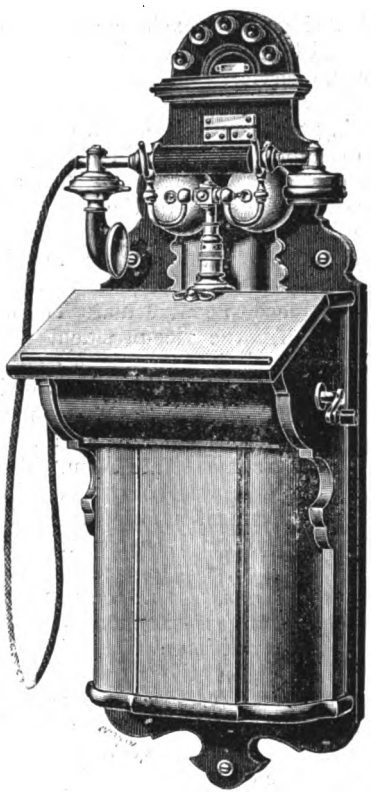

FIG. 9.—The G.E.C. Telephone in use at Tunbridge Wells.

to go outside, then Post Office trunk fees became chargeable, but as in practice 98 per cent. of conversations originated and ended within their own local area, the fees incurred for trunk messages would not be a burdensome additional cost. The local area, which had been enlarged to bring in a number of important villages to share in the privileges conferred by their license, extended from north to south 22 miles, from east to west 17 miles, covered an area of about 229 square miles, and had a population estimated at 60,000 or 70,000. For unlimited speech, both day and night, throughout, the charge was £5. 17s. 6d. per year, and, to suit the purses of those whose requirements were only for a limited number of outward calls, they had a £3. 10s. rental, plus ½d. per call, or £2. 10s. plus 1d. per outward call tariff. Some idea of the advantage due to a competing system would be gathered from the fact that since the start of the Corporation movement for a second and improved service, in the spring of 1896, telephones had multiplied fully eightfold—or, to put the matter in another form, whereas for every sovereign spent in telephone rent in 1895 only nine persons could be spoken with, now, as soon as their installation was completed, for the same expenditure speech would be possible with 90. This was a full tenfold multiplication of efficiency.

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In fact, what was in its origin a costly luxury attainable only by the rich, now, thanks to the enlightened policy of Parliament, was being made accessible to the everyday necessities of even the poorest.

The company then adjourned to the Pump Room for a luncheon, which was well served. The chair was taken by the Mayor of Tunbridge Wells, and the guests present included the Lord Mayor, Mr. Pigott, the Mayor of Hastings, the Town Clerk of Tunbridge Wells, the Deputy Town Clerk of Brighton, Sir John Monckton, Sir James Woodhouse, M.P., Captain Boscawen, M.P., the Mayor of Hove, Sir H. Bullard, M.P., Mr. G. C. T. Bartley, M.P., Colonel Hamilton Grace, and the Town Clerk of Hastings. During luncheon connection was made to the Glasgow municipal telephone exchange, and congratulations passed between the Lord Provost of Glasgow and the Lord Mayor of London.

After the usual loyal toasts, Mr. Councillor ROBINSON, L.C.C., proposed "The Members of Parliament." He said they were well content with their admirable representatives in Captain Boscawen and Colonel Brookfield. They welcomed the several members of Parliament on that occasion, which, they believed, would have far-reaching consequences, and he believed that the already assured success of the Tunbridge Wells exchange would demonstrate that Parliament had taken a very wise step in allowing a municipal telephone service.

Mr. G. C. T. BARTLEY, M.P. for North Islington, had no hesitation in saying that the House of Commons was fully alive to the importance of developing the powers which science had given them. They had not been alive as they should have been in the past to the advantages of telephones. It had fallen to the lot of a comparatively small town to set the example in municipal work in this direction.

Sir JAS. T. WOODHOUSE, M.P., also responded, and desired in the first place to congratulate Tunbridge Wells on its achievement. As the vice-president of the Municipal Corporations Association, he might convey to them the congratulations of the whole of the municipalities of the country. As one who, with their member, Mr. Boscawen, helped to pass the measure in the House of Commons, he might also congratulate them. The telephone was in its infancy, and it was a national disgrace that, owing to the mismanagement of the Post Office and the Treasury, England was behind other countries in the use of the telephone. He hoped, as the result of the practical example of Tunbridge Wells, that no longer would England be behind in having a complete telephone system. In these days of commercial competition, every facility must be at the disposal of the public, and the telephone was one of the most potent factors in this respect. Like electric tramways and electric light, the telephone was the right of the people. In congratulating Tunbridge Wells he remembered Mr. Nicholson, who gave evidence very ably before a Select Committee, and in congratulating Tunbridge Wells he congratulated Mr. Nicholson, who had done such good service.

Captain BOSCAWEN, M.P., in proposing "Success to the Tunbridge Wells Municipal Telephone System," congratulated Tunbridge Wells on the enterprise it had displayed in having the first municipal telephone. He confessed that when he looked back to their first struggle he did not think it possible then that they would now be starting a municipal telephone in Tunbridge Wells. They would remember the early history of this question, and how they were oppressed by a heavy hand with no prospect of competitive advantages. They would remember how they determined to shake off that heavy hand and to get a better system in their own boundaries. Their enterprising townsmen came to him and suggested that he should undertake the fight against the National Company. He confessed he rather discouraged that fight. He thought they were a small town fighting against a great giant which had been allowed to grow up by the carelessness of the General Post Office. He felt that to undertake such a severe fight was to undertake a grave responsibility. His first idea was to endeavour to obtain a better service from the Telephone Company at lower rates. Those efforts were instructive at the present moment—he meant to the Telephone Company. Their rate in those days was £10 per annum, and he suggested to them that if they would give a £7 service, they would probably stop further trouble in Tunbridge Wells. They utterly refused. They said that a lower rate would mean working at a loss. If less than a £10 rate meant working at a loss, what about the £4 rate they had instituted now? When the Telephone Company adopted an attitude which he could only compare to that of President Kruger, he determined that the battle must be fought in the interests of the public, who must not be treated as Uitlanders. They remembered what happened in the House of Commons. He must confess that in telephony one found rather strange bedfellows. He found himself seconding a motion by a member whom he usually found in an opposite lobby to himself. The House of Commons had passed the enabling Act, and he then stepped out of the picture and said to his friends in Tunbridge Wells, "Here are the powers. You can adopt them or reject them as you please." They had acted on those powers, and they were enjoying the benefit of them to-day. Before sitting down he wished to refer to the services of Mr. Nicholson, with whom he had the privilege of exchanging telephonic congratulations from his house at Speldhurst the previous evening. Mr. Nicholson had rendered splendid service to the advance of telephony. There was one more remark he wished to make. Do not be discouraged by the cutting rate of the National Company. Do not attempt to imitate them, but make the system a commercial success. Rely on the loyalty of their citizens, and then they would knock opposition out of the field. In starting a municipal system they were abreast of the line of progress. It was a mistake to suppose that the future of the telephone must be either in the hands of the National Telephone Company or the General Post Office. He believed that public opinion would never allow the license of the National Company to be renewed universally throughout the kingdom. They had tried a monopoly once, and they were not going to make the same mistake again. When they remembered that 98 per cent. of telephone messages were local messages, he believed that if the General Post Office controlled the trunk lines that the remainder of the telephone system was best under local control. He wished to appeal to the general public of that neighbourhood, and ask them not to be led away by the £4 rental of the National. They should not attempt to save the miserable sum of £1. 17s. 6d. per annum, but support the municipal system in preference to the monopoly. If they attempted to effect a small saving they would be digging the grave of cheap telephony, and they might depend upon it that if the National Company succeeded—and he did not believe they would succeed—in crushing competition, then they would go back to the old rates.

Sir JAMES WOODHOUSE: Like they did at Dundee.

Mr. BOSCAWEN said he was reminded that at Dundee the National Company came down from £10 to £5, and then they bought up the local company; but if they could buy up a company, they could not buy up the Corporation of Tunbridge Wells. That was one reason why he always supported municipal enterprise to local companies. He coupled the names of Mr. Nicholson and Mr. Bennett with the toast. To Mr. Bennett the greatest credit was due for getting the municipal exchange so expeditiously and efficiently in operation, and he had every confidence in its future success.

Mr. A. NICHOLSON, chairman of the Telephone Committee, in reply, said he felt that despite the difficulties that had already beset them, and that might beset them in the future, more especially in the matter of wayleaves, that he had laid a good foundation, which, he believed, was a sure guarantee of future success. There were one or two ways in which, he thought, the further success of telephony would be largely helped forward—first and foremost, the rapid multiplication of trunk lines throughout the whole country. They knew the Postmaster-General was, to a certain extent, pressing this forward, but it was most desirable that extra pressure should be applied. Another desideratum, in his opinion, was "uniform" and "much lower" trunk rates—say, a general charge not exceeding 1s. for three minutes' conversation, irrespective of distance. This would increase the total revenue from trunk calls, while such greater facilities for long-distance "teletalks" would tend very

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much to popularise the general use of the telephone. Another point was the establishment of numerous call offices, not only in towns and villages, but also in the more sparsely-populated districts of each local area. These call offices, by affording a ready means of communication with the town which happened to be the business and social centre of its neighbourhood, would develop trade, and most effectively educate the public to realise the manifold utilities of the telephone in those places where at present it was unknown—and because unknown, unappreciated. Further, in this direction, he would give licensees the power at a fixed nominal fee to fetch non-subscribers to call offices at either end. Another great help would be the prompt provision by the Post Office of subsidiary trunk lines between every adjacent local area. Another detail tending much to ensure success would be the regular publication at stated intervals by the Post Office of a general telephone directory embracing the names, addresses, and numbers of all subscribers to every Government and municipal exchange throughout the kingdom. The beneficial results which they were now so greatly appreciating were largely due to the keen foresight, the patriotic and persistent efforts and high technical skill of the engineer (Mr. Alfred R. Bennett), who had so skilfully planned and so effectively carried out the telephone system. Great credit was also due to the hard-working manager (Mr. C. M. Gardner), his admirable lieutenant (Mr. Joseph Chamberlain), and their staff.

Mr. A. R. BENNETT, the consulting engineer, also replied, and said he was afraid he did not altogether deserve all the very kind things which had been said about him. They were there that day really as the result of a mistake by the Post Office, which had allowed a powerful monopoly to become established. If the Post Office had established a monopoly of its own and taken steps to give this country a telephonic system commensurate with its commercial importance, and something on the lines adopted in America and on the Continent of Europe, little or nothing could have been said against that monopoly. But they vested the monopoly in a private company, and that company had not taken a wide view of their duties. When it was considered that the extremities of the kingdom simultaneously took up arms against the monopoly they could judge what its policy must be. Glasgow, the great city of the North, started a good many years ago to free itself from the National Telephone Company. Almost at the same time the little island of Guernsey took similar steps, and shortly afterwards Tunbridge Wells lent its valuable aid and encouragement. The men of Kent joined hands with the men of Lanark, and both joined hands with the men of the Channel Islands to fight the monopoly. The little island of Guernsey was the first to establish its own exchange, and it had been open about two years and nine months. He could scarcely call the system in Guernsey a municipal system, because home rule prevailed in the island, and the system was really under the local authority. Years ago the National Company stated it would be impossible for them to start a system in the island at a lower tariff than £10. When they found the people would not pay this, they came down to £8, and from this they would not budge. When the island obtained a license of its own, the National Company said they might possibly make both ends meet at £6, but Guernsey once having taken the step would not recede. They were now making a profit on an annual charge of £3. 5s. per line, so they would understand how little was required in a well-managed system to make telephones pay. The consequence of cheap telephones in Guernsey had been very remarkable, and there they had the largest telephone exchange in proportion to the population in the United Kingdom. There was one telephone for every 44 souls, but that did not come up to some of the Swedish statistics. In Stockholm there was one telephone for every eight or nine souls. In Guernsey the exchange was increasing, and the Telephone Committee were in hopes they might in time rival Stockholm. The second exchange to be opened was that of Glasgow, which was unofficially inaugurated in March last. The great opening ceremony was to take place next month. In the Scotch city there were 5,400 names on the books to be joined up, and there were altogether 1,000 of them speaking. The prospects of the Glasgow exchange were most promising. The third system to be opened was that of Tunbridge Wells. Another aspect of the telephone question which had received considerable attention was that of the manufacture of telephonic apparatus. Owing to the fact that there was little demand for this class of goods outside that of the monopoly, and the further fact that the monopoly got most of its goods from abroad, British manufacturers had had no chance of competing. Under the municipal system, this would be speedily remedied, and he was glad to say that Tunbridge Wells was supporting British manufacture. He added that if Tunbridge Wells people stuck to their colours, as he had no doubt they would do, victory over the monopoly would attend them.

The remaining three toasts were: "The Right Hon. the Lord Mayor of London," proposed by the Mayor and responded to by the Right Hon. the Lord Mayor; "Our Distinguished Visitors," proposed by the Deputy-Mayor (Mr. Alderman Stone) and responded to by the Mayors of Hastings and Hove; and "The Mayor of Tunbridge Wells," proposed by Sir Harry Bullard, M.P., and responded to by the Mayor.

THE PACIFIC CABLE.

In the early hours of Wednesday morning the House of Commons in Committee considered a resolution to the effect that it was expedient to make provision for constructing and working the Pacific cable and to authorise the issue out of the Consolidated Fund of such sums not exceeding two millions as might be required for such purposes, and for the repayment of any temporary loans for the same purposes. It was explained by Mr. Austen Chamberlain that this was merely an enabling resolution on which to found a Bill providing for the construction of an all-British cable from Vancouver to Australia. It had been agreed that we should advance the money for this cable, which was only to touch at British possessions. This country was responsible for only five-eighteenths of the capital, and as regards the remainder, the different colonies undertook to bear all the charges. The resolution was eventually agreed to by 158 against 44.

At Wednesday's sitting, on the report of the resolution, Mr. Dillon and others opposed the motion, "That the House do agree with the committee in the said resolution."

Replying on several points raised by the discussion which ensued, Mr. Austen Chamberlain said there was no ground for the suggestion that there were disagreements between the Government and the existing telegraph companies which had not been disclosed. It was the belief of the Government and their hope that the traffic passing over this new line would be in a large measure new traffic created by the increased facilities which were to be given, and that this line would not in any sense be dependent upon traffic which it could gain by unfair competition. The Government had undertaken to raise the money required to make the line. It would not be an economical arrangement that each of the Governments concerned should separately raise a loan to the amount of its share. He could not agree that this country had no interest in a cable of this kind. The fact that our great Colonies were themselves so deeply interested in this matter was sufficient to give this country an interest also. We could not and would not lightly refuse our co-operation in a great Imperial undertaking when it was asked for by these self-governing Colonies. But it was a distinct interest of ours that we should have an alternative line of communication. The present lines passed close to foreign countries, and landed at foreign stations. By this cable we should be able to send messages from this country by cables landing at each side on British territory, and through Canada by lines which would pass over nothing but British soil, and thence to Australia without anywhere touching foreign land or coming under the control of a foreign power. Since we had agreed to make this line existing companies having other routes had seen their way to make reductions which they had not made before, thus facilitating trade between this country and the Colonies. It was for these reasons—because of the strategic import-

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ance of this cable in time of war, of its commercial importance in time of peace, and the deep interest felt in it by the Colonies concerned and his Majesty's Government—that they had entered into an agreement to bear their part in this great Imperial undertaking.

In reply to Mr. Weir, Mr. Austen Chamberlain said that if the cable did not pay the Colonial Governments concerned would make up thirteen-eighteenths of the deficit, and we would make up five-eighteenths.

Further discussion was prevented by Mr. Balfour moving that the question be now put.

This having been agreed to, the report of the resolution was adopted by 180 to 55.

CABLE CONNECTORS AND FUSES.

In all installations of electric light, and particularly in the electric lighting of towns where a large number of cables are required, the question of the end connections becomes a very serious matter. For instance, it frequently happens in central-station work that there is need to disconnect all cables from a certain portion of the switchboard while alterations on the same are being made, or to disconnect the mains from the switchboard because of extensions being connected on to the mains while the rest of the network is kept alive. Of all the various systems we have seen designed for this object there have been none to equal the arrangements now in general use on the Glasgow Corporation mains, and we are accordingly illustrating these devices for the benefit of our readers. We believe that the apparatus in question was designed by Mr. J. C. A. Ward, the Glasgow mains superintendent. In Fig. 1 is given a plan of two double-pole fuses and connectors, while Fig. 2 gives an elevation of the same. Details of the apparatus will be found in Figs. 3 and 4. It will be seen that the standard practice at Glasgow provides double insulation between the ironwork supporting the fuses and the fuses themselves. This is a most essential detail, as it prevents the creeping effects with moisture which are the cause of such frequent trouble in continuous-current work. As to the design of the fuse itself, it will be seen that it is not unlike in general arrangement certain other fuses in the market, but that the handle is so designed as to give great protection to the hand when removing the same. The great feature, however, in the arrangement is the device by which the end of the cable is connected on to the porcelain base of the fuse block. It will be seen from the illustration (Fig. 3) that the end of the cable is connected into the one jaw of the fuse block, and hence there is no loose contact between the same. Also that the shank in this jaw is not passed through a hole in the porcelain block, but is slipped into position through a slot at the end of the porcelain. At the back surface an indiarubber ring is inserted, and then the jaw is locked firmly into position by means of the eccentric locking lever, which is seen in detail in Fig. 4. The indiarubber ensures that there is always tension between the parts of the fuse jaw and the porcelain block, and yet by knocking up the end of this locking lever the cable and fuse jaw can be at once removed from the porcelain for isolation tests, etc. The good points which are to be seen in the apparatus are as follows: There is always a good rubbing contact between the various parts through which current has to be transmitted, as these parts are always in tension. Again, a vibration is not liable to cause any bad contact through the slacking back of nuts, which so frequently occurs in switch work. Another point is the exceedingly few working parts in the apparatus, and the fact that fuses can be disconnected and removed and cables displaced from position without requiring any tools; also the use of the few parts and of the double insulation ensures a very high insulation between the conductors and earth. At the end of the lock-

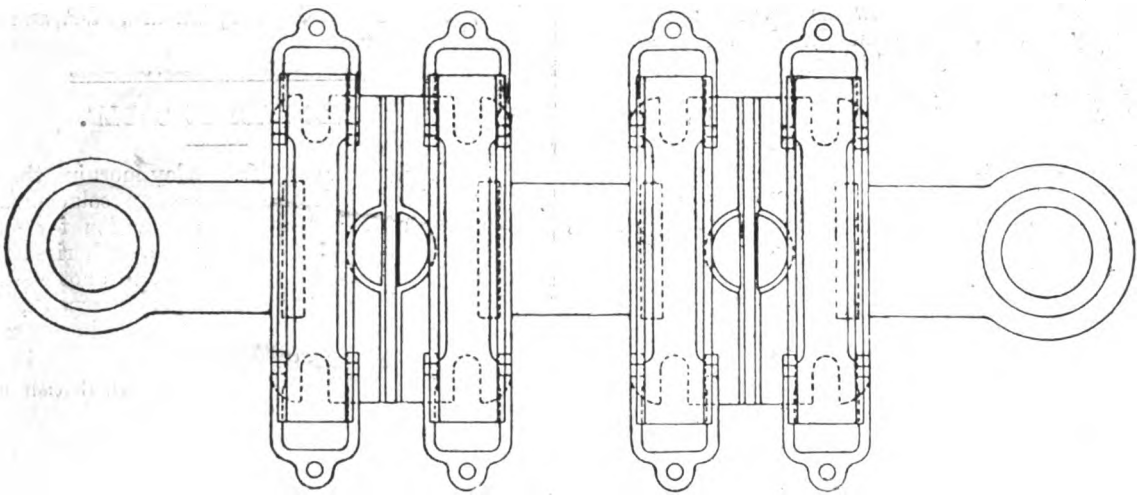

FIG. 1.—Plan of the Glasgow Standard Fuses for Street Mains.

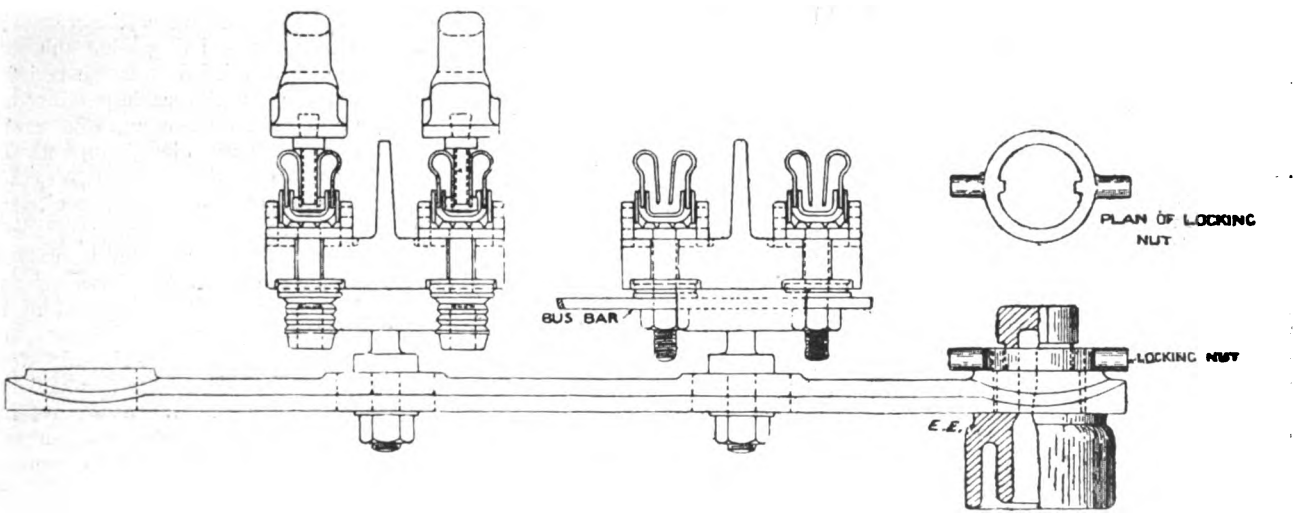

FIG. 2.—Elevation of the same, showing Second Insulator supporting the Main Frame.

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ing lever which secures the fuse jaw in position will be seen a circular hole. The use of this is to test, after a fuse has gone, the transmitting current which would still be taken if the same were replaced. In order to do this, a $^{7}/_{16}$ cable is threaded through one of these holes and twisted round, and with the other end of the cable a momentary contact is made with the locking lever at the other end of the fuse block. From the flash which results an experienced man can tell whether the fuse has been blown on account of a short-circuit on the mains, or simply due to overload. The damage done by this testing of the fuse gear is practically nil, and the danger arising

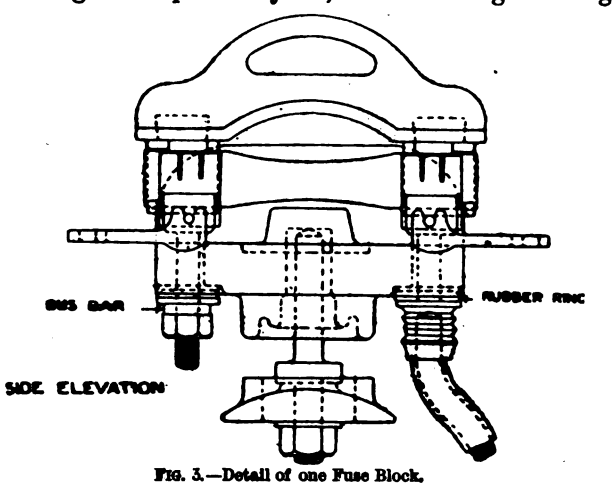

FIG. 3.—Detail of one Fuse Block.

from inserting a fuse while a short circuit is still on is avoided. The whole of the circuits from the main switchboard in the Glasgow Exhibition are fused by means of the apparatus illustrated above, as the boards were orginally designed with absolutely no protection of the kind. The ease with which the cables can be shifted from one part of the board to the other and connected on to these fuse blocks has proved to be of great use, especially in the first few weeks of the exhibition lighting, before matters had got into full working order. We have to thank

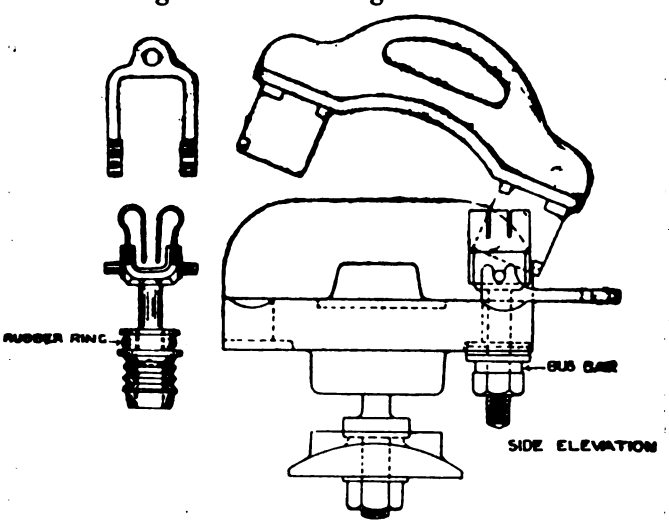

FIG. 4.—Details of the Locking Lever and Fuse Contacts.

Mr. J. C. A. Ward for his kindness in lending us drawings from which the above illustrations were prepared.

THE FORTHCOMING INTERNATIONAL ENGINEERING CONGRESS.

The programme of the International Engineering Congress to be held in September this year at Glasgow has now been finally settled, and from a glance through the same we believe that the meeting will prove to be one of great interest, particularly to electrical engineers. Opening on Tuesday, Sept. 3, the congress will occupy till Friday, Sept. 6. Those to whom invitations have already been issued and members of societies specified by the executive committee are eligible for membership of the congress, and become members on payment of the subscription of 10s. 6d. The Billeting Committee has secured a number of rooms in hotels in Glasgow and neighbourhood, which will be allotted by ballot among members who apply before 10 a.m. on Aug. 10. Each member will receive free on application one season ticket for the Glasgow Exhibition available from Monday, Sept. 2, to Saturday, Sept. 7. The railway companies, too, whose lines are in direct communication with Glasgow, are granting special fares and facilities to congress members. Other general arrangements include the opening of several offices in the Bute Hall of the university during the congress week for the use of members from 9 a.m. to 6 p.m. on each day. On Monday, Sept. 2, at 8 p.m., a banquet will be given to the foreign delegates, honorary members, and London committee in St. Andrew's Halls. The next morning the foreign delegates and honorary members will meet in the Randolph Hall at 9.45 a.m., and proceed to Bute Hall, where they will be received at 10 o'clock by the president (Mr. James Mansergh, F.R.S.), who will deliver a short address. In the Electrical Section this will be followed by the reading of papers at 11 a.m., after which a visit will be paid to the electrical exhibits in the exhibition. On the ensuing two days the members of the Electrical Section will meet at 10 a.m., and until 1 p.m. will be occupied with the reading of papers. These include the following: Short introductory address by the chairman (Mr. W. E. Langdon), entitled "Notes on the Electrical Exhibits in the Exhibition"; "Electricity Supply Meters of the Electrolytic Type," by Mr. J. R. Dick; "The Relative Advantages of the Three, Two, and Single-Phase Systems for Feeding Low-Tension Networks," by Mr. M. B. Field; "Modern Commutating Dynamo Machinery, with Special Reference to the Commutating Limits," by Mr. H. M. Hobart; "The Protection of Trolley Wires," by Prof. A. Jamieson; "Kelvin's Electric Measuring Instruments," by Prof. M. Maclean; "Continuous-Current Dynamo Design," by Mr. H. A. Mavor; "The Use of Electricity in the Propulsion of Road Vehicles," by Mr. A. R. Sennett, and "High-Speed Railways," by Herr Lasche. In the Mechanical Section 15 papers are down to be read—viz.: "Effect of Temperature on Cooling Water in High-Speed Automobiles," by Prof. H. S. Hele-Shaw; "Trials of Steam Turbines for Driving Dynamos," by Hon. C. A. Parsons and Mr. G. Gerald Stoney; "Some Particulars of the Results of the Compound Locomotive on the Buenos Ayres Great Southern Railway," by Mr. P. Gould; "The Cassel Self-Regulating Waterwheel," by Mr. E. C. de Segundo; "100-ton Universal Testing Machine, with Variable Accumulator, at the James Watt Laboratories, Glasgow University," by Mr. J. Hartley Wicksteed; "A Premium System of Remunerating Labour," by Mr. Jas. Rowan; "Application of Metric System to Workshops," by Mr. A. Greenwood; "Power Required to Drive Marine Engine Works, and for Electric Lighting," by Messrs. Jas. Crighton and W. G. Riddell; "Workshop Methods," by Messrs. Wm. Weir and J. R. Richmond; "Economical Manufacture of Marine Engines," by Mr. Wm. Thomson; "Canadian Agricultural Machinery at Glasgow Exhibition," by Mr. G. H. Frost; "Rating and Testing of Electrical Machinery," by Mr. G. Kapp; "Some Experiences and Results derived from Use of Superheated Steam in Engines," by Mr. R. Leuke; "Pneumatic Riveting and Other Useful Applications of Pneumatic Tools," by Mr. J. C. Taite; "A Regenerative Steam Accumulator and its Application to the Utilisation of Exhaust Steam," by Mr. A. Rateau; and "Experiments on the Draining of Water Vapour," by Mr. A. Rateau. A paper on "Improved Rapid Group Flashing Lights," by Mr. A. Brebner, in the Waterways and Maritime Works Section, should also be of interest to electrical engineers; and, further, two papers in the Railways Section—viz., "Modern Practice in Railway Signalling," by Mr. J. A. Timmis; and "The Economy of Electricity as a Motive Power on Railways at present Driven by Steam," by Prof. C. A. Carus-Wilson. In the Iron and Steel Section the papers to be read include the following: "On the Profitable Utilisation of Power from Blast-Furnace Gases," by Mr. B. H. Thwaite; and "On a Mechanical Gas-Producer," by Mr. B. Talbot. In the Gas Section: "Electrolysis of Gas-Pipes, etc.," by Dr. Leybold; and "Lighting of

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the Exhibition by Means other than Electricity," a paper prepared by the committee from particulars supplied by exhibitors. In the Municipal Section: "Recent Tramway Practice," by Mr. Jas. More; and in the Mining Section: "Alternating Currents and their Possible Application to Mining, Part 2," by Mr. S. F. Walker. On the afternoons of the first three days of the congress numerous visits to some of the interesting works and electrical installations in the locality are arranged for. Amongst these we particularly notice the works of Messrs. Babcock and Wilcox, Renfrew; Messrs. Kelvin and James White; the Glasgow Corporation and National telephone exchanges; the Pinkston tramway power station; and the Port Dundas electric lighting station. On the afternoon of Tuesday the opening of the new James Watt engineering laboratories will take place at three, and in the evening the Lord Provost and Corporation of Glasgow will hold a reception in the City Chambers at eight. Other functions in connection with the congress include a ball in St. Andrew's Halls on Thursday evening at 9.30 o'clock. Afternoon excursions to various places of interest in the surrounding country will give members an opportunity of seeing some of the scenery of the Scottish Lowlands. On Wednesday trips are arranged for to Aberfoyle and Loch Ard, and to Lanark and the Falls of Clyde; and on Thursday an excursion to Loch Lomond will be made. On Friday, the concluding day of the congress, whole day excursions will be possible, and visitors will have the choice of the three following—viz.: to Edinburgh and Forth Bridge, round Bute and Arran, or from Broomielaw round Bute, thence to Arrochar and Loch Lomond. We think the Wednesday afternoon trip to Lanark and the Falls of Clyde will be of particular interest to engineers. At the Farme Colliery, which may be visited on this trip, and which is situated about a quarter of a mile from Dalmarnock Bridge (a tramway car terminus), and within 10 minutes' walk of Rutherglen Station, is an "atmospheric" or "Newcomen" engine, which has been at work drawing coal since it was erected in 1809. The cylinder never was bored, and is open at the top. The piston is packed from time to time with hemp, which with a little water at the top keeps it sufficiently tight, and it gets an occasional scrape to keep it in order. It takes about 35 seconds to lift coal from the bottom of the pit to the top; a man works the handle which admits steam to raise the piston and alternately water to condense the steam under the piston, so that the weight of the atmosphere may press down the piston. With the exception of one or two spur wheels which were broken by accident, no part of the engine has been renewed. It is the oldest engine at work in Scotland, and the only "atmospheric" engine at work in Great Britain. It is suggested that some public body should make an effort to secure this old engine as a curio, as none of the old engines of this type have been preserved. The manager of the Farme Colliery will be pleased to show this engine to any interested visitor. The other excursions arranged for are equally interesting, and doubtless many members will avail themselves of the opportunity of visiting some of the places mentioned.

LONDON UNDERGROUND RAILWAYS.

The following is the report of the Joint Select Committee of the House of Lords and the House of Commons on the above subject:

This Joint Select Committee was appointed to consider and report on (1) whether the lines of route for underground railways in and near London, proposed by Bills which have been or may be introduced during the present session, are best calculated to afford facilities for present and probable future traffic, and, if not, what modification of those lines of route are desirable; (2) what special provisions (if any) should be made for the protection of the owners, lessees, and occupiers of properties adjacent to underground railways from possible damage and annoyance; (3) what special terms and conditions (if any) as to construction and working should be imposed upon the promoters; (4) whether any, and which, of the schemes proposed by the said Bills should not be proceeded with during the present session, and have agreed to the following report:

Looking to the general terms of reference, it appeared to the committee that these Bills were not to be considered and dealt with by them as by ordinary Private Bills Committees to whom they might have been referred; that the committee had not, for example to deal with the financial questions that ordinarily arise, nor with any special engineering details, and only partially and indirectly to consider questions of competition. They, therefore, called for no evidence upon these points.

For the purposes of this report the committee adopted the map handed in by Sir Alexander Binnie, on behalf of the London County Council, of the London tube railways, 1901, showing all lines open to traffic, in progress, authorised, and proposed, from which it will be seen that the needs of considerable areas are unprovided for, specially north of the river in the neighbourhood of East and West Ham, and south of the river between Greenwich and Dulwich. This is possibly accounted for by the fact that the subsoil is of such a character as to make the construction of underground railways very costly.

The committee have had before them 10 Bills proposing lines of routes for underground railways in and near London, or extensions of already authorised lines.

The difficulty in dealing with the question of the best routes is greatly increased by the fact that a considerable number of underground railways have already been authorised by Parliament; some of these have not been commenced, while others have been only partially constructed. It is obvious that any conclusions as to the best lines of route, or modification of the schemes now before Parliament, must be materially influenced by this fact.

The committee think it may be useful to state, in the first instance, some general points which they suggest should be borne in mind when dealing with this question of routes: (*a*) Underground railways or underground tramways in London and its immediate suburbs, which can be hereafter extended if required, above or below ground, into the country, but from the termini of which passengers could, for the present, proceed by electric surface tramways, omnibuses, and so forth, appear to be the best mode of dealing with the present traffic, and the probable requirements of an increasing population. (*b*) These underground railways or tramways should run from well-recognised centres of traffic to other like centres of traffic, or from centres of traffic to districts whence large numbers of people have to be carried daily to and from their work in London or the suburbs. (*c*) It is desirable that Parliament should carefully investigate the circumstances under which authorised lines apply for an extension of time. The result of many of the authorised railways having remained in abeyance for a considerable number of years has been in some cases to prevent other companies coming forward to make lines along the same route. The renewal, therefore, of lapsing powers should not be granted without the most careful consideration as to the probability of a company, which has already failed to carry out its obligations to the public, being able by an extension of time to fulfil those obligations within a reasonable period. (*d*) The committee have been informed that the London County Council have had difficulty in getting a *locus standi* to oppose the renewal of powers before Parliament because they have not opposed the original scheme. The committee are of opinion that the county councils and the City Corporation should be granted a *locus standi* in all such cases where they are concerned. (*e*) The underground lines may be worked at the termini on the shuttle system, or by means of terminal loops. Which system should be adopted in each case is a question for the Parliamentary Committee to which the Bill is referred. But while the advantages to the working of the line by loops are obvious, and in outside districts there can be no objection to them, the committee think that very great caution should be exercised by a committee in sanctioning them in the heart of the City on the ground of the large amount of space occupied to the possible exclusion of future railways. They have the less hesitation in making this recommendation as the multiple-motor system, by which much time is saved in shunting at terminal stations, appears likely to be adopted in future. (*f*) Confluent junctions inside tubes should be avoided, nor are they desirable in the open where the service of trains at the converging point is very frequent, since slight detentions on one line impair the service on both. (*g*) We concur in the recommendations of the Joint Parliamentary Committee of 1892 as to the acquisition of wayleaves in the case of private property, and in the case of passing under the streets. (*h*) One of the main objects of underground railways being to relieve traffic in congested places, it is desirable that stations should be so constructed as to avoid, as far as possible, the discharge of passengers into crowded streets. Interchange stations should, where practicable, be placed at all points where underground lines cross one another, and should be connected by subways so as to facilitate the passing from one system to another underground.

Damage and annoyance to the owners, lessees, and occupiers of properties adjacent to underground railways may occur through one or other of the following causes: (1) Subsidence due to construction, especially to the construction of a station; (2) vibration due to the working of the railway. (1) The committee did not think it desirable to receive evidence on the general question of underground railways causing subsidence; they considered that each case of probable or alleged subsidence must be judged by the circumstances of the particular case. (2) The committee found that a Special Committee (known as Lord Rayleigh's Committee) was examining fully into the question of vibration, and it was decided, therefore, not to enter upon this part of the reference. It was, however, thought desirable to have some short statement as to the proceedings of Lord Rayleigh's Committee, and at the second sitting a memorandum was handed in by the late Sir Courtenay Boyle. It concluded with the following statement: "The committee may in the meantime say that from the information already obtained they believed that on new tubular railways, under proper conditions, no objectionable amount of vibration need be apprehended, but they abstain from a definite recommendation until the further experiments above alluded to are completed." To wait for the final report of Lord Rayleigh's Committee would have necessitated considerable delay. As soon, therefore, as the evidence and arguments of counsel were concluded, the committee decided to report upon the other parts of the reference, and to deal with the future report of Lord

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Rayleigh's Committee by the following general recommendation—namely, a clause should be inserted in every Bill binding the company to adopt and give effect to the recommendations, etc., which Lord Rayleigh's Committee may make. As regards a line already authorised such a clause can be properly imposed, if and when application is made to Parliament for an extension of time or of works.

The committee find a want of uniformity in the clauses imposing upon companies an obligation to run trains in the early hours of the morning for the accommodation of workmen at specified fares; but every Act should contain clauses imposing these obligations, and the clauses in the Central London Railway Act, 1900, with some modifications suggested by the representatives of the Corporation of London and London County Council, appear well adapted to secure the desired object.

The committee have taken a considerable amount of evidence as to through fares for the various systems of railway proposed, and as to uniformity of fares. While there would be obvious advantages to the travelling public in both these proposals—and they would commend them to the consideration of the various companies—they cannot make any practical suggestion for their adoption so long as the interests involved are in various hands, but they recommend that the Board of Trade should make a report to Parliament every five or ten years on the working of these railways, of their relations to one another, and on the reasonableness of the fares charged thereon. They consider that such a report, while giving no absolute power regulating the conduct of the railways, would have a very strong moral effect in inducing the companies to take a reasonable view of their duties to the public.

The committee proceed to report upon the several schemes for underground railways proposed by Bills introduced during the present session from the route point of view, leaving, as above stated, ordinary financial questions and other details to Parliamentary Committees. The Bills that have been referred are as follows: Central London; Charing Cross, Euston, and Hampstead (No. 1 and No. 2); Islington and Euston; King's-road; West and South London Junction; City and North-East Suburban; North-East London; Brompton and Piccadilly-circus; Charing Cross, Hammersmith, and District; Piccadilly and City.

The Central London Railway apply for power to make loops at each end of their line, so as to enable them to increase the number of trains, and thus facilitate traffic. It appears to the committee that there can be no objection to the proposed loop at the western end of the line. There is more difficulty with regard to the proposed loop at the east end of the line. This Bill may be referred to a Parliamentary Committee in the ordinary course, subject to the remarks contained in Paragraph 6, Sub-Section (*e*).

Charing Cross, Euston, and Hampstead, No. 1 and No. 2.—These Bills may be referred to a Parliamentary Committee in the ordinary course. The committee think there should be no confluent junction on the authorised line. One of the branches should join end-on and the other should be connected by an interchange station. There should be no difficulty in securing this, as the works of the authorised line have not been commenced.

Islington and Euston.—This Bill may be referred to a Parliamentary Committee in the ordinary course.

King's-road.—This Bill may also be referred in the ordinary course if interchange stations are provided at Victoria. An extension to Putney Bridge would be desirable.

West and South London Junction.—This Bill may also be referred in the ordinary course. The question has been raised whether there should not be an end-on junction with the North-West London, which might involve the abandonment of the line between the Marble Arch and Paddington Station. On the whole the committee think that the proposed scheme is the best, as securing the direct through route between Paddington and Victoria Stations.

It will be convenient to consider the City and North-East Suburban and the North-East London together: (*a*) an extension further north of the North-East London would be very desirable, especially in view of the area of land taken by the County Council for building purposes. The committee are of opinion that the Chingford branch is not wanted if the City and North-East Suburban is sanctioned. (*b*) The committee consider that that portion of the City and North-East Suburban route from the centre of the City along Bishopsgate, and thence turning to the east to Victoria Park, is not desirable, and they suggest that (unless engineering difficulties prevent it) a better route would be eastward from the centre of the City along Leadenhall-street or other streets in like direction, and thence in a north-easterly direction to Victoria Park. This would prevent the overcrowding of Bishopsgate with tubes, and would also bring communication to an overcrowded district of Whitechapel, which otherwise would remain without these facilities of rapid transit. (*c*) Subject to the above remarks, it appears to the committee that both these schemes may be referred in the ordinary course, as they both afford great facilities to crowded districts, and to districts where building is increasing and likely to increase.

Brompton and Piccadilly-circus, Charing Cross, Hammersmith and District, and Piccadilly and City. The committee are of opinion that there ought to be one through line from Hammersmith along Piccadilly to Piccadilly-circus and the City. They consider it most desirable that there should be an end-on junction between the Hammersmith line and the City and Piccadilly at or near Piccadilly-circus. Failing that, the alternative junction at Charing Cross should be adopted so as to secure a through route.

The committee, under the circumstances, do not approve the proposed extension of the Brompton and Piccadilly-circus line to Bloomsbury-square, but if the through line from Hammersmith to the City can be secured, an extension to The Angel, Islington, from Piccadilly-circus, with an interchange station at the latter place, would be a useful route, and should receive favourable consideration.

In the course of their deliberations the committee have had brought under their notice several matters which do not appear to lie distinctly within the terms of their reference. Of these the most important was the proposal that all these underground railways should be subject within certain limits to the control of a central authority. On this the committee desire to make the following observations: The question of underground railways in London and the suburbs and of their working is so complicated and of such importance, from a financial as well as traffic point of view, that the committee are disposed to agree with the views of the Corporation of London and the London County Council that in some way there should be a more direct control and supervision of all projects for such underground railways. Whether this should be effected by the supervision of some public department, as the Board of Trade, or by some body like the Light Railways Commission, or by a joint committee of members of both Houses of Parliament, appointed at the beginning of each session, to consider all projects affecting the relief and distribution of traffic in or near London, is a question which appears to them to deserve serious consideration.

The railways should be constructed on sound economical principles and without undue inflation of capital. It is obvious that if dividends are to be paid on inflated capital, fares to produce such dividends must be on a scale higher than would be required to pay a fair remunerative interest on the money expended on the works. The Light Railways Act gives power to the local authority to construct or to assist in the construction of light railways, and the committee are of opinion that some such power given to the City Corporation and the county councils concerned in respect to London underground railways would be of the greatest advantage. They therefore recommend that the Board of Trade should insert in each Bill a model clause based upon that in the Light Railways Act, with such modifications as may be necessary, giving powers to the City Corporation and the county councils in the counties in which the railways would be constructed, either to construct or aid in the construction of the lines.

Such powers would enable the councils to encourage, by subsidy or otherwise, the prolongation of railways into districts thinly populated, and therefore suitable for the relief of congested districts, whereas, in many cases at any rate, a public company would not feel justified in extending their line till the population became greater.

It has indirectly been brought to the notice of the committee that another system of underground locomotion—namely, that of subways or shallow tunnels immediately under the surface of the roadways—has been successfully developed and is in process of further extension, both on the Continent and in America. The committee have heard no evidence with regard to this system, but in view of the large amount of capital involved in the schemes now before Parliament, and the importance of utilising it to the best public advantage, the committee recommend that an early enquiry should be held by the Board of Trade upon this system.

In consequence of the above report, it has been decided to give leave to the promoters of these Bills to proceed with them, if they think fit, in the next session of Parliament without incurring all the expenses of giving the usual parliamentary notices. The promoters who intend to avail themselves of this leave will be required to give notice of their intention to do so within three days of the close of the present session. The opponents who have already deposited petitions against these Bills are to be allowed next session to appear in support of the petitions presented this session without any further notice or leave being required. The Bills affected by this decision are the two promoted by the Charing Cross, Euston, and Hampstead Railway Company, and the following other nine Bills: Brompton and Piccadilly-circus Railway, Central London Railway, Charing Cross, Hampstead, and District Railway, City and North-East Suburban Railway, King's-road Railway, Islington and Euston Railway, North-East London Railway, Piccadilly and City Railway, West and South London Junction Railway.

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THE TUNBRIDGE WELLS TELEPHONES.

The gist of the report in 1899 of the Government committee on telephones was to the effect that competition, and active competition, was greatly to be desired in telephone matters. This decision, while it stultified the previous policy of the Post Office with respect to telephones, was not accompanied by any clear statement of the ultimate policy of the Government concerning the National Telephone Company. It was decided, however, that local authorities should be allowed to compete with the National Telephone Company under licenses. The first of these licenses was granted to the Tunbridge Wells Corporation, and the system of telephones in that district was successfully inaugurated by the Lord Mayor of London on Saturday last. It provides in every way the active competition recommended. Leaving on one side for the present the policy of the Government and the ultimate end of the fight between two telephone undertakers in the one area, we wish to look at the telephone system at Tunbridge Wells on its own merits. In the first place, under the advice of their consulting engineer, Mr. A. R. Bennett, the Corporation were not content to supply a telephone service within the municipal boundary or even within a comparatively wide area surrounding this boundary. Instead of this, they decided to ask Parliament for powers to give telephone connections in no less than one hundred and eighty square miles of country. The towns and villages within this area are, with one exception, too small to undertake telephone work themselves, and in a large number of instances they have not up to the present received any telephone facilities whatever. In consequence of this action of the Corporation of Tunbridge Wells, which has not been stultified by any defects in performance, their telephone system becomes of great benefit to the area in question. Trunk wires have already been erected to a large number of the villages in question, although the work was only commenced in March last. The need for such interconnections is manifested by the number of subscribers who have already become connected to the local exchanges in these villages. When the Lord Mayor of London opened the system on Saturday last he was accordingly connected, not to any subscriber in Tunbridge Wells itself, but to three different subscribers in outlying parts of the telephone area, whom he was able to congratulate on the new facilities they could now enjoy. Reverting, before closing, to the probability of the financial side of the undertaking proving a success, it is well to note that already the municipal exchange has connected to it more than double the number of subscribers connected to the local exchange of the National Telephone Company. In telephony the number of subscribers already on goes far to determine to which of two rival exchanges new subscribers shall be connected. Against this in Tunbridge Wells is the lower charge now made by the National Telephone Company. This lower charge, however, is so obviously a temporary matter only that it can hardly weigh with any sensible ratepayer. At the banquet which followed the opening, references were made by members of Parliament who have been largely interested in telephone matters as to the probable policy of the Government with respect to telephone licenses when the present powers both of the company and the local authorities expire—some 25 years hence. These prophecies may be taken for what they are worth; but we can see from the experience at Tunbridge Wells that any municipal authority which sets up a telephone system on broad lines will receive the support which they deserve from the public. This

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support, liberally given, as at Tunbridge Wells, can only result in a financial success.

MANCHESTER ELECTRICITY DEPARTMENT.

We gather from the Manchester daily and evening papers that the words "private and confidential" have no terrors for their editors. All these papers have recently been giving, more or less *in extenso*, the annual report of the Manchester Corporation electricity department. They have evidently also received another report by Mr. G. F. Metzger as to the condition of the undertaking when he took office. For instance, the *Manchester Evening Chronicle* for the 25th ult. says: "There has also been issued to-day a very long report by Mr. G. F. Metzger, the electrical engineer, on the condition of the department when he was appointed in March last. Mr. Metzger commences by complaining that he received little help from Mr. Wordingham, and says he obtained most of his information before he actually took charge from subordinates. He speaks of each department separately, and in nearly every instance criticises severely, chiefly on matters of organisation. His statements are too lengthy for quotation in detail, but the general tenor of them may be gathered from the following paragraph: 'It has unfortunately been necessary for me to point out in many cases a very undesirable state of affairs. The discipline throughout was conspicuous by its absence, and your entire support (referring to the Electricity Committee) must be given me if this all-important item in such a vast undertaking is to be maintained. The men appeared rather to follow their own inclinations than to obey orders, and to ensure a more efficient method of timekeeping I suggest adopting the time-check system. The present method, with brass checks hung on a hook, is too antiquated, and lends itself to inaccurate results. My best attention will be given to all matters relating to a general reduction of working costs. Oil has been used regardless of economical running, and the same must be said of many other items of expense.'"

The *Manchester Evening News* of the same date adds from the same report. Mr. Metzger's concludes that "Much trouble has been experienced due to cables breaking down, and I have made some suggestions to you for relaying the old rubber cables in certain portions of the town, and which you adopted, although the cables had not actually broken down. I carefully examined the old cables which had been drawn from the pipes, and I discovered that it was only a matter of a few months and changeable weather, and these would have gone in exactly the same way as the rest—viz., short-circuited or earthed—and I therefore have no hesitation in saying that it is the wisest policy to draw all these old rubber cables from the pipes as soon as possible, and replace same by vulcanised bitumen cables laid solid."

In view of the above we think it only right to reproduce Mr. Wordingham's reply, which appeared in the *Manchester Daily Dispatch* the next day:

"Sir,—My attention has been called to an account of an extract from a report made by Mr. G. F. Metzger to the Electricity Committee of the Manchester Corporation, which, although marked 'private and confidential,' has appeared in the newspapers with, I understand, the sanction of the chairman of the committee. I should have treated this document with contempt were it not that I am advised that my silence might be construed as an admission that the statements made are correct, and I therefore break through my usual rule of not courting publicity.

"Mr. Metzger's statement that I refused to give him information, or put obstacles in the way of his obtaining it, is absolutely untrue. He admits that I was away from Manchester for a part of the fortnight he was there, and that I was extremely busy, as indeed I was, the committee pressing me for reports, specifications, and drawings up to the very last moment. I did not on any occasion raise any obstacle to seeing him, and when I saw him I answered fully all his questions, adding such information as I thought would be useful to him, besides putting him in the way of getting detailed accounts of the working of each department from the responsible official at its head. Our relations were apparently most cordial throughout, and on my side the cordiality was genuine. I did everything in my power to facilitate his taking over the work; I volunteered reports to the committee, in which I set forth in detail the plans that I had had in my mind for the future, so that my successor might know fully the purpose of works in progress, and I left copies of these reports for his use, together with a complete set of all the reports and specifications I had written during the seven years I was with the Corporation, most of them being bound up in a convenient form and the remainder ready for binding. In order to test my attitude when leaving the Corporation, appeal should be made to Dr. Kennedy as to whether, at any time, he or his assistants had any difficulty in obtaining the fullest information from me on all points.

"I think I have demonstrated that there was no 'lack of professional etiquette' on my part, though most persons who read the report that Mr. Metzger thought fit to write behind my back will form their own opinion of his ideas on the subject.

"The report itself is full of mis-statements and misrepresentations, but I cannot trespass on your space to refer to them in detail. I will only mention a few salient ones.

"I deny emphatically that the discipline was faulty in any respect whatever. The attack made in the report on foremen and other officials—indeed, on practically the whole staff—constitutes a very grave injustice to a number of highly competent men who, many of them for a long course of years, have done their duty splendidly, often under conditions of the greatest stress.

"As to the deficiency in the number of assistants in the engine-room, these appointments were solely in the hands of the committee, and they allowed such an important vacancy as that of chief assistant to remain unfilled for as long as six months in spite of my protests.

"Again, the system of timekeeping employed is that which I found in use when I came to Manchester, and it had been approved by the committee. It is the same as is employed in most of the engineering works in Lancashire and elsewhere.

"The portion of the report dealing with the replacement of rubber cables by those insulated with the vulcanised bitumen has been referred to as containing 'valuable suggestions' by Mr. Metzger. The absurdity of this remark will be apparent when I state that this substitution was determined on by my advice, and that the process has been going on for a very long time past, only the fag end of the work remaining to be done, and this having been deferred by me until the season of the year when there would be least inconvenience to ratepayers along the routes affected.

"In another part of the report cables carrying a pressure of only 400 volts are referred to as a 'death-trap.' To apply such an epithet is to wilfully mislead non-technical persons.

"I refrain from referring to more items from considerations of space, though I could refute every adverse statement, but would just mention a point in the annual report of the committee which has evidently been misunderstood by some of the newspapers—viz., the so-called 'leakage.' The difference between the units generated and the units sold is given as 1,695,433, and it is assumed that this is leakage; it is nothing of the kind. It includes not only the leakage, but also the unavoidable loss of energy in passing through the mains, which is analogous to friction, and which may be compared to the power consumed in driving the shafting in a large mill. The leakage proper was only some 25,000 or 30,000 units, or about one-third of 1 per cent. of the units sold, which in a system compelled by the Board of Trade to run with an earth connection is abnormally small. The cost price of these units would be under £125, instead of £21,250, which is the figure given in one newspaper.

"In conclusion, I would point out that if the undertaking has been mismanaged and the staff has been so incompetent, it is remarkable that the public should have shown so unmistakably their satisfaction with the results by the unprecedented growth of their demand for electrical energy, and that profits should have been earned during

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every year of my management, amounting in all in the seven years to £77,440 after paying all interest and sinking fund charges. Mr. Metzger generously says this is due to 'sheer luck.' I can only express the hope that the same 'luck' will attend him during the next seven years. The prospects of its doing so should be greater than in my case, seeing that the whole of his duties comprise but a small portion of what mine were, and he is provided with a staff many times greater and more costly than I was, and a staff that, according to his own account, is much more competent; while it is guided by one who, after being in charge of the undertaking for but nine days, is able to write such a report, and to confidently condemn nearly every part of the concern and practically the whole of a staff of some 400 or 500 men.—Yours, etc.,

"C. H. WORDINGHAM.

"19, Brazennose-street, Manchester,
"July 29, 1901."

We think it is a matter for deep regret that this "private and confidential" report should ever have been allowed to reach the Press, as it can do no possible good outside the department, and, as will be seen from the above, is calculated to do a great deal of harm.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

399. Describe a simple method of getting high-frequency alternating currents from a direct-current arc lamp. How can the frequency be altered?—J. C. R.

400. Discuss the relative advantages and disadvantages of direct and polyphase currents as applied to mining.—F. M. M.

ANSWERS.

Question No. 393.—What arrangement with three assistants working eight-hour shifts, plus a day-shift assistant, is best adapted to give each the least possible Sunday labour?

Answer to No. 393 (*awarded* 7*s.* 6*d.*).—This question is most interesting, and worthy of close attention, for though the seven-day week is absolutely necessary in central stations of any size, everything possible should be done to secure that the amount of Sunday labour is a minimum. Many small stations are able to entirely dispense with an assistant during the light hours of Sunday, and in these cases the work does not fall heavy on them on that day; but in stations where the output would warrant four assistant engineers, it would probably be advisable or necessary to have a responsible assistant on duty the whole of the 24 hours for seven days per week.

The usual "shift hours" in such stations are—first shift, 12 midnight to 8 a.m.; second shift, 8 a.m. to 4 p.m.; third shift, 4 p.m. to 12 midnight. These "shifts" are generally worked for one week, then each assistant changes over to another "shift" systematically, the "change-over day" usually being Sunday. There are two reasons for Sunday being taken as "change-over day." The first is, being a light day, the duties on the new shift are not very heavy, and the second is that by two of the assistants working 12-hour shifts, each assistant is able to be off duty a clear week-end every third week.

In the particular case under consideration, where there is an extra day-shift assistant, assuming that assistant always remains on day duty, as the question seems to indicate, the following arrangement would be the best to give each the least possible Sunday duty, A, B, C representing ordinary-shift assistants and D day-shift assistants:

Assistants.	Saturday.	Sunday.	Monday.
A ...	12 to 8 a.m.	... 6 a.m. to 12 noon	... 4 p.m. to 12 mid.
B ...	8 a.m. to 4 p.m.	... 12 mid. to 6 a.m.	... 12 mid. to 8 a.m.
C ...	4 p.m. to 12 mid.	... 6 p.m. to 12 mid.	... 8 a.m. to 4 p.m.
D ...	Day shift.	... 12 noon to 6 p.m.	... Day shift.

In the above table the column Saturday times will have been worked all that week from the previous Monday, and the Monday column includes the times up to the following Saturday (inclusive) that week. It will be seen from this arrangement that each assistant only works six hours on Sundays, and that the hours as shown in the table for Sunday will be the most convenient to give suitable breaks between the hours of duty on Saturday and Monday.

An alternative arrangement is shown below, which would most probably be preferred to the first one, as it would enable each assistant to have a clear week-end off duty every fourth week, the remaining assistants only working eight-hour shifts.

TABLE II.

Assistants.	Monday to Saturday.	Sunday.	Monday to Saturday.
A ...	12 mid. to 8 a.m.	... Off duty.	... 4 p.m. to 12 mid.
B ...	8 a.m. to 4 p.m.	... 12 mid to 8 a.m.	... 12 mid. to 8 a.m.
C ...	4 p.m. to 12 mid.	... 8 a.m. to 4 p.m.	... 8 a.m. to 4 p.m.
D ...	Day shift.	... 4 p.m. to 12 mid.	... Day shift.

The above table is a typical week-end, and if worked out for a number of weeks will be found to run continuously. It will be seen that the assistant coming off night duty on Saturday morning at 8 a.m. is free from duty till 4 p.m. on Monday, thus getting a fair length of time away from the works without inconveniencing the other assistants. It will be found on studying the above table that the "week-end off" will average out every four weeks, but owing to the day assistant always remaining on day duty, two will be taken in three-week periods and one in a six-week period.

A table covering a number of weeks might have been shown, but this would have taken too much space, and it can easily be worked out from the above.

Without doubt the position of "shift assistant" is a very trying one, and where a fourth assistant can be worked in to relieve a man on Sunday it ought to be done.—E. T. W.

Answer to No. 393 (*awarded* 7*s.* 6*d.*).—Assuming that the day-shift assistant changes round in turn with the others, the best way of working the Sundays would be as given in the tables below:

First Week.

Assis.	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.
	am.	am.	am.	am.	am.	am.	am.	am.
A		8— 4	8— 4	8— 4	8— 4	8— 4	8— 4	Off duty.
	pm.	pm.	pm.	pm.	pm.	pm.	pm.	pm.
B		4—12	4—12	4—12	4—12	4—12	4—12	Off duty.
	md.	am.	am.	am.	am.	am.	am.	md.
C	12—8	12—8	12—8	12—8	12—8	12—8	12—12	noon.
	am.	pm.	pm.	pm.	pm.	pm.	pm.	noon
D		9— 6	9— 6	9— 6	9— 6	9— 6	12—12	mid.

Second Week.

	am.	am.	am.	am.	am.	am.	am.	
D		8— 4	8— 4	8— 4	8— 4	8— 4	8— 4	Off duty
	pm.	pm.	pm.	pm.	pm.	pm.	pm.	
A		4—12	4—12	4—12	4—12	4—12	4—12	Off duty.
	md.	am.	am.	am.	am.	am.	am.	md.
B	12—8	12—8	12—8	12—8	12—8	12—8	12—12	noon.
	am.	pm.	pm.	pm.	pm.	pm.	noon	md.
C		9— 6	9— 6	9— 6	9— 6	9— 6	12—12	

Third Week.

	am.	am.	am.	am.	am.	am.	am.	
C		8— 4	8— 4	8— 4	8— 4	8— 4	8— 4	
	am.	pm.	pm.	pm.	pm.	pm.	pm.	
D		4—12	4—12	4—12	4—12	4—12	4—12	
	md.	am.	am.	am.	am.	am.	am.	md.
A	12—8	12—8	12—8	12—8	12—8	12—8	12—12	noon.
	am.	pm.	pm.	pm.	pm.	pm.	pm.	noon md.
B		9— 6	9— 6	9— 6	9— 6	9— 6	9— 6	12—12

Fourth Week.

	am.	am.	am.	am.	am.	am.	am.	
B		8— 4	8— 4	8— 4	8— 4	8— 4	8— 4	
	pm.	pm.	pm.	pm.	pm.	pm.	pm.	
C		4—12	4—12	4—12	4—12	4—12	4—12	
	md.	am.	am.	am.	am.	am.	am.	md.
D	12—8	12—8	12—8	12—8	12—8	12—8	12—12	noon.
	am.	pm.	pm.	pm.	pm.	pm.	pm.	noon md.
A		9— 6	9— 6	9— 6	9— 6	9— 6	9— 6	12—12

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In the tables the assistants are A, B, C, and D. The first week A is on the 8 a.m. to 4 p.m. shift from Monday till Saturday. The second week A comes on duty at 4 p.m. Monday, thus getting two days off duty. He works through till Saturday midnight, and commences his third week on the Sunday following at 12 midnight. He thus gets another clear Sunday off duty. He finishes his third week on Sunday at noon. His fourth week will be as the day-shift assistant, the hours being, I presume, 9 a.m. to 6 p.m. It will be seen from the tables that the other assistants work round in the same way.—F. B. A.

Answer to No. 393 (*awarded* 5*s.*).—If the day-shift assistant is, say, the chief assistant, and only does the day shift, and not going round watch after watch, then the following table if worked by will give each assistant 48 hours off every three weeks:

	Watches.		
	Morning.	Evening.	Night.
	a.m. p.m.	p.m. p.m.	p.m. a.m.
Monday	9 to 3.30	..... 3.30 to 11.30	..... 11.30 to 9
Tuesday	,,	..... ,,	..... ,,
Wednesday ...	,,	..... ,,	..... ,,
Thursday.....	,,	..... ,,	..... ,,
Friday	,,	..... ,,	..... ,,
	a.m. p.m.	p.m. a.m.	p.m. p.m.
Saturday	9 to 3.30	..... 11.30 to 10	..... 3.30 to 11.30
		p.m. a.m.	a.m. p.m.
Sunday	off	..... 10 to 9	..... 10 to 10

If the day-shift assistant worked the watches round with the other men, then each assistant would act as an extra in his turn and do what is called a boiler watch over the period of top load. The following table gives each man two Sundays off out of every four:

	Watches.			
	Morning.	Evening.	Boiler.	Night.
	a.m. p.m.	p.m. p.m.	p.m. p.m.	p.m. a.m.
Monday	9 to 3.30	3.30 to 11.30	2 to 10	11.30 to 9.
Tuesday	,,	,,	,,	,
Wednesday..	,,	,,	,,	,,
Thursday ...	,,	,,	,,	,,
Friday.....	,,	,,	,,	11.30 to 9
			p.m. a.m.	a.m. p.m.
Saturday.....	9 to 3.30	3.30 to 11.30	11.30 to 10	
Sunday	off	off	10 to 9	10 to 10

The above has been found to work very well. It might be thought that, if in changing over, the night man took the Saturday evening watch and came on again at 10 a.m. on Sunday, this would be an improvement, but it was found to give the night man a severe twisting. If two men were required on the Saturday evening watch, the assistant coming off night shift would come in at 2 p.m. on Saturday.—J. H. S.

Answer to No. 393 (*awarded* 5*s.*).—I was pleased to see this question appearing in your paper, and hope it will be well ventilated. After working 16 hours every second Sunday in a certain station, I made proposals to relieve this pressure of Sunday work, and these proposals were scouted by my superiors, and the matter was allowed to stand as it had done. Many resident engineers seem to think Sunday a day of light duty, and, therefore, a favourable day for changing shifts and getting any double duty that has to be done done on that day, and thereby keeping the engineers fresher for their other heavier shifts during the week. My own experiences in this matter are quite enough to justify the statement that in many stations enough attention is not paid to a proper arrangement of shifts with a minimum of Sunday work. It would, therefore, be pleasant to know the arrangement of shifts which obtain in stations with a minimum of Sunday work.

In the case stated let us denote the three assistants by the letters A, B, C, and these, I take it, are capable of taking any shift whatever. Let us call the day assistant D. It would have helped us to a proper answer in this case if D's capabilities had been stated, but we will take it that he is always on the second shift. There will also be a station superintendent, and most likely some students. The shifts, we will say, are eight hours each, and the hours as follows: first shift, 12 midnight to 8 a.m.; second shift, 8 a.m. to 4 p.m.; third shift, 4 p.m. to 12 midnight.

The second shift on Sunday will in all likelihood be the lightest shift of the week, and in most cases this will be easily looked after by D, and the station superintendent, and the students, if there are any. These gentlemen will be able to relieve each other at intervals and give each other as little Sunday duty as possible. Taking the second shift (Sunday) to be worked in this manner, we have still to arrange A, B, and C's shifts in the best manner possible. Say the shifts at the time of consideration are as follows: A, third shift; B, second shift; C, first shift; D, second shift always.

The best change would be, I think, as follows: A, third shift (Sunday) to second shift (Monday); B, second shift (Saturday) to first shift (Tuesday); C, first shift (Monday) to third shift (Monday). This means that C does double duty on Monday, and this is quite feasible. The change at each week-end would be similar, only with different engineers, and three weeks would complete the routine. Out of the three Sundays of these three weeks the engineers would have 16 hours off on two of them, and on the third the whole Sunday off—indeed, from 4 p.m. on Saturday till midnight Monday. Thus they would be able to get train home (if they were lucky enough to have that means at hand) or anywhere, spend the Sunday away and come back on Monday afternoon. It will be seen, of course, that there are advantages in having this extra time on Saturdays and Mondays.

If D were capable of taking the first shift, say, more favourable arrangements still might be worked out.—S. L.

Question No. 394. Describe fully some method of testing the qualities of two samples of carbons sent for use with an open arc lamp.

Answer to No. 394 (*awarded* 7*s.* 6*d.*).—For the testing of carbons it is best to have a small motor driven from an accumulator battery to run a dynamo, as by this means a steady speed can be obtained and the motor can be regulated to any speed. In the circuit there should be a recording volt- and ampere meter, and from the diagrams it can be seen what the quality of the carbons are, and if they contain many peaks it shows unsteady burning and that the quality is not good. Under the lamps there should be placed tin pans to catch the dust, and also a slip of blue or red glass should be handy, through which to study the light.

A photometer is also required; one of the Bunsen kind is best, the main object being to get the relative values of each carbon. For this purpose an incandescent lamp of about 50 c.p. or 100 c.p. can be taken as a standard, while the light of the arc is toned down by ground glass. It is also necessary to know what length of arc each carbon produces, and by using a simple photographic lens, and interposing it between the arc and the screen, a full inverted picture is obtained. As the picture of the arc is magnified, it is only necessary to measure the distance from the lens to the arc and to the screen to get the real length of arc, as the length of the arc is to that of the picture as the distance between the arc and the lens is to the distance between the screen and the lens. This method also shows the steadiness of the light and if the core works well.

The dust caught in each pan should be weighed, and it is also well to measure the volume of dust, as some dust has a larger volume for the same weight than others. For measuring the resistance of the carbons, a set of low volt- and ampere meters of the Weston pattern is required, as the best way to measure the resistance is by using a few amperes and noting the voltage between the two ends.

The following observations should also be very carefully noted in testing carbons: (1) measure the diameter and length of each carbon, the diameter to be very carefully taken, as 0·5mm. has some perceptible influence on the life of the carbon; (2) measure and compare the relative intensity of light given by the carbons, taking care that the arc and its angle to the screen of the photometer are the same in both tests; (3) measure and compare the rate of consumption per hour having a 10-hour test, conditions, of course, being the same; (4) measure and compare the dust caught from each carbon; (5) measure the resistance of each carbon, the lower the resistance the better the carbon; (6) measure the length of each arc; (7) notice the colour of light given by each arc. A practical way is simply holding a piece of white cardboard in front of the arc, and if there is any blue or yellow light it will show on the cardboard.—R E. P.

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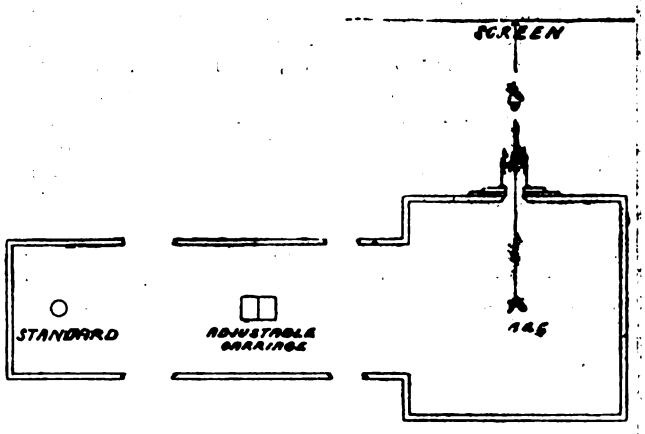
Answer to No. 394 (*awarded* 7*s.* 6*d.*).—Examine each carbon of the two brands as to its being of the diameter represented, and note if that diameter is continued throughout its whole length. Compare also their relative straightness. In practice, carbons which are bent or are of the wrong diameter cause considerable annoyance. Regard should also be had as to any cracks or flaws that may be in the carbons. Carbons should be hard, and when struck give out a sharp ringing sound. The carbons should be compared as to their resistance, their behaviour whilst burning, the amount consumed per hour for a given illumination, and the residuum in the shape of ash or other deposit. The ohmic resistance of the carbons may be measured by "bridge" in the ordinary manner.



An arrangement similar to sketch will be found convenient for some of the tests to be taken. The lamp in which are carbons under test, is suspended by screw link (adjustable for height and position) in covered box; the lens projects an inverted image of the arc on screen. A suitable lens will be one of 12in. focus; if this lens is 10in. from arc and 5ft. from screen, we shall have an image of the arc six times its natural size. Another lens of a different focus may be employed, distances being found from the formula:

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{F}$$

where u = distance of lens from object;
v = distance of lens from image;
F = solar focus;

and $$\frac{\text{size of image}}{\text{size of object}} = \frac{v}{u}.$$

The lens should be in a sliding tube for focussing outer tube, being fastened to wooden slider having horizontal and vertical motions, such as may be seen on most ordinary cameras. The photometer, consisting of two blocks of paraffin wax, is perhaps as good as any; we also want a standard light. An ampere-meter should be placed in series with and a voltmeter placed across the terminals of the lamp.

We are now in a position to obtain some knowledge as to how the arc is "burning," evidence of any abnormal forms that may be taken by the carbons, evolution of gases, tendency to "mushroom" formation, and of impurities that may be in the carbons. Some carbons hiss badly; others flare with lengthening arc. This flaring veils the crater, from which comes the great part of the arc's illuminating power. Sometimes parts split off and fall away from the carbon. Another fault, although not now often met with, is that the carbon becomes incandescent some distance from the arc, wears thinner, and often breaks off. This will cause the lamps to go out, and even when the carbons come together again they may overlap, and thus prevent an arc being struck. Of course, care must be taken that none of these faults may be in a measure caused by the lamp itself. There will be very little difficulty in measuring carbons and noting time burned, and from these data obtaining amount of carbon consumed per hour. Note, also, if the carbons, positive and negative, burn well in pairs—*i.e.*, burn so as to keep the arc concentric, and are consumed approximately together.

Although the absolute measurement of the illuminating power of the arc is an extremely difficult operation, we shall be able to obtain a relative test by means of the photometric arrangement, as shown in sketch. Some little care will be required to collect and estimate the percentage of ash, and considerable experience will be necessary to determine the effect of any deposit that may be found upon the globe or cover round the arc. The amount of ash will be found to average from 1 to 1·5 per cent. by weight of carbon consumed.—M.

Answer to No. 394 (*awarded* 5*s.*).—First of all the carbons should be tested with calipers or a screw gauge to see whether they are of uniform diameter or not. If one sample is of uniform diameter throughout, and if the diameter of the other varies in different places, then, other things being the same, the former sample will give the steadier light. The next thing to test is the rate at which the carbons burn. To do this, put carbons chosen from the first sample in an ordinary arc lamp which has an ammeter and a variable resistance in circuit. Connect a voltmeter directly between the two carbons. Now make a horizontal mark with a knife about 2in. from the point of each carbon. Switch on the current and let the lamp burn for about 20 minutes, until the carbon points assume their normal state. Now switch off the current, and measure with calipers the distance from the marks to the points of each carbon. Fix a convex lens on a stand near the arc, and receive the image of the arc on a screen. By measuring the distance between the images of the points (x), and knowing the distance of the lens from the arc (a), and the distance of the lens from the image (b), the distance between the carbons $\left(\frac{x\,a}{b}\right)$ can be found. It saves trouble to make a scale, so that the true length of the arc can be read directly from its image.

During the experiment the volts should be kept as constant as possible by adjusting the resistance, R, in the circuit. In addition to measuring the rate of burning, we have also to measure the mean spherical candle-power and the ash. In practice, it is customary, instead of measuring the mean spherical candle-power, to measure merely the maximum and the horizontal candle-power. This is best done by a Rumford's shadow photometer, as this does not need a darkened room. The horizontal candle-power is measured in the ordinary way, and the maximum is got by tilting the lamp until the photometer shows that the illumination is a maximum. The mean spherical candle-power is taken as $\frac{H}{2} + \frac{M}{4}$, where H is the horizontal and M the maximum candle-power. The watts are simply the product of the voltmeter and ammeter readings, and hence the watts per candle-power can be found for a given current and a given distance between the carbons. At the end of an hour the distance from point to mark on each carbon is again measured, and the rate of burning of the positive and negative carbon found in inches per hour.

The measurement of the ash is most difficult. A piece of non-inflammable paper about 18in. in diameter is placed about 2ft. above the lamp during the run. It is then folded up and weighed on a chemical balance. The ash is then blown off it and it is weighed again. The difference between the two weights will give us the ash produced per hour by the given sample. As each sample is tested in exactly the same manner, the above experiment will show their relative merits.—J. C. R.

NEW COMPANIES.

The following new companies have been registered since our last issue:

Birmingham Motor Manufacturing and Supply Company Limited.—Capital, £5,000. Object: to manufacture, sell, let on hire, and deal in motors, cycles, cars, carriages, carts, wagons, vans, and vehicles of all kinds and all component parts thereof and accessories thereto, and to carry on the business of electricians, engineers, etc.

Electric Haulage Company, Limited. — Capital, £10,000. Object: to adopt an agreement with G. Davis and E. W. Rudd for the option to purchase certain patents in respect of an invention of an improved system of distribution and collection of current for electric

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traction, to acquire any other inventions, and to carry on the business of electrical engineers, manufacturers of electric motors and electrical apparatus and appliances, makers of electric tramway cars and other vehicles, rail, conductor, and trolley manufacturers, etc.

Folkestone Motors, Limited.—Capital, £5,000. Object: to manufacture and deal in auto-motorcars, tramcars, cycles of all kinds, ships, boats, etc.

Coventry Lighting and Engineering Company, Limited.—Capital, £15,000. Object: to acquire the business now carried on by the Coventry Gasfitting, Electrical, and Engineering Company, Limited, at High-street, Coventry, and at Rugby and Nuneaton, and to carry on the business of gas, electrical, pneumatic, hydraulic, and general engineers, etc.

William Parton, Limited.—Capital, £5,000. Object: to carry on the business of wholesale and retail ironmongers, brassfounders, ironfounders, agricultural implement makers, tool and boiler makers, machinists, electrical, gas, and general engineers, etc.

Morgan, Mondey, and Co., Limited.—Capital, £3,000. Object: to acquire the business of Morgan, Mondey, and Co. and such part of the business of Messrs. H. and W. Green as may consist of dealing in electrical appliances, and to carry on the business of electricians, electrical, mechanical, sanitary, gas, and water engineers, ironmongers, builders of electric tramcars, motorcars, etc.

John Cameron, Limited.—Capital, £60,000. Object: to acquire the business of a maker of steam pumps and shipbuilders' tools, general engineer, and ironfounder, now carried on at Oldfield-road Ironworks, Salford, Lancashire, and elsewhere, as John Cameron, to adopt an agreement with H. H. Cameron, and to carry on the business of hydraulic, mechanical, electrical, and marine engineers, etc.

LEGAL INTELLIGENCE.

KALGOORLIE ELECTRIC POWER.

The Court of Appeal, composed of the Master of the Rolls and Lords Justices Vaughan-Williams and Sterling, have dismissed the application of the plaintiff in the case of Bicknell *v.* the Kalgoorlie Electric Power and Lighting Corporation, Limited, for a new trial of the action. The proceedings before Mr. Justice Grantham, from whose decision the present appeal was made, were reported in a recent issue of this journal. It will be remembered that the plaintiff, Mr. A. C. Bicknell, sued the company for the rectification of its register of shareholders by the removal of his name as holder of 850 shares and for the return of moneys paid on application for shares in the company, on the ground that he had been induced to apply for shares owing to alleged misrepresentations in its prospectus. The defence was that there had been no misrepresentation, and the company counterclaimed for costs.

The learned judge below, on the verdict of the special jury, gave judgment for the defendants, and this decision has now been affirmed by the Court of Appeal.

RIGHT OF TENANTS TO ORDER TELEPHONE WIRES.

At Gateshead County Court Judge Greenwell recently heard an application for costs in a withdrawn action taken by Mr. Robert Howe against the National Telephone Company.

It appeared 18 months ago that the company placed wires on a house owned by plaintiff. They were put up without his knowledge. Plaintiff stated that when there was a high wind the wires did damage, which was not covered by the 10s. a year allowed as rent.

Mr. Meynell, barrister, who appeared for Messrs. Gules and Boulton, said that the house on which the telephone wire was placed was leased to Mr. Aitchison, and he applied for the telephone. The point was an important one, as it raised the question whether a tenant was entitled to place a telephone into a house without the owner's permission. The particulars of the claim were—6s. 7d. for damages to the roof in putting up the wire, and 10s., a year's rent. The 6s. 7d., Mr. Meynell added, had been paid into court. He submitted that the company were entitled to judgment and costs.

The **Judge** said that he thought, though it was not to be taken as a considered judgment, that plaintiff had no right to interfere. He had handed over his house for seven years to a tenant, and a telephone was nowadays part of the ordinary conditions of household management. Subsequently he awarded the costs to the company.

WRIGLEY v. WINDERMERE AND DISTRICT ELECTRICITY SUPPLY COMPANY, LIMITED.

In the Chancery Division on Tuesday an action was begun for an injunction to restrain the defendants from committing a nuisance by noise, smoke, and vibration, owing to the manner in which they conduct their works.

Mr. Lawrence said, on behalf of the defendants, that he was prepared to admit, after Mr. Cartwright's report, that they caused a nuisance by noise if the other questions were held over until next sittings, the question of law as to prescription being left over.

After a long discussion Mr. Cartwright was directed to make a further report as to vibration by noise, the action to stand over until next sittings without prejudice to any other question than the nuisance by noise. The defendants would in the meantime do what they reasonably could to abate the nuisance.

His Lordship subsequently fixed the hearing of the action, subject to anything part heard, for Nov. 5.

BRITISH MOTOR TRACTION COMPANY, LIMITED, v. FRISWELL.

In the Chancery Division on Monday Mr. Justice Farwell delivered his reserved judgment in this case. It was said to be a test action, and was brought by the company to restrain infringement of its Maybach patent, 16,072 of 1893, for improvements in the method of producing an explosive mixture in hydro-carbon engines. The defence was a denial of the infringement, and that the patent was bad for want of novelty, being anticipated by the prior specifications of Butler and Wilkinson.

His Lordship gave judgment for the defendant, holding that Maybach had told the world nothing it did not know before; that he was anticipated by Butler, whose invention would work as well, if not better, than any other. He therefore dismissed the action, with costs.

Mr. Fletcher Moulton, K.C., Mr. A. J. Walter, and Mr. Hume appeared for the company (instructed by Messrs. J. B. and F. Purchase, of Regent-street, W.); while Mr. T. Terrell, K.C., and Mr. Roger Wallace, K.C. (instructed by Messrs. Firth and Co., Chancery-lane, W.C.), represented the defendant.

COMPANIES' MEETINGS AND REPORTS.

CHILI TELEPHONE.

The report of the directors for the year ended March 31, 1901, states that the aggregate number of subscribers at all centres at the end of the year was 4,723, as compared with 4,613 at the beginning, or a gain of 110 for the year. The gross revenue in Chili from all sources was: in 1900-1901, 683,170dol.; in 1899-1900, 651,436dol.—an increase of 31,734dol. The expenditure in Chili was: in 1900-1901, 347,413dol.; in 1899-1900, 364,549dol.—a decrease of 17,136dol. The net income in Chili from all sources was: in 1900-1901, 335,757dol.; in 1899-1900, 286,887dol.—an increase of 48,870dol. The average rate of exchange for the year was 16·65d., as compared with 15·17d. in the previous year, giving an increase for the year of 1·48d. Converted into sterling at these rates the figures are: in 1900-1901, £23,290; in 1899-1900, £18,130—an increase of £5,160. The liquid assets and liabilities in Chili on March 31, 1901, were valued at 17d., the current rate of exchange on that day, as compared with 16½d. at which they were valued on the corresponding date of the previous year. The increase in the value of the liquid assets over liabilities in Chili due to this rise in exchange amounts to £800, which has been carried to reserve. The balance to the credit of the revenue account, including £1,003 brought from the previous year, is £18,879, of which £5,199 has been carried to reserve for depreciation and renewals. The directors recommend the payment of a dividend of 5s. per share, free of income tax, being at the rate of 5 per cent. per annum, absorbing £11,000, and leaving a balance of £2,680 to be carried forward. During the year the capital outlay in sterling was £488, and the total mileage was: on March 31, 1901, 8,591 miles 548 yards; on March 31, 1900, 8,298 miles 990 yards—an increase of 292 miles 1,318 yards. In accordance with the articles of association, Mr. Frank W. Jones retires from the board of directors, and, being eligible, offers himself for re-election. The auditor, Mr. Thomas A. Welton, also retires, and offers himself for re-election.

WATERLOO AND CITY RAILWAY.

The directors' report for the half-year ended June 30 last states that the capital account shows a total outlay of £599,184 on June 30 last. The further estimated expenditure of £15,000 is provided for by the capital powers of the Company. The gross receipts of the line, less Government duty, amounted to £16,315, and the working expenses to £8,937, being at the rate of 54·78 of the receipts. The difference between these two amounts is not sufficient, by the sum of £1,567, to pay a dividend at the rate of 3 per cent. per annum on the Company's ordinary and borrowed capital, and the working company has, therefore, under the agreement of March, 1894, made up the deficiency, and have deducted in respect of working expenses the sum of £7,370. The number of passengers carried during the pass six months, exclusive of season-ticket holders, was 2,134,062, showing an increase of 265,325 over the number carried in the corresponding period of 1900. The season-ticket holders on June 30 last numbered 1,057, as against 911 at the end of June, 1900.

DUBLIN UNITED TRAMWAYS.

The directors in their report for the half-year ended June 30 last state that, in accordance with the desire of the shareholders expressed at the last half-yearly meeting, the revenue and other detailed accounts of the Dublin United (Old) Company and of the Dublin Southern District Company are amalgamated in the accounts now submitted. The directors have declared a dividend at the rate of 6 per cent. per annum on the preference shares and at the rate of 4 per cent. per annum on the whole of the ordinary shares, of which £85,500 did not rank for dividend this time last year. These dividends will absorb £29,028, leaving a balance of £3,372 to be carried forward. This balance includes £1,667 to the credit of stores suspense account and £1,257 unclaimed dividends on the shares purchased by the Company. The results of the half-year's working have been adversely affected by the exceptional charges which the Company had to meet under the head of compensation for accidents and legal expenses connected therewith, amounting to the sum of £6,337, which represents more than 2 per cent. dividend on the ordinary share capital.

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The directors have now affected a third party insurance policy for one year from March 5, 1901, covering all claims for accidents up to £7,500 in the aggregate. The premium payable in respect of this insurance is £3,050 for the year. The auditors in their report remark: "No portion of the preliminary expenses has been written off during the half-year. The debt due by the British Thomson-Houston Company still remains the subject matter of dispute. Interest upon the "B" debenture stock has been provided for only up to April 30 last. Counsel has advised in respect of the discount on the issue of the said stock that £500 a year should be provided during the 32 years they have to run and should be a charge to revenue account. This has not been provided for. The above accounts are affected by the matters referred to in our certificates attached to the accounts of the Dublin United and the Dublin Southern District Tramway Companies from which this Company derives its revenue."

The above report was submitted to the ordinary general meeting of the shareholders in the Company which was held at Dublin on Tuesday last. **Mr. Wm. Murphy** occupied the chair and moved the adoption of the report.

Mr. Wigham seconded, and the motion was carried unanimously.

A dividend of 4 per cent. on the ordinary shares of the Company was declared, and the proceedings terminated.

ANGLO-AMERICAN TELEGRAPH.

In their report for the half-year ended June 30 the directors state that the total receipts, including the balance of £1,156 brought forward, amounted to £188,358. The traffic receipts show a decrease of £3,954 as compared with the half-year ended June 30, 1900. The total expenses, including the repair of cables, etc., amounted to £64,979, an increase of £4,195. The directors have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £111,378. One quarterly interim dividend of 15s. per cent. on the ordinary stock and of £1. 10s. per cent. on the preferred stock was paid on May 1, 1901, absorbing £52,500, and a second quarterly dividend of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock, amounting to £52,500, will be paid on Aug. 1. The balance of £6,378 will be carried forward.

SIR HIRAM MAXIM ELECTRICAL AND ENGINEERING.

An extraordinary general meeting of the shareholders in this Company was held on Friday for the purpose of considering the passing of resolutions for the alteration of the articles of association.

Mr. Jules de Meray presided, and in the course of his address stated that the business of the Company could be divided into three important departments—namely, (1) the lamp factory, (2) the engineering contracting department, and (3) the export department. Having detailed the business that is carried on in these three departments, he moved several resolutions for the alteration of some of the articles of association of the Company.

The **Hon. Massey Mainwaring** seconded the resolutions, which were carried unanimously.

Sir Hiram Maxim then addressed the meeting in a long speech on the subject of electric traction. Referring to the great advances that had been made in electrical traction in the United States, Sir Hiram stated that more than 4,000,000,000dol. had been spent in the last 16 years on electrical plant, the greater part of which had been for electrical traction, and electrical traction had worked a complete revolution in the social condition of the people of the United States. In New York City people once obliged to live in the towns had now been able to move out, and the property in the suburbs had increased in value tenfold. No country in the world was so well calculated for the introduction of this new system of travel as England. Suppose a line should be established between London and Brighton. If a train were run from London to Brighton propelled by the ordinary locomotive, it was necessary to carry the motive power and also water with the train. Consequently the train was very heavy, and it was necessary to tunnel the hills and fill up the valleys. Whereas by the establishment of an electrical railway they would be able to use considerably cheaper coal, and would put up very large and economical engines on the triple-expansion system. An extremely important factor was that the power delivered in an electrical train was considerably cheaper than when an ordinary locomotive was employed. In an electrical railway to Brighton it would not be necessary to fill up the valleys or tunnel the hills, unless they were very steep and small ones. He did not hesitate to say that with the appliances they had already at hand, with only a slight change in the shape of the train so as to avoid atmospheric resistance, it would be quite practicable to run trains at a speed of 120 miles an hour, and passengers could be carried from London to Brighton at a very much less price than railroads were able to do at the present time. It might be possible to pay a large dividend and take passengers to Brighton in a few minutes for 2s. 6d. He spoke of this as a possibility of the case. Referring to the relative value of English and American engines, Sir Hiram Maxim quoted the opinion of an engineer connected with the London United Tramways Company, who said, "The trouble is, gentlemen, that if we buy our engines in England, they will not work, and if we go to America and purchase them, they do work." Now, this slander, if he might so call it, with regard to English engineers, continued the speaker, was partly deserved and partly not deserved. The trouble was that engineers had been trying to make engines very cheap, and so cheap, in fact, that they did not work well. He did not think that at the present time, at any rate, it would be prudent for their Company to go in for the building of engines, because such work required a great plant, and he only touched upon the subject to show what people said about English productions in regard to the very important business which was sure to result from the introduction of electric traction into England.

A vote of thanks to the chairman concluded the proceedings.

GENERAL ELECTRIC.

At the first ordinary general meeting of the shareholders held at the Cannon-street Hotel on Tuesday, Mr. Hugo Hirst, who presided, apologised for the absence of Mr. G. Byng (chairman of the Company) owing to illness.

In moving the adoption of the report, the **Chairman** said that if their advance during the last year had not been quite in the same proportion as they had been used to in former years, it had been due to the disturbances that had affected trade all over the world. Having dealt with some of the items in the accounts, the chairman said their engineering works at Witton, near Birmingham, were now nearly ready, and they expected to be working in them before the end of the year. The order for the foundry had been placed. It was their intention not only to have the most modern and comfortable buildings, both from the point of view of manufacture and comfort for their workpeople, but they also intended to have the very latest machinery, so that they could compete with anybody, both in England and abroad. They had so far erected six model dwellings, which for the moment were intended to serve for the managers who would go down to start the works; but eventually they were to be the type of buildings which they should put up on the other side of the canal that traversed their property for their workpeople. The electro-chemical works also which they had started recently were well up, and they were most anxious that they should earn something from this big enterprise before the end of this financial year. With regard to the staff, during the year they had allotted 685 ordinary shares to the various members of the staff, who would be allowed to invest more, and year by year their numbers would be added to. Apart from the ordinary shares, they had given them a direct bonus dependent upon the net profits. They were most anxiously watching the result of this policy, because if it were followed by the success that they anticipated they hoped to extend it much more later on. It would be satisfactory to the shareholders to learn that the London and Manchester Stock Exchanges had given a quotation for their debenture and preference shares. Finally, he should like to add that they had in their various trading departments kept pace with the requirements made upon them. Not only had they increased the turnover of almost every supply department, but they had added a new department—the electric traction department—from which they anticipated good results before long. During the last 12 months they had been successful in getting orders for the complete electric plant for the Central Electric Company, which was a combination of the St. James's and Pall Mall; they had recently fitted up the Notting Hill and Kensington Court Company with their electrical plant; they had just finished Fulham; they had on the stocks the electrical plant for the city of Dublin; they had—though South Africa was shut out—some very nice orders for South America; and the Indian Government had just given them a very important order for plant for utilising waterfalls in connection with gunpowder and ammunition works in that country. The room that they would get at the Manchester works through the removal of the engineering works to Witton would enable them to carry out extensions in their telephone department.

Mr. Max Byng seconded the motion, which was carried unanimously.

Dividends on the preference shares of 5 per cent., and on the ordinary shares of 10 per cent., having been declared, a vote of thanks to the chairman terminated the proceedings.

DIRECT UNITED STATES CABLE.

At the ordinary general meeting of the shareholders held at Winchester House on Tuesday, **Mr. E. M. Underdown, K.C.**, the chairman, said he thought that they would regard the report as satisfactory. The revenue showed a reduction of £1,554 as compared with that of the corresponding period of last year, but this was by no means an unfavourable result in view of the fact that additional competing cables had been working in the Atlantic since the autumn of last year. At a former meeting he remarked upon the probability of there soon being 14 cables working across the Atlantic, and that might be taken to be correct, although one of the cables did not actually reach as far as America. The Company and those with whom they were acting were carrying on their business in such a way as to meet the wants of the public, and in view of the competition it was gratifying that their position had not become worse. Having referred to other items in the report the chairman said he regretted that they had lost the services as a director of Sir Spencer Walpole, but he was glad to state that to fill the vacancy they had been able to appoint the Hon. Thomas Cochrane, M.P. He knew of no cloud of any kind that was hanging over the Company He concluded by moving the adoption of the report and the payment of the dividend and bonus recommended, both tax free, making with the three interim dividends already paid a total distribution of 3¼ per cent. for the year ended June 30.

Sir James Pender seconded the motion, and it was carried *nem. con.*

GLOBE TELEGRAPH AND TRUST.

On Tuesday the general meeting of the shareholders was held at Winchester House, the Marquis of Tweeddale presiding.

The **Chairman**, in moving the adoption of the report (which appeared in our last issue), referred to the item "Differences on securities realised £415,595." The amount was almost entirely attributable to the sale of their holding in the deferred stock of the Anglo-American Telegraph Company. The shareholders should, however, understand that, although the directors spoke of this as a loss—and it was a loss—yet, so far as the shareholders' pockets were concerned it was a decided gain, for the money realised from the sale

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of the stock had been invested in good dividend-earning securities. Perhaps the most striking remark he had to make on the point was that, although this loss was shown in the accounts, yet there was no diminution in the value of the Company's investments as compared with their cost; indeed, the contrary was the fact, for taking the present market price of the securities now held by them—namely, £3,292,363—there was a profit of between £400,000 and £500,000 as compared with the original capital. They sincerely regretted the resignation of Mr. St. John Brodrick, M.P., of his seat on the Board on account of his position as Secretary of War. The vacancy had been filled by the appointment of Sir John Wolfe-Barry. In conclusion, he stated that everything pointed to the current year being as prosperous for the Company as last year.

Sir James Pender seconded the motion, which was unanimously adopted.

LIVERPOOL OVERHEAD RAILWAY.

Abstract of the report of the board of directors to be presented to the twenty-sixth ordinary half-yearly general meeting of the shareholders, to be held at the Law Association Rooms, 14, Cook-street, Liverpool, on Aug. 13:

In presenting the half-yearly statement of capital and revenue accounts to June 30, 1901, the directors have to report that the gross revenue receipts amount to £41,701. 4s. 8d., and the working expenses to £30,658. 2s. 4d. The number of passengers carried during the half-year ending June 30, 1901, is as follows: first-class, 721,999; second-class, 3,157,111 (including tramways); workmen (special return tickets), 1,503,114—total, 5,382,224. The traffic on the railway has felt the extensions of the Liverpool Corporation tramways—on the other hand, the traffic at Dingle Station shows some signs of improvement. The Waterloo and Crosby tramways continue to yield satisfactory returns. Your directors much regret the retirement, in consequence of ill-health, of Mr. Jas. Barrow, who has been associated with the undertaking from its earliest days, and who has given very valuable assistance. In his place they have elected Mr. Harvey C. Woodward. The revenue account shows that the receipts from passenger traffic and miscellaneous receipts and interest amount to £41,701. 4s. 8d., which after deducting working expenses and interest on mortgage debentures, leave a balance available for dividend of £11,722. 15s. 8d. Out of this balance the directors recommend the declaration of dividends at the following rates (less income tax), payable on and after Aug. 16 next: 5 per cent. per annum on preference shares, £3,000; 2 per cent. per annum on ordinary shares, £5,000, leaving a balance of £3,722. 15s. 8d. to be carried forward to next half-year.

REVENUE ACCOUNT.

Expenditure.	£	s.	d.
Maintenance of way, works, and stations	4,373	9	9
Locomotive power	8,817	14	5
Repairs and renewals of carriages	388	12	9
Traffic expenses	11,363	7	3
General charges	2,264	7	9
Law charges	294	3	8
Compensation	81	18	9
Rents, rates, and taxes	3,002	5	0
Government duty	72	3	0
	30,658	2	4
Balance carried to net revenue account	10,703	5	0
	£41,361	7	4

Receipts.	£	s.	d.
Passenger traffic	40,673	16	0
Parcels, etc.	58	3	2
Rents	621	15	2
Transfer fees	7	13	0
	£41,361	7	4

METROPOLITAN RAILWAY.

The half-yearly meeting of the proprietors of this Company was held on Friday last at Cannon-street Hotel, Colonel J. J. Mellor presiding.

Having explained the absence of Mr. John Bell (the chairman of the Company) owing to illness, the **Chairman** proceeded to move the adoption of the report and accounts, which he described as being not altogether pleasant reading. The reduction of £32,740 in the net revenue was entirely due to the competition of the Central London Railway. There was also another £10,000 which the competition of that railway had deprived them of, being the increase to merchandise and other traffic on other parts of the Metropolitan system. The increase in working expenses was £7,359, which, under the circumstances, might be regarded as moderate. Dealing with the question of electric traction, the chairman said they all recognised that it was in this direction that they must look for the restoration of their traffic and of the earning capacity of the railway. And it was here that they had been attacked, as though they—the Metropolitan Company—were the obstacle and the hindrance to the immediate prosecution of this most important work. Their neighbours and partners in adversity (the Metropolitan District Railway Company) were as anxious as this Company about the matter, and at first the two Boards were united together hand and glove in their determination to push the business through. He then referred to the appointment of Sir Wm. Preece and Mr. Thomas Parker to proceed to Budapest and make a thorough examination of the Ganz system of electric traction on the spot. This they did, continued the chairman, and it was evident from their report (the full text of which will be found below) that the Ganz system possessed features of such novelty and importance that it amounted practically to a new departure in electric traction. Eventually, in the month of March last, a joint letter was agreed upon by the Boards of the two companies and sent to Ganz and Co., and up to that time the two companies had worked together in perfect harmony for the prosecution of the objects they both had at heart. But about this time a new influence appeared to be at work in the councils of the District Company. A group of American capitalists, with Mr. Yerkes, of Chicago, at their head, came forward and offered to find a million sterling if a new company, to be called the District Electric Traction Company, might have the contract for equipping the District Company with its electrical installation. A meeting took place between the Boards of the Metropolitan Company and the District Company, but that meeting came to an end in consequence of a statement being made by the former that they would not have the Ganz system on any consideration. What, asked the speaker, was this Company to think of the mental attitude of men who professed to be leaders in scientific and industrial progress, who could express themselves in these narrow and contemptuous terms of a system which the distinguished electrical engineers of the two companies declared to be in advance of any system of electric traction at present existing either in this country or in America? He ventured to tell this meeting that it was idle to attempt to arrest the progress of electrical discoveries and inventions. If this new method of Messrs. Ganz and Co. was what their experts said it was, then it was destined to render valueless millions of dollars' worth of electrical plant, both in this country and especially in America, and there were not wanting signs that a determined effort would be made by interested companies who commanded immense wealth to stifle and strangle this new departure in electrical engineering. The refusal of the District Company to have the Ganz system made it absolutely impossible for the Metropolitan Company to apply the Ganz system over their part of the Circle, because they must have one and the same system all over the Circle. The Metropolitan Company even offered to do what they could to assist the District Company to raise funds independent of the American combination, but it was all of no use, and when the District Company applied to Parliament for powers to force their system upon them, this Company felt bound to oppose them. Having stated that this Board had no interest, direct or indirect, in the Ganz system, the chairman went on to say that this system was the most up-to-date which the best electrical engineering firms could give them. The Ganz system required no sub-stations with moving machinery, thereby saving about £150,000 in capital outlay, and about £10,000 a year in annual upkeep. In fact they were advised that the total cost of the Ganz system would be at least 30 to 40 per cent. less than that of the American syndicate. Referring to the fact that a tribunal is to be appointed to settle the system to be adopted by both companies, he stated that, whatever the decision of the tribunal might be, they should loyally accept it and at once go to work with their neighbour to carry it into effect. In the meantime, they were proceeding with their power house, so little or no further delay need ensue. He would advise the Board to make an official representation to the District Company for the appointment of the tribunal at once. Turning to another question, he thought that all sensible men must agree with the opinion expressed by Sir John Kennaway, the chairman of the House of Commons Committee, that it was desirable that the two companies should be placed under one management. It so happened that proposals had been made by both companies on this vitally important matter in 1898, but the terms demanded by the District Company had stood in the way of an amalgamation. The chairman then alluded to the statement which had appeared in that morning's papers as to the directors of the Metropolitan Company having declined the offer of the Metropolitan District Traction Company. The proposals made, he said, were considered by the directors most carefully, and were also submitted to the Company's accountants, Messrs. Price, Waterhouse, and Co., while their electrical expert went into the electrical part of the question. The first proposal was that the Metropolitan Company should pay ¾d. per passenger, which, on the number carried in 1900, would amount to £291,000 per annum for working the railway, which was now costing them £101,000 per annum. Well, all he could say was that the directors were not born yesterday. That part of the proposal could not be entertained for a moment. The second proposal was that the traction company would guarantee 3½ per cent. upon the ordinary stock of the undertaking. The question of a guarantee might be a matter of bargain, but this proposal was altogether inadmissible, for there was absolutely no security or guarantee whatever worth the paper it was written on. The proposal was simply ludicrous. As to the miserable, paltry, and spiteful suggestion that the reason of the rejection of the proposals was that the directors did not want to relinquish the control of the line, he could only ask whether it was supposed that men with such a large stake as they had would allow any personal consideration to prevent their entertaining any proposal which was worthy of consideration? The chairman then moved the adoption of the report and accounts.

Mr. C. B. B. McLaren, M.P., seconded the motion.

In reply to questions, the **Chairman** said he believed electric traction would be as cheap as steam traction. The directors had received no communication from any of the trunk lines as to a more close union or fusion between the Metropolitan and any of these lines, but if such a suggestion should come and fair terms be offered, the Board would, of course, consider them. The Ganz system was at work on five or six railways in Switzerland, and the Italian Government had constructed 65 miles of railway on that system.

The resolution was then put and carried unanimously, and the dividends recommended were declared.

The **Chairman** then referred to Mr. Bell's retirement from the managing directorship, and said that at this important juncture they could ill spare his counsel and advice, so they had requested him to continue to hold the office of chairman, a request to which he had acceded.

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It was further resolved that the remuneration of the chairman be £2,000 per annum, and the proceedings closed.

The following is the full text of the report of Sir W. H. Preece and Mr. Thos. Parker recommending the adoption of the Ganz system of electric traction on the Metropolitan and the Metropolitan District Railways:

"In accordance with the instructions conveyed in the resolution passed by the committee on Jan. 9, we have visited Budapest, and have devoted several days in making a thorough examination and exhaustive experiments on the line and in the works, upon the construction details, and practical operation of the system of working proposed by Messrs. Ganz and Co. to equip the Inner Circle for electrical traction.

"1. *The Electrical Question.*—The main feature of this section of the system is the supply of three-phase alternating currents directly to the motors upon the cars themselves. There is nothing new in this proposal. It is in practical use on the following lines: Lugano tramways, Jungfrau Railway, Gornergratt Railway, Engelberg Railway, the Burgdorf and Thun Railway, and several other lines are being equipped, especially the Valtellina branch of the Adriatic network of the Italian State railways—66 miles of this railway will be in working order early in the approaching summer. Three-phase alternating currents have not hitherto been extensively used for traction, for the following reasons: (1) Their use necessitated two insulated conductors, which are objectionable in the public streets, but in the case of a private railway this is of little importance. (2) The frequency at which they had been used did not give high efficiency nor sufficient torque, but by designing motors for a much lower frequency Messrs. Ganz and Co. have obtained an efficiency equal to that of continuous-current motors, and a torque quite beyond what practice demands. We experimented on motors constructed for the Valtellina Railway similar to those tendered for the Inner Circle, and found their efficiency and torque as stated by Messrs. Ganz and Co. correct, and satisfactory to us. (3) In the use of continuous-current motors great economy is obtained by what is known as the 'series-parallel' control. This operation seemed to exclude the three-phase motors, by reason of the large current required to start and accelerate by them; but Messrs. Ganz and Co.'s arrangement of two three-phase motors in 'cascade' removes all disability, and places other real advantages to the advantage of the three-phase motor over the continuous-current motor for the requirements of the companies. The tension to be used on the Valtellina line, and proposed to be applied for the Inner Circle, is 3,000 volts. This is the voltage used on the circular line of railway, one mile in length, constructed by Messrs. Ganz and Co. on the Altenfener or Old Budda Island on the Danube, near Budapest. This voltage is taken only to the static portion of the first motor, the current induced in the rotary and used by the motors being only 300 volts. The use of 3,000 volts in such a form is but the ordinary practice in alternating-current lighting, and similar instruments to the static part of the motor, and 3,000 volts, have been working in hundreds of houses in London and elsewhere for many years. The motors need no attention—they have no commutators, no brushes, no sparking. No part of the apparatus within the reach of the wattman (driver) is alive at 3,000 volts, and no official of the railway can come in contact with such a pressure. It requires no moving machinery, except in the generating station, nor any attention at sub-stations. The static transformers for reducing the current pressure are stationary, and would not occupy more space than Smith's book-stall at possibly five stations, or any convenient points on the circle. It has the advantage of requiring very small conductors, thus reducing the cost of the line equipment, and the liability to faults from heating and fusing, by diminishing the intensity of currents at collecting contacts to a very low figure. The maximum current employed in starting and accelerating a train will be only 250 amperes, while that used on the Earl's Court experimental line was over 1,000 amperes. To obtain the same acceleration with continuous currents at 500 volts would require 2,500 amperes. We apprehend no difficulty with the Board of Trade, for the features of novelty introduced are all familiar quantities in other applications of electrical engineering, and that Department is never averse to allowing elasticity in their rules when public security is not affected, and public advantage is promoted. Two wires are carried overhead, and the rails are used as the third conductor, but earthed. These wires are similar and of the same size as those in use for the ordinary electric tramways, and are especially convenient for the rapid and economical equipment of the Metropolitan system. It is, however, not imperative that they should be placed overhead. We approve of the overhead system, and to add point to our preference for the overhead arrangement we would draw attention to the recent fatal accident to an employé on the Central London Railway, due to an accidental short-circuiting of the charged rail. The inquest on this case was held on the 18th inst. at Westminster. It would be impracticable to work the Inner Circle system with overhead wires if we used any of the continuous-current systems proposed. The starting, controlling, braking, and stopping of the trains will be a great improvement upon anything that has been done on any existing electric railway. The series-parallel system of control used on most lines now worked by continuous currents is efficient in power consumption; but Messrs. Ganz and Co., by their cascade system, have gone one step further, for they not only accelerate and run with equal efficiency, but they are able to slow the train down to half-speed by electric braking, and at the same time to restore energy to the system, while the air-brakes will be called upon to expend only one-quarter of the energy hitherto used to stop the trains. This tends to reduce working expenses. Again, on any steep down grades, energy is restored to the line, and the train is prevented from exceeding the proper speed without any brake being applied. We have seen 40 motors, similar to those proposed for the Metropolitan railways, under construction. We have inspected their parts. We have tested one in its complete state, and we are perfectly satisfied with their practical workmanship and efficient character. Motors worked on the three-phase alternating-current system have this great advantage over continuous-current motors—they maintain uniform speed up ordinary grades, and with the usual varying loads, thus the motor automatically tends and assists in the maintenance of railway service time-tables. They are lighter in weight than equal continuous-current motors. The motors for the Inner Circle train of 160 tons would weigh 24 tons, while those on the Central London weigh 32 tons, a saving of weight which is secured in every train run, and means a considerable saving in the yearly consumption of energy.

"2. *The Mechanical Question.*—Messrs. Ganz and Co. propose to supply motorcars with the whole weight of the motors entirely spring-borne. No jolting of the axle is felt by the motor, or pounding of rails. No other system proposed accomplishes this essentially important feature. The weight per axle of the motorcar we examined had 12½ tons useful for adhesion, while of this only 15cwt. was unspring-borne, being the weight of the axle and wheels. We were satisfied with the mechanical features. They are proved by experience on the Old Budda line. The smooth running of the motorcar on this line, 12½ tons per axle adhesion, is remarkable. We have never experienced anything equal to it. The mechanism is simple, effective, and practical. It will be free from vibration, and impart to the Inner Circle service a freedom from pounding and noise that will secure great public satisfaction, and cause a very marked reduction in the maintenance expenditure on the permanent way.

"3. *The Financial Question.*—Messrs. Ganz and Co., as an industrial company, stand in a very strong position. Their capital consists of 6,000 shares of 400fl. each, now quoted on the market at from 1,500 to 1,600. They have also 3,000,000fl. debenture stock. Their average dividend for some years back has been 25 per cent. Their bankers are the Hungarian Credit Bank, virtually a branch of 'Rothschild's,' of Vienna. We saw Mr. Lukiacs, the manager of the Anglo-Austrian Bank in Budapest, who pronounced them to be the strongest industrial house in Hungary. They have 6,000 men at work, and they employ 400 clerks. The works are in full play and are most thoroughly equipped There is no electrical manufactory in the United Kingdom to compare with them. We can find no reason why the joint committee should not accept Messrs. Ganz and Co.'s tender. The firm itself is perfectly competent to carry out a contract. They possess a large and highly technical staff. The system itself has received the practical test of experience, and we believe its adoption will be satisfactory to the companies in all respects. It is a decided step in advance over any other system in use in the United Kingdom, or in America, and it is eminently adapted to facilitate the application of electric traction upon our principal railways.

(Signed) "W. H. PREECE.
"THOS. PARKER."

CITY AND SOUTH LONDON RAILWAY.

The meeting of the shareholders in this Company was held at the offices, Finsbury-pavement, E.C., on the 26th ult., Mr. C. G. Mott presiding.

In moving the adoption of the report, the **Chairman** said that their position was more satisfactory than before. Their extensions were nearly completed, and in a few weeks he hoped the whole of the line would be opened for public traffic. When they had the extension to Islington fully at work they expected a large increase in traffic; but, besides this, there was the exchange traffic between the Great Northern at Moorgate-street, the City subway at London Bridge, and, he hoped, a junction with the Baker-street and City line at the Elephant. All this would tend to feed their already fast-growing traffic, for they had carried 1,718,000 more passengers than in the corresponding half of last year, at a comparatively small increase of outlay. They could, in fact, have paid a 2½ per cent. dividend but for the fact that they had to supply new plant, for which no provision had been made, hence the necessity for such a renewal fund as they had now commenced. The receipts averaged 2d. per passenger, and the working expenses had been reduced to 52·36 per cent., from 59·36 a year ago, and 79 per cent. at the outset. Their difficulties, he thought, were at an end, and their prospects brighter, while they were moving steadily along in the direction of increased dividends.

The motion was seconded by **Mr. C. S. Grenfell**, and carried unanimously.

EDISON AND SWAN UNITED ELECTRIC LIGHT.

Directors: James Staats Forbes, Esq. (chairman); the Earl of Lichfield; Major Samuel Flood Page; Joseph Wilson Swan, Esq., F.R.S.; Ernest Villiers, Esq.

Eighteenth annual report of the directors (with abstract of accounts) for the year ending June 30, 1901, to be presented to the shareholders at the ordinary general meeting to be held at the Cannon-street Hotel, E.C., to-day (Aug. 2):

The profit and loss account shows that the sum of £19,514. 4s. 1d. has been carried to net revenue account, £18,242. 15s. of which has been absorbed in payment of interest on the debenture stock. Competition in every branch of the business has been very keen, lamps especially being sold at very diminished prices. The price of materials has considerably increased, hence the cost of production has been higher, and as the sales have been smaller, the business has suffered seriously. At the last meeting of the shareholders, the chairman announced that a new manager of the fittings department had been appointed. On his getting to work, everything in that department was thoroughly overhauled and examined. During this investigation it was discovered that, in the past, work which had been completed at a loss was reported as "work in hand," and carried forward as a good asset. This led to further changes; amongst others, the general

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manager was removed from that office, and the directors set on foot a special enquiry into the value of the whole of the stock belonging to the Company; and they regret to say that they have found it necessary to write off therefrom the large sum of £31,048. 5s. When this Company absorbed the Manchester Edison-Swan Company, it took over their Broadheath factory, and as it was found impossible to work it at a profit, it has been closed; such plant as could be beneficially utilised has been removed to Ponder's End, and the rest has been sold. The Walsall and Kalk factories have also been closed, and the loss on the closing of these factories has been provided for in the accounts. The sums of £31,048. 5s. depreciation of stock, £19,875. 14s. 4d. special outlays written off, £9,069. 7s. 9d. loss on closing factories, and £4,578 provision for bad and doubtful debts, together with the interim dividend paid March 1 of 2½ per cent., amounting to £9,586. 19s., have absorbed the whole of the reserve; £784 is carried forward, as against £6,199. 18s. 5d. last year. The fall in the market quotation of the shares, the changes which were known to have been made in the staff, and other reasons, led to the formation of a committee, which consisted of shareholders holding more than one-fourth part of the A shares of the Company. A deputation from this committee has had several interviews with the directors, has visited Ponder's End, and has made an examination into the affairs of the Company. As the result of these meetings an arrangement has been arrived at between the directors and the committee, by which two seats at the Board have been placed at the disposal of the committee, and in accordance with this Mr. E. B. Ellice-Clark and Mr. H. Wolfenden have been nominated for election as directors at the ensuing meeting of shareholders. Mr. J. S. Forbes, who has been chairman of the Company from its commencement, resigned his seat on the Board on July 19, stating that he was compelled to reduce his engagements owing to domestic bereavement and from considerations of health. Major Flood Page retires in rotation, and offers himself for re-election. Mr. E. Villiers retires in rotation, and does not offer himself for re-election. Mr. E. B. Ellice-Clark and Mr. H. Wolfenden have been duly nominated to serve as directors, and offer themselves for election accordingly. The directors have in this report placed before the shareholders fully and unreservedly the result of the special examination which has occupied them for several months. In expressing their sincere regret as these unexpected results, they desire to say that they are of opinion that the business, if properly conducted, is good, and that there is reason for believing that with certain changes in organisation and in policy, which have been already under consideration, and which will have to be decided when the Board is reconstituted, the Company can once again be placed in a satisfactory commercial position. Messrs. Welton, Jones, and Co., the auditors, offer themselves for re-election.

Dr. Profit and Loss Account.	£	s.	d.
Stock on hand, July 1, 1900	203,649	12	2
Wages, purchases, etc.	206,626	18	8
Salaries, directors' remuneration, etc.	13,578	2	8
Balance carried to net revenue account	19,514	4	1
	£443,368	17	7

Cr.	£	s.	d.
Sale of lamps, fittings, etc.	235,433	9	0
Interest, discount, etc. (net balance)	2,188	0	11
Stock on May 31	205,747	7	8
	£443,368	17	7

Dr. Balance-Sheet.	£	s.	d.
Share capital—17,139 A shares of £5 each, fully paid	85,695	0	0
99,261 A shares, £5 each, £3 paid	297,783	0	0
	383,478	0	0
23,564 B shares, £5 each, fully paid	117,820	0	0
4 per cent. first debenture stock	344,023	0	0
5 per cent. second debenture stock	100,000	0	0
Debenture interest accrued to date—4 per cent. first debenture stock	6,880	9	2
5 per cent. second debenture stock	1,250	0	0
Sundry creditors and credit balances	43,724	13	3
Balance at net revenue account	784	0	0
	£997,960	2	5

Cr.	£	s.	d.
Cost of establishing the business, goodwill, etc.	325,631	8	1
Amount of B shares of this Company	117,820	0	0
	443,451	8	1
Altrincham Electric Supply, Limited	64,895	3	1
Freehold and leasehold property	89,200	2	1
Stock, May 31, 1901, and plant	293,535	1	11
Sundry debtors	69,015	4	7
Sundry payments in advance	18,415	1	10
Investment—National Telephone Company	15,500	0	0
Cash at bankers and in hand	3,948	0	10
	£997,960	2	5

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Farnworth.—The Urban District Council invite tenders for a carshed traverser. Tenders by Aug. 12. Details in our advertisement columns.

Paris.—Tenders are invited for 21 double telephone cables, silk and cotton insulated, by the Post Office Department, 103, Rue de Grenelle. Tenders by Aug. 12.

Cardiff.—The Corporation invite tenders for main switchboard, with instruments complete. Tenders by Aug. 6. Details in our advertisement columns.

Amsterdam.—The Corporation invite tenders for tramcars for electric traction with overhead wire (perhaps 140). Tenders by Sept. 2. Details in our advertisement columns.

Cardiff.—The Corporation invite tenders for double-deck bogie cars, double-deck four-wheel cars, and single-deck bogie cars. Tenders by Aug. 6. Details in our advertisement columns.

Keighley.—Tenders are invited for electric light installation at the parish church, Keighley. Specifications, etc., can be obtained from Messrs. Gibbings and Baker, Old Bank-chambers, Bradford.

Manchester.—The Electricity Committee invite tenders for 70 feeder and section pillars. Specifications, etc., may be obtained from Mr. F. E. Hughes, Town Hall, Manchester. Tenders by Aug. 7.

Dundee.—The Gas Commissioners invite tenders for surface condensers, electrically-driven pumps, cooling towers, feed-water heaters, etc. Tenders by August 5. Details in our advertisement columns.

Wigan.—The Corporation invite tenders for the supply of enclosed electrical motors and starters as required during the ensuing 12 months (sizes, 1 h.p. to 50 h.p.). Tenders by Aug. 10. Details in our advertisement columns.

Brecon.—The Committee of the Talgarth Joint Asylum invite tenders for the electric lighting of the asylum. Particulars can be obtained from the architects, Messrs. Giles, Gough, and Trollope, 28, Craven-street, Strand. Tenders by Aug. 5.

Farnham.—The Urban District Council are desirous of contracting with a responsible firm for the supply of electricity under the requirements of their Electric Lighting Order, 1900, in their area. Proposals by Aug. 27. Details in our advertisement columns.

Amsterdam.—The Municipality invite tenders for 5,000,000 kilos of tramway rails, with plates, bolts, etc. Specification, 2s. 7d. Tenders by Sept. 2. Information is given at the office of the Director of Municipal Street Railways, Nieuwe Achtergracht, 164.

Darlington.—The Corporation invite tenders for the supply and delivery of one Lancashire boiler (first extension), one 350-h.p. engine, coupled to a continuous-current dynamo (first extension), and extension steam, drain, and feed pipes. Tenders by Aug. 22. Details in our advertisement columns.

Grays Thurrock.—The School Board invite tenders for electric lighting to three schools at Grays Thurrock, Essex. Specifications may be seen at the Board-room, Quarry-hill, Grays, or at the offices of Mr. Christopher M. Shiner, A.R.I.B.A., 3, Bond-court, Walbrook, E.C. Tenders by Aug. 6.

Mansfield.—The Electric Lighting Committee invite tenders for refuse destructors (to deal with the whole of the refuse of the borough) by Sept. 5. Specification, etc., may be inspected at the offices of Mr. Robert Hammond, M.I.C.E., the consulting engineer to the Corporation, 64, Victoria-street, Westminster, London, S.W.

Middlesbrough.—The Electric Lighting Committee invite tenders for the supply and erection of mechanical coal-handling plant in connection with the municipal electricity works. Specification, etc., may be inspected at the offices of Mr. Robert Hammond, M.I.C.E., consulting engineer to the Council, 64, Victoria-street, Westminster, London, S.W. Tenders by Sept. 3.

Worcester.—The Corporation invite tenders for water-tube boilers, economisers, steam and feed pipes, pumps, steam dynamos, motor-alternator, booster, Korting condensers, electric pumps, cast-iron suction, delivery, and exhaust pipes, tank, switchboard, overhead travelling crane, and accumulators, for the new electricity works. Tenders by Aug. 23. Details in our advertisement columns.

Croydon.—The Lunacy Visiting Committee invite tenders for the execution of the wiring for the electric installation, including ring main and feeders, sub-mains, lamp circuits, switchboards, distribution boards, fittings, etc. Specification, etc., can be inspected at the Borough Engineer's Office, Town Hall, Croydon. Tenders by Aug. 26.

St. Helens.—The Electric Supply and Tramways Committee invite tenders for the purchase of one 120-kw. direct-driven steam alternator and exciter, horizontal engine by Robey and Co., Lincoln, alternator by Johnson and Phillips, 2,000 volts, 60 periodicity, Ferranti switchboard and instruments, arranged for two distributing circuits, two alternator circuits, and synchronising gear, eight 21-kw. transformers, 2,000 to 200 and 100 volts, steam and exhaust pipes, valves. Details in our advertisement columns.

Norway.—Tenders are invited by the Norwegian Government for the supply of battery zinc, conducting wires, soldering tin, sal-ammoniac, and sign-board shields for the Telegraphs Administration. Specifications and conditions of tender may be inspected daily between 12 and 1 at the office of the Controller of Material, Kongens Gade 21, Christiania. Apart from customs duty, a 15 per cent. preference is given to native tenders by the Norwegian Government. Tenders will be received not later than August 12.

RESULTS OF TENDERS.

Ilkeston.—The Town Council have accepted the tender of Dick, Kerr, and Co. for the construction of the permanent tramways and electrical equipment.

Chester.—The Guardians have accepted the tender of Messrs. Rooper and Co., at £47, for lighting the central children's home in Wrexham-road with electricity.

Nelson.—The tender of Messrs. Danks and Co., Birmingham, for two Lancashire boilers fitted with Weir's pumps, Proctor's stokers, and Green's economisers, has been accepted.

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Rochdale.—The Corporation have accepted the following tenders for the supply and delivery at Rochdale of six specimen electric tramcars: Messrs. Dick, Kerr, and Co., Limited, 110, Cannon-street, London, E.C. (three); British Thomson-Houston Company, Limited, 83, Cannon-street, London, E.C. (three).

West Ham.—The Tramway Committee have recommended the Borough Council that they be empowered to accept either the tender of Messrs. Hornsby (£14,791), or Babcock and Wilcox (£14,720), as may appear desirable on a further report from the electrical engineer, subject also to the execution of a satisfactory contract.

Epsom.—The Lighting Committee have accepted the tender of the Keighley Electrical Engineering Company for supply of cut-outs, at 10s. 3d., subject to their providing a deeper sealing chamber, and also the tender of Messrs. Chamberlain and Hookham for meters as required by the Council at the following prices: 3-ampere, £2. 15s. (two-wire), £5. 10s. (three-wire); 5-ampere, £3 and £6; 10-ampere, £3. 13s. 6d. and £7. 7s.; 15-ampere, £3. 15s. and £7. 10s.

Bedford.—The Urban Sanitary Authority have accepted the following tenders: Henley's Telegraph Works Company, Limited, for 800 yards of service cable, £113. 6s. 8d.; British Insulated Wire Company, Limited, for the necessary cable for duplicating the high-tension mains to the central sub-stations, £482. 17s. 11d., with the addition of the usual guarantee charge of 1 per cent. after the first 12 months, also 12 disconnecting boxes, £38. 5s.; Messrs. Johnson and Phillips, for supplying and erecting an exciter, £262; Messrs. E. Green and Son, Limited, new sections to the economiser, £110.

Exeter.—The City Council have received the following tenders for the erection of electricity station buildings:

C. Brealey, Exeter	£27,096	5	10
B. Cooke and Co., London	23,895	0	0
A. N. Cole, Stonehouse	18,927	0	0
R. F. Ridd, Bristol	18,300	0	0
A. Krauss, Bristol	17,000	0	0
W. Cowlin and Sons, Bristol	16,900	0	0
W. Gibson, Exeter	16,000	0	0
Woodman and Son, Exeter	15,979	0	0
Mingo and Boon, Exeter	15,818	0	0
G. Herbert, Exeter	15,432	0	0
Horn and Passmore, Exeter	15,405	0	0
Westcott, Austin, and White, Exeter	14,344	0	0
Stephens and Son, Exeter	13,990	0	0
W. Brealey, Exeter	13,905	0	0

Hammersmith.—The Council have received the following tenders for the supply of six 50-kw. transformers:

		Drop in volts.	Magnetising watts.	Temp. rise, deg.F.
British Electric Transformer Co.*	£540	1·5	375	50
International Electric Company	546	0·2	450	72
British Westinghouse Electric Co.	552	1·45	658	†40
J. Fowler and Co., Leeds	564	1·8	450	60
British Thomson-Houston Co.	570	1·75	500	†48
Siemens Bros. and Co.	573	1·5	620	70
British Schuckert Electric Co.	600	1·5	880	70
J. Fowler and Co.	606	1·8	450	60
S. Z. de Ferranti	618	1·8	440	50
Electric Construction Co.	630	1·5	460	85
Johnson and Phillips	690	0·2	425	52
Brush Electrical Engineering Co.	822	1·5	450	40

* Accepted. † Centigrade.

London County Council.—The following tenders have been received for wiring and fittings in connection with the lighting of the Manchester-square, Bishopsgate, and Brompton fire stations by electricity:

Manchester-square.

G. Forrest and Son*	£236	10	0
Drake and Gorham	243	15	0
F. A. Glover and Co.	245	0	0
Lighting Corporation, Limited	256	9	6
C. Esson	259	0	0
F. J. Coleby and Co.	295	10	0
Laing, Wharton, and Cunnington	299	16	0
E. P. Allam and Co.	312	16	0
J. Sperati	378	0	0
Wells and Co.	470	0	0

Bishopsgate.

G. Forrest and Son*	208	10	0
Drake and Gorham	220	15	0
F. A. Glover and Co.	220	0	0
Lighting Corporation, Limited	233	10	6
C. Esson	215	0	0
F. J. Coleby and Co.	273	12	0
Laing, Wharton, and Cunnington	238	12	0
E. P. Allam and Co.	274	10	0
J. Sperati	313	0	0
Wells and Co.	410	0	0

Brompton.

G. Forrest and Son*	122	10	0
Drake and Gorham	128	0	0
F. A. Glover and Co.	143	0	0
Lighting Corporation, Limited	147	6	6
C. Esson	125	10	0
F. J. Coleby and Co.	165	18	0
Laing, Wharton, and Cunnington	152	10	0
E. P. Allam and Co.	164	15	0
J. Sperati	186	0	0
Wells and Co.	230	0	0

* Recommended for acceptance.

Barnsley.—The Parks and Lighting Committee have received a number of tenders for the supply of two boilers for the electricity works, and have accepted that of W. Arnold and Co., at £1,865.

Exeter.—The City Council have received the following tenders for the supply of electric plant, with alternative sections A and B:

S. Z. de Ferranti, Limited	£26,461
British Westinghouse Company	28,989
British Electrical Company	28,625

Alternative tender (A).

S. Z. de Ferranti, Limited	24,657
British Electrical Company	28,715

Alternative tender (B).

S. Z. de Ferranti, Limited	26,300

BUSINESS NOTES.

TRACTION.

Sunderland.—The takings of the Corporation tramways for the fortnight ending July 20 were £2,500.

Worcester Tramways.—The Worcester Tramways Bill has been read a third time in the House of Commons.

Wolverhampton.—The annual report on the past year's working of the tramways shows a loss of £143. 15s. 3d.

Cardiff.—It is expected that the Corporation will be able to run cars on their newly-constructed tramlines on Jan. 1 next.

Wimbledon.—The District Council have rejected the recommendation of the Tramways Committee to introduce electric tramways in the district.

Central London Railway.—The directors announce a dividend for the half-year at the rate of 4 per cent. per annum, carrying forward £19,000.

Heysham.—The Urban District Council have resolved not to entertain the proposal of Messrs. Heape and Ledward to run electric trams in the Heysham district.

Waterloo and City Railway.—The directors recommend a dividend on the ordinary stock at the rate of 3 per cent. per annum for the half-year ended June 30 last.

Bedford.—The Council are considering the advisability of inviting applications from persons or companies willing to take over the powers conferred by the Bedford Corporation Tramways Order, 1900.

Swansea.—On Wednesday a Board of Trade enquiry was held to hear objections to the light railways order granted to the Corporation for the extension of the tramway service to Port Tennant, Brynmill, Sketty, Fforestfach, and Clydach.

Hampton.—The District Council and the London United Tramways Company have come to terms as to the introduction of tramways in the district, and the Council have decided to oppose the order being applied for by the Middlesex County Council.

Portsmouth.—Trial runs have been made over the main line of the new electric tramways, and very soon it is expected the public service will be commenced on the main sections. Satisfactory tests have also been carried out at the tramway power station.

Devonport.—The erection of the generating plant at the power station has so far advanced that an improved tram service has been put on. When the full power is available throughout the day the traffic will be still further augmented very considerably.

Cork Tramway Company.—In the Chancery Division this week the Master of the Rolls granted an extension of time, for a fortnight, for the registration of certain debentures issued by the Cork Electric Tramways and Lighting Company since the new Act was passed.

Bradford.—With praiseworthy expedition, the overhead equipment of the Corporation tramway from Horton Bank Top to Queensbury has now been completed, and a trial journey was made over the new line on Monday. The inspection of the Board of Trade is now awaited.

Volk's Railway.—The work which has been going on for some time in connection with the extension of Volk's electric railway east of Paston-place groyne, at Brighton, is now complete. The line therefore now runs from the Aquarium to Black Rock, and is open for traffic.

New Tramways.—The Committee of the Chairman of Ways and Means have passed Bills confirming provisional orders made by the Board of Trade relating to Cheriton, Colchester, Littleborough, Folkestone, and Weston-super-Mare. The Bills had already passed the Lords.

Mr. Behr's Proposed Monorail.—Sir D. M'Iver's Committee of the House of Commons has passed the Bill for the construction of a high-speed railway on the monorail principle between Manchester and Liverpool. The scheme has already received the sanction of the House of Lords.

Stroud.—A crowded meeting was held at Painswick on Thursday week to consider Mr. Nevin's scheme for an electric light railway between Stroud and Painswick, the estimated cost of which is about £48,000, or £12,000 per mile. The meeting unanimously approved the scheme.

Hampstead.—The Borough Council have decided to inform the London County Council that the Council are not prepared to contribute one-third of the net cost of the necessary street widenings in connection with the proposal to construct a tramway from the Marble Arch to Cricklewood.

Sheffield.—The Corporation Tramways Committee some time ago decided to embark on the building of tramcars, and six are now nearly

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completed, and will be put on the streets in a short time. It is intended to purchase turning machinery, and to greatly develop this branch of the committee's work.

Brighton.—At to-day's meeting of the Corporation a motion will be submitted for the rescinding of the resolution to run a Sunday service on the tramways when completed. Mr. Thomas B. Holliday, the tramways engineer, has prepared a report on the advantages of adopting the stopping-place system in working the cars.

Southgate.—The Middlesex County Council have notified the Rural District Council that it is proposed to have the roads over which the light railway would be laid 50ft. wide except in places where there are bridges and where prohibitive prices are charged for the land. The roads would be maintained at the expense of the Council.

Northampton.—The tramways company and a specially-appointed committee of the Town Council have now practically come to terms as to the purchase of the company's system, the price being £37,000, a sum considerably less than that originally asked. The Council has passed the necessary resolution for the compulsory acquisition of the undertaking.

Selkirk.—A public meeting has been held to consider a proposal to construct a light railway from Selkirk to St. Mary's Loch. The promoters' report stated that it was proposed to start from near Selkirk Bridge and run up the valley to St. Mary's Loch, a distance of over 16 miles. The total cost is estimated at £70,000. It was unanimously agreed to support the scheme.

Bilston.—The District Council have approved plans submitted by the British Electric Tramway Company showing the routes of the proposed tramways in the district. It was stated at the meeting of the Council that progress was being made with the line between Dudley-road and Bilston, so that there was a prospect of communication with Sedgley, if not with Wolverhampton.

Ealing.—A numerously-signed petition has been sent to the District Council complaining of the injury caused to the health and other interests of the residents along the main road by reason of the "great speed and excessive number of the newly-inaugurated electric trams." The Council has appointed a deputation to wait on the tramway company with a view of minimising the trouble.

Southport.—In about a week the Roe-lane tramway track will be laid as far as the corner of Leyland-road. Then, by arrangement with the Southport Tramways Committee, the company's cars will be enabled to run over the Corporation route, along Manchester-road to Lord-street. An agreement has been come to between the Corporation and the company for the use of the Corporation track specified.

Hastings.—The tramway question is becoming complicated. The latest development is the service of a writ by the opposition on the Corporation asking for an injunction to restrain the Corporation from acting upon the agreement which they have concluded with Mr. Murphy in favour of electric tramways, it being contended that it is *ultra vires*. The Corporation have decided to defend the action.

Vibration Claim.—The church of St. Mary-le-Bow is the latest structure to suffer damage on account of vibration from the running of the trains on the Central London Railway. On Tuesday the Common Serjeant and a jury were engaged in hearing a claim of £10,000 in respect of this damage, but while the jury had gone to view the church the parties agreed to a verdict for £1,000, and so the case ended.

Halifax.—The Corporation tramway manager has prepared a report on the subject of effecting economy in the working of the tramways system. He suggests, in addition to several alterations in the service, to double the lines on certain routes and to construct loops on the Booth Town and Illingworth sections. The Tramways Committee have decided to adopt the manager's recommendations with one exception.

London County Council.—On Tuesday evening the London County Council agreed to make application for powers to construct, *inter alia*, new tramways along the Victoria-embankment from a point near Westminster Bridge to a point near Blackfriars Bridge. The Council further approved an expenditure not exceeding £400 in connection with the construction, under the chief officer's supervision, of a motor fire-engine.

Beckenham.—While the majority of the urban district councillors are in favour of the introduction of electric tramways in the district, a certain number are decidedly antagonistic to the proposal. At the last meeting of the Council a motion was negatived that a representative committee be formed to communicate with the frontage owners, property owners, and everyone interested in the matter in order to oppose tramways.

Barrow.—After a smart discussion, the Town Council on Monday resolved: "That the trams be taken over by the British Electric Traction Company, the Corporation being able to absorb them at given periods." It is provided in the agreement that the British Electric Traction Company are to use their best endeavours to complete the line for electric traction on the overhead system within six months of the contractor commencing work. The estimated cost is £60,000 to £65,000.

Leicester.—Mr. E. Manville, the consulting engineer for the Corporation tramways, has prepared a supplementary report, in which he reaffirms his recomemndation to the Council to provide a separate power station for tramway purposes on the continuous-current low-tension system on the Lero site. At the meeting of the Corporation on Tuesday, the Lero site for the tramways power station was approved. The agreed price to be paid by the Corporation for the old tramways is £134,000.

Paisley.—At present, under Mr. Murphy's Tramways Bill, the Corporation may supply the necessary power to work the tramways from their power station, but they may, if they so resolve, cease to supply the power. Mr. Murphy now desires a readjustment of the clause, so that if the Corporation begin to supply the power, they shall be compelled to continue it. The Corporation decline to accede to this proposal, which would make them anticipate the future, and they have lodged a protest with the Scottish Office.

Stourbridge.—At this week's meeting of the Urban District Council the Railway Committee reported that, with reference to the proposed tramway extensions to Lye and Wollaston, there had been negotiations in relation to road widenings on part of the route. The County Council would share in the expense of the projected widenings, and it was necessary that their consent to the proposals should be obtained. It was resolved to purchase a plot of land in Birmingham-street, adjoining the present depôt of the Council.

Cheltenham.—A somewhat serious accident occurred on the new electric tramline running to Cleeve Hill on Monday night. A car was making a trial run, and had nearly reached the summit of the hill when, it is said, the current failed, and the car commenced to go backwards. The brakes failed to arrest its downward progress, and the speed was so great that at Southam corner the car overturned. Two workmen were crushed to death by the falling car. The new line was awaiting official inspection, which was announced for Tuesday.

Greenwich.—At the last meeting of the Borough Council the General Purposes Committee reported the consideration of the proposal of the London County Council for the widening of Blackheath-road, Blackheath-hill, Shooters' Hill-road, and New-road, in connection with the proposed tramway across Blackheath. The estimated net cost was stated to be £4,000, and the cost of forming the tramway £9,100. The Council, while consenting to the proposal to construct the tramway, decided that they were not prepared to contribute to the cost of widening the roads.

Hendon Tramways.—Mr. Jeffrey's Committee of the House of Commons have unanimously refused to pass the preamble of the Bill for the construction of electric tramways from Hendon and from Finchley to Golder's Green, with proposed extensions to Hampstead, and so on to London by the authorised tube, thus reversing the decision of the House of Lords Committee. Opposition was raised by the Hendon Urban District Council, and by 113 frontagers, on the ground of injury to the amenities of their dwellings and land. The Middlesex County Council also objected to the Bill in its present form.

Norwich.—The Corporation have decided that the tramways company shall be allowed to abandon the construction of certain short lengths of line, and shall be repaid the £10,000 now on deposit as security for the performance of the work within the specified time. The consideration offered by the company for this advantage is that they will, if called upon, complete by April next the tramway in Unthank-road, between Mile End-road and Judge's-walk, or in the alternative, at the option of the Corporation, will within six months construct additional lines in Oxford-street as desired by the committee.

Aberdeen.—The accounts of the Corporation tramways for the 12 months ended May 31 last show the revenue to have been £35,452. 10s. 9d. Traffic expenses amounted to £8,533. 11s. 3d. In electric traction the Corporation spent £2,524. 3s. 7d., of which the largest item was for current, amounting to £1,997. 12s. 7d. A sum of £2,850. 2s. 7d. was spent in maintenance, and in general charges the outlay came to £2,453. 4s. 7d. The maintenance of rolling-stock was responsible for £1,421. 11s. 8d., and rates, salaries, and other charges involved considerable outlay. The total working expenses came to £26,683. 7s. 9d., and the balance carried to net revenue account is £8,769. 3s.

Birmingham.—The City Council on Tuesday decided to promote a Bill in the next session of Parliament conferring upon the Corporation power to work tramways, to reconstruct and alter existing tramways, and to work new tramways, including authority to construct tramways between the centre of the city and the districts of Edgbaston and Harborne. It was stated that in the matter of traction the committee were looking to electricity, but they were not pledged to any particular form of electric traction. They would soon have further information from London and Wolverhampton as to the conduit and surface contact systems, and would be able to decide better in view of this information.

West Riding Extensions.—The Bill to confirm a provisional order made by the Board of Trade relating to West Riding tramways came this week before the Chairman of Ways and Means of the House of Commons as an unopposed measure, having already passed the House of Lords. The order authorises the United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited, to construct tramways in the borough of Pontefract, the urban districts of Castleford, Featherstone, Normanton, and Whitwood, and the rural district of Pontefract, all in the West Riding of Yorkshire. Formal proof of the preamble having been submitted, the measure was ordered to be reported for third reading.

Greenock and Port Glasgow Tramways.—The directors in their report state that the balance of net revenue brought forward from last half-year was £123, the total receipts on revenue account £5,085, and the working expenditure £4,212, showing a balance of revenue of £995. Owing to the reconstruction of the lines and the consequent decrease in receipts, no dividend will be declared for the half-year ending June 30. The sum of £165 will be carried forward. The shareholders have received a circular, dated July 24, from the British Electric Traction Company, Limited, intimating their willingness to purchase the shares in the company at the price referred to in the agreement of June 8, 1898.

Lancaster.—At the monthly meeting of the Town Council on Wednesday, a memorial, signed by 1,454 inhabitants of Skerton Ward, was read praying for the Council to reopen the negotiations for the purchase of the Lancaster and District Tramways Company's line from Lancaster to Morecambe, which passes through a portion of Skerton. The Corporation intended to convert the line into an electric

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tramway and extend it along Slyne-road, where there has been a lot of building development. It has already been decided to proceed with an electric tramway to Scotforth and Williamson Park, at a cost of £26,000. After discussion, in which it was pointed out that it would be necessary to act in conjunction with the Morecambe District Council, the memorial was referred to the Tramways Committee.

London United Tramways.—The Select Committee of the House of Lords of which the Duke of Northumberland is chairman have passed the preamble of the Bill of the London United Tramways Company, Limited, for power to electrically equip part of their existing system and to make extensions to Barnes and Richmond, and from Hampton Wick to Malden and Coombe, Surbiton, Thames Ditton, and East Molesey. A clause was agreed to with the water companies to meet the objections to the Bill on the question of electrolysis. The only other objections were in regard to the two bridges at Kingston and Hampton Court. It was eventually agreed that in the event of it being found necessary to rebuild either or both of these bridges, one third of the cost should be borne by the company. The preamble of the Bill, with the exception of the Kew-road line, was then passed.

Bristol. — A largely attended meeting, called by the Gasworkers' and General Labourers' Union, was held on Sunday to discuss the relations between some of the tramway employés and the company. It appears that the company have discharged 92 of their employés on account of their having joined the union. The meeting unanimously passed a resolution that all the working classes should boycott the tramways during the present week. On Wednesday the friction between the employés of the Bristol electric tramway and the company reached a crisis. Three hundred men who had joined the Gasworkers' Union and had given a week's notice to terminate on the eve of bank holiday, were paid a week's wages and discharged. The company will replace them, but in the meantime they are running a smaller number of cars and are taking proceedings against the men for intimidation. After dark on Wednesday evening, as affairs looked threatening, the service was suspended, and the cars sent to the depôts.

Southampton.—The Corporation have decided upon several extentions of the existing Corporation tramways. The report of the borough treasurer on the tramway undertaking for the year ended March 31 last shows that the total income amounted to £34,178. 18s. 8d., and the expenditure to £22,238. 15s. 3d., leaving a gross profit for the year of £11,940. 3s. 5d. After deductions, interest on stock, etc., this leaves a net profit of £7,021. 11s. 2d. The accumulated profits for the nine months ending March 31, 1899, and the 12 months ending March 31, 1900, amounting together to £4,163. 9s. 10d., have been brought into this year's transactions, so that the total amount of profit to appropriate for the two years and nine months amounts to £11,185. 1s. The Council has already appropriated £8,163. 9s. 10d., so that the balance left for further appropriation amounts to £3,021. 11s. 2d. It has been referred to a sub-committee to allocate the amount of £3,021. 11s. 2d. to meet the depreciation over the various accounts.

The Middlesex Light Railway Schemes.—The Light Railway Commissioners last week opened an enquiry at Hounslow as to the expediency of granting the applications, or either of them, made by the Middlesex County Council and the London United Tramways Company, Limited, for extensions of light railways in Middlesex, the Earl of Jersey, G.C.B., and Colonel Boughey, C.S.I., being the commissioners. On the conclusion of the evidence for the Middlesex County Council scheme, the Earl of Jersey said: "We think very inaccurate estimates must be fatal to a scheme like this. It is very essential that a public body should, above all combinations of people, present carefully thought-out estimates. In going over the scheme, Colonel Boughey and I were both struck with what we thought were inadequate estimates, and the short enquiry we have held has proved them to be more inadequate than what we thought, and we should certainly not be justified in creating a precedent, which we have been asked to do, by allowing estimates which are confessedly inadequate for the purpose of the undertaking, to count as being substantially correct. Therefore it is no use continuing this scheme." The hearing of evidence on behalf of the application of the London United Tramways Company was then proceeded with.

New Issue.—The Blackpool Electric Tramways (South), Limited, has been registered for the conversion of the existing Blackpool, St. Anne's, and Lytham tramway system into an electrical line with various important additions, and eventually an extension to the town of Preston and the Preston Docks. The whole of the district through which this line will run is being rapidly developed, and there is no doubt that the inhabitants will readily support the enterprise. The company's prospectus states that the contractors have obtained an option to purchase the effective majority of the shares of the company. An Act of Parliament has now been obtained for the conversion of these lines for electric traction, the laying down of double lines, and the increase of speed, so that it may equal the rest of the Blackpool system. The present issue consists of 10,000 5½ per cent. cumulative preference shares of £10 each, 15,000 ordinary £10 shares, and 1,500 5 per cent. mortgage debentures of £100 each, issued to trustees, and against which £150,000 mortgage debenture stock is to be created, divisible as may be required. The debenture stock is redeemable after 1915 at the option of the company at £105. Interest on the debenture stock and dividends on the preference shares are, it is said, guaranteed by the contractors during the conversion of the line.

Edinburgh.—The Corporation and the tramways company are at loggerheads on the subject of the tramways. In reply to the Corporation's demand for immediate payment of arrears of interest, the directors of the tramway company state that they will meet any action taken to recover the sum by the plea that they have not been in possession of a workable system, and have therefore been unable to earn the interest agreed upon, which they ask should be reduced to 5 per cent. next year, 6 per cent. the following year, and thereafter the 7 per cent. agreed on under the lease. The Corporation under the lease are entitled to recover the balance of rent due, either by realising the stock held in security or by entering into possession of the tramways. The Corporation have remitted it to the Lord Provost's Committee to press for immediate payment or consignation of the arrears of rent due at Whitsunday last, with power to adopt legal proceedings for recovery, and also to enforce the other obligations incumbent upon the lessees and their co-obligants; and, further, to consider and report upon the alternatives open to the Corporation in regard to the tramways, with power to the committee, if they consider it advisable, to put in operation the Corporation's power under the lease to enter into possession and work the tramways until further instructions from the Council.

Darlington.—We take the following cutting from the *Leicester Daily Post*: "Three weeks ago the Darlington Corporation formally put an end to their prolonged difficulties with the Imperial Tramways Company by purchasing the existing tramways in the borough, and acquiring a provisional order empowering them to construct and work, or to contract for the construction and working of light railways. Now they have before them a proposal—which was most favourably received at an informal gathering of the Council—from the Electromagnetic Traction Company, who desire to put down and demonstrate the practicability and superiority of a totally new system of surface traction on electric railways. So far the new method has not been tried in any municipality, and the Darlington Corporation are asked to enter into an agreement for a small experimental section of a mile, or less, for the purposes of demonstration. The new system differs from all other methods in that there are no slots in the street surface, and no unsightly poles or overhead wires required. The necessary current is obtained from a flexible electrical conductor (or cable) underneath the track by means of a powerful magnet and brush operating on studs running at frequent intervals between the metals. By this means the flexible conductor is brought in contact with the studs as the car passes over them, and as the car proceeds it receives a continuous supply of current, the flexible conductor falling back into its bed, and becoming quiescent immediately the car and magnet have moved on. The proposal of the company includes a guarantee against loss to the Corporation, inasmuch as in the unexpected event of their system not proving satisfactory they will substitute over the experimental section (without extra cost) an approved method of overhead traction."

LIGHTING AND GENERAL.

Nuneaton.—The Urban District Council intend to apply for sanction to borrow £1,200 for extension of mains.

Portsmouth Telephones.—We understand that there are about a thousand telephone subscribers in the city now.

Yorkshire College, Leeds.—The twenty-eighth session will begin Oct. 1, 1901. Prospectus may be obtained from the Registrar.

Heckmendwike.—The District Council have decided to adopt the system of free wiring to consumers, and the engineer has been instructed to obtain tenders for the same.

Southgate.—The Urban District Council have deferred consideration of the question of a provisional order for electric lighting until a meeting of the Joint Committee has been held.

Westminster Electric Supply Co.—The directors have declared an interim dividend for the half-year ended June 30 at the rate of 10 per cent. per annum, less income tax, payable Sept. 1.

Finchley.—The Urban District Council are advertising for a resident electrical engineer. Applications received will be opened on Aug. 19. The commencing salary will be £250 per annum.

Brush Electrical Engineering Co.—The directors have declared an interim dividend at the rate of 6 per cent. per annum on the preference shares for the half-year ended June 30, payable Sept. 1.

Metropolitan Electric Supply Co.—The directors have declared an interim dividend of 6s. per share on the original shares and 4s. 6d. per share on the new shares, being at the rate of 6 per cent. per annum.

Kensington and Knightsbridge Electric Lighting Co.—The directors have declared an interim dividend at the rate of 10 per cent. per annum for the half-year ended June 30 last on the ordinary shares.

Share Market.—There was hardly anything doing in electric shares during the week. Tractions were especially neglected; debentures were in demand. The week's feature was the great fall in Edison and Swans.

Removal.—The registered offices of Accumulator Industries, Limited, have been transferred to the works premises at Maybury, Woking, Surrey. The London offices remain, as heretofore, at 14, Silver-street, Bloomsbury, W.C.

New Branch.—Electromotors Limited, Openshaw, Manchester, have opened a London office at Cornwall-buildings, 35, Queen Victoria-street, E.C., and have appointed Mr. G. H. Congdon their sole representative for London and district.

Dundee.—The amount of electricity rental collected for the months of May and June was £1,202. 15s. 9d., being £601. 5s. 3d. for May and £601. 10s. 6d. for June—an increase as compared with the total for the corresponding months last year of £974. 9s. 6d.

Grays.—The cable-laying is nearly completed. Up to the present 25 meters and the same number of demand indicators will be required for fixing on consumers' premises. Tenders for the instruments and for the required supply of steam coal for the works have been issued.

Barnsley.—The Standing Joint Committee have agreed to light the whole of the county police buildings at Barnsley with the electric light. At the last Town Council meeting the Parks and Lighting Committee

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were instructed to consider the question of a municipal telephone exchange.

Amble.—The Urban District Council on Wednesday received the engineers of the Northern Counties Electricity Supply Company, Limited, who explained the details of their proposed application for powers to supply electricity for public and private use within the district of Amble.

Gwyrfa.—The District Council are in communication with Mr. Peterson, solicitor, London, in connection with schemes of electric lighting, etc., in different parts of Carnarvonshire, who intends to renew his application for a provisional order to light the district of Gwyrfa with electricity.

Aberdeen.—The proposed electric lighting of the town and county hall has been left with the Finance Committee of the Commissioners under the Aberdeen County and Municipal Buildings Act, 1866. The probable cost of introducing the electric light to the hall will be about £220, and to the staircases £45.

Burnley.—Mr. W. A. Ducat has held an enquiry into the borrowing by the Corporation of £11,448 for electric lighting purposes. It is significant, as a reply to the outcry that electricity does such great harm to gas companies, that the same enquiry extended over an item of £20,000 in respect of gasworks.

Walker.—The District Council have completed their loan of £33,550 for electric lighting, and notice has been given to the Newcastle Electric Supply Company that the Council are asking the Newcastle Corporation to reconsider the price charged for the site for the electric works with a view to a reduction.

Chislehurst.—The Chislehurst Electric Supply Company have obtained permission to lay their cable on the edge of the footpath across the Pauls Cray Common as far as "Leesons," subject to the road being reinstated to the satisfaction of the surveyor appointed by the Board, his fee to be paid by the company.

Bath.—At a recent meeting of the Electric Lighting Committee, Mr. Teague (electrical engineer) reported that during June they had had applications for 1,066 8-c.p. lamps, making a total at that date of 31,408. During the month they had connected on the mains 927 8-c.p. lamps. No installation had been discontinued.

Fire.—The directors of the St. Helens Cable Company, Limited, Warrington, ask us to state with reference to the fire which took place at their works on July 26 that no damage has been done to the machinery, and that work will be resumed immediately the fire insurance people have completed their assessment.

Stock Exchange.—The Stock Exchange Committee has ordered the Bournemouth and Poole Electricity Supply Company's further issue of 1,500 ordinary shares of £10 each, fully paid, Nos. 6,001 to 7,500, and 1,500 cumulative 4½ per cent. preference shares of £10 each, fully paid, Nos. 13,501 to 15,000, to be quoted in the official list.

Brynmawr.—We understand that the Urban District Council look with favour upon the proposed application by the Electric Supply Corporation, Limited, London-wall, London, for a provisional order, under the Electric Lighting Acts of 1882, 1888, 1890, granting to the applicants statutory powers under the said Acts within the urban district of Brynmawr.

Marriage.—On July 10 at St. Martin's-in-the-Fields, Westminster, Mr. Wm. Ernest Brandreth, resident engineer to the Wycombe (Borough) Electric Light and Power Company, Limited, was married to Mr. Daisy Challice, youngest daughter of Mr. Wm. Challice, churchwarden of St. Martin's. A reception and breakfast was afterwards held at the Trocadero Restaurant.

Brighton Telephones.—The Brighton telephone area has been referred to a committee of the West Sussex County Council, with power to cause the common seal to be affixed to an agreement giving consent to the construction of overhead telephone circuits in the said area, or any part thereof, on such terms and conditions and with such provisions as they think expedient.

Bedford.—The Urban Sanitary Authority require as a successor to Mr. Hope-Johnstone an electrical engineer, at a commencing salary of £350 per annum, such engineer to commence duties before the cessation of Mr. Hope-Johnstone's term of office—viz., Sept. 9 next. A further loan of £1,000 is to be taken up, and electric lamps erected on the Kempston-road and also in other streets.

Dunstable.—The Luton Rural District Council have written, in reply to the Town Council's notice of their intention to apply to the Board of Trade for an order for supplying electrical energy to Dunstable and the district, that the Rural District Council "did not approve" of such application. The Town Council have now decided to arrange with Mr. Snell to meet them at a preliminary conference to discuss the matter.

Huddersfield Telephones.—At a meeting of representatives of district councils within the area of the proposed Huddersfield municipal telephone exchange held on Tuesday to discuss the scheme and the terms offered by the Huddersfield Corporation, a committee was appointed to wait upon the Electricity Committee of the Huddersfield Corporation with a view to obtaining better terms and conditions than those offered.

Honley.—The Lepton and Kirkburton Councils having asked if the Council had not already agreed to the establishment of municipal telephones by the Huddersfield Corporation not to do so, as it was thought that better terms might be got, at the last meeting of the Honley Council a deputation was appointed to attend a meeting of those authorities which was to be held on the 30th ult. to consider the question.

Presentation.—Mr. Edgar J. Sanders, late manager of the Sir Hiram Maxim Electrical and Engineering Company's Works, was presented on Monday, by Mr. Carters, on behalf of the staff, with a handsome tobacco cabinet, suitably engraved; also with a salad bowl and servers, by Miss Daisy Rudd, on behalf of workers, who incidentally mentioned how kind he had been to them all, and how deeply they regretted his resignation.

Ashington.—A deputation representing the Northern Counties Electrical Supply Company, who are applying for the consent of the Ashington Council to supply electric power for lighting and other purposes, have had an interview with the Urban District Council in committee. We understand that the company propose to lay down plant between Ashington and North Seaton. A system of tramways is also contemplated for the district.

Epsom.—A number of extensions are to be carried out immediately. The charge for supply for motive power or heating purpose through separate meters is to be at the rate of 3d. per unit, and for rent of meters from 1s. a quarter up to 2s. a quarter, as follows: for 30 lamps, 8 c.p., 1s. a quarter, over 30 up to 50 lamps 1s. 3d., over 50 up to 100 2s., and 2s. for every additional 100. Mr. Foster is preparing a specification for lighting the Bromley Hurst and clock tower buildings by electricity.

Budapest.—It may be news to our readers that since July 1, 1901, it is by law prohibited to solicit orders from private people in Hungarian towns and villages. Only manufacturers or dealers in the special line offered can be bothered with travellers, circulars, catalogues, etc. There are, however, certain exceptions, and we are glad to be able to announce that the list of free custom extends to installation of lighting, motor power, and telephone apparatus. Scientific instruments are also exempt.

Stockton.—At a meeting of the Rural District Council on Wednesday a letter was read from the Cleveland and South Durham Electric Power Company advising the Council that they proposed applying to the Board of Trade for a provisional order authorising them to supply electricity to the rural districts of Stockton. The Clerk said in those circumstances it would be advisable to consider the question of applying themselves for a provisional order. The matter was referred to a special committee.

County of London and Brush Provincial Electric Lighting Co. The directors have declared an interim dividend on the preference shares at the rate of 6 per cent. per annum for the half-year ended June 30, and an interim dividend on the ordinary shares for the same period at the rate of 4 per cent. per annum. The amount of electricity sold in the Company's London districts during the half-year is estimated to realise £39,267, which compares with £24,359 for the corresponding period of last year.

Electric Propulsion, Limited.—This Company has been formed with a capital of £100,000 in £1 shares, the object being to acquire the British patent rights of the system of electric propulsion invented by Mr. W. J. Still, and to manufacture and deal generally in electric and other motors, storage batteries, and other electrical apparatus. The first issue is 75,000 shares, 20,000 of which will be taken by the vendor as part payment of the purchase money, while the balance of 55,000 shares are offered for subscription.

Brighouse.—The report upon the present condition of the electric lighting undertaking, which has been prepared by Messrs. Lacey, Clirehugh, and Sillar, is shortly to be considered at a meeting at which Mr. Clirehugh will be present. We cannot say much about the state of affairs until then, but a peculiar light was thrown on the position during a recent discussion of the Town Council, when it was said that £90 a year was paid as interest on capital expenditure, while no sinking fund for repayment of capital had been provided.

National Telephone Co.—The directors recommend the following dividends for the half-year ended June 30 last, after charging £17,673 against revenue, being the special expenditure incurred in repairing damage caused by the snowstorms in the early part of the year, at the rate of 6 per cent. per annum on the first and second preference shares, at the rate of 5 per cent. per annum on the third preference shares, and at the rate of 5 per cent. per annum on the ordinary shares, carrying £65,000 to reserve and about £6,000 forward.

West Ham.—The borough treasurer has prepared an interim statement of accounts of the electricity fund for the half-year ended March 31, 1901, from which it appears that the gross profit amounted to £1,614. 5s. 5d., but that after charging repayment of capital and interest, there was a net loss of £1,256. 3s. 3d. This deficiency is mainly attributable to a considerable increase in the capital charges, in respect of extensions which are not yet remunerative, and a reduction in the charge for current from 3d. to 2d. per unit.

Cowpen.—The Northern Counties Electrical Supply Company now suggest, with regard to the proposed lighting of the public streets by electricity, that double the proposed number of lamps be agreed to. The surveyor has reported that the company had submitted a plan showing the streets through which they proposed to lay the cable, but as that did not include all the streets they undertook to light, he wished to bring the matter to the notice of the Council. The whole question of lighting has been referred to the Sanitary Committee.

Hampstead.—The Council have adopted a recommendation of the Finance Committee to the effect that the London County Council be informed that this Council accepts their sanction to the borrowing of £9,525, being part of the sum of £12,667 applied for in respect of capital expenditure on the electric lighting undertaking in the year ended March 25, 1900, but reserves the right of making a further application, if necessary, for the sum of £2,810 on account of the purchase of meters, which is still under the consideration of the County Council.

Greenwich.—The Borough Council have decided to offer no opposition to the application of the Blackheath and Greenwich District Electric Light Company, Limited, for a provisional order for the supply of electricity in St. Nicholas parish, Deptford, provided a clause be inserted giving the Council the right to purchase so much of

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the undertaking of the company as should be in St. Nicholas parish at any time before the expiration of 42 years, limited by the Electric Lighting Acts, on payment of the sum of money expended by the company on that portion of the undertaking.

Royal Aquarium.—Those interested in biography, or biographology, ought to pay a visit to the Royal Aquarium, Westminster, where a series of Henley views are shown which are far ahead of anything we have yet seen. They are remarkable for their sharpness and steadiness. There is a total absence of flimmer. By an ingenious contrivance a double movement is produced, so that not only an ever-moving scene is presented, but the locality itself is imperceptibly changed at the same time, producing upon the spectator the illusion of walking along the river in full view of the ever-moving crowd.

Exeter.—The City Council at their last meeting considered the question of the building and equipment of the proposed electrical station at the Basin. They adopted a recommendation by the Electrical Lighting Committee to have the advice of an expert (to be selected from three names to be submitted by the President of the Institution of Electrical Engineers) on the plans, tenders, etc. There were 14 tenders for the building, the highest being £27,096 and the lowest £13,905—that of Mr. W. Brealey, 183, Cowick-street, Exeter. The tenders for the buildings will not be considered until the expert had reported.

Electric Lighting Bills. — In the House of Commons the Unopposed Committee presided over by Mr. Parker Smith, has just passed a Bill to confirm certain provisional orders made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888. Among other orders was one authorising Mr. Alfred Gibbings to supply electricity at Ilkley. The Bill has already been passed by the House of Lords. The same committee dealt with a Bill containing an order enabling the Corporation of Pudsey to supply electricity in the borough. This Bill, which also has passed the House of Lords, was likewise ordered to be reported for third reading.

Wireless Telegraphy.—The dangers of wireless telegraphy are well shown in a telegram from Toulon, referred to by the *Daily Telegraph's* Paris correspondent in connection with the French naval manœuvres. On the night of the 2nd ult. the "Bouvines" was entering the Straits of Gibraltar when its wireless telegraphy apparatus revealed to it the neighbourhood of a ship which was similarly provided. The "Bouvines" made overtures with a view to entering into communication, and it then ascertained, to the surprise of the officers, that the other ship was a British cruiser, and not, as had been imagined, one of the vessels of the French fleet.

Wimbledon.—The Maldens and Coombe Urban District Council having asked upon what terms the Council would be prepared to supply electric current for public lighting and private purposes in the Urban District Council's district, delegates were appointed to meet the representatives of the Urban District Council to discuss the matter. The last report of the electrical engineer on the position of the undertaking on June 30 last is as follows: private lamps applied for (in 8 c.p. equivalent) 28,125, street lamps connected (in 8 c.p. equivalent) 4,340, street lamps to be connected (in 8 c.p, equivalent) 180, total number of lamps to provide for 32,645, number of consumers on books 519, maximum load reached during the month 358 kw.

Church Lighting.—A special service was held at St. Lawrence Jewry, Gresham-street, yesterday morning, to inaugurate the installation of the electric light. The sacred edifice, sometimes called the Lord Mayor's Church, owing to the Lord Mayors worshipping there, is noted for its stained-glass windows and mosaic work; and redecoration has been going on, step by step, for the last two years. The Rev. J. Stephen Barrass, rector, and chaplain to the Lord Mayor, explained in the cause of his inaugural address that it might seem strange to many to hold such a service at mid-day, but the fact was the population of the parish during the day numbered thousands, whereas at night it only amounted to a few hundreds. It being one of the many churches in the City open daily for rest and prayer, the congregation was therefore larger during the day than if the service were held at night. The work was carried out by Messrs. Hulett, of Holborn.

Maidenhead.—The Town Council have adopted a report of the Electric Lighting Committee stating that the committee had been approached by the Kitson Light Company with a view to the lighting of the town with their patent oil lamps, and they had had submitted to them the conditions under which the company were prepared to erect and maintain for 12 months 20 1,000-c.p. lamps, by way of experiment, and with a view to their replacing the arc lamps contemplated under the electric lighting scheme, at a greatly reduced cost. The committee did not recommend any departure from the proposals contained in the scheme submitted to the Local Government Board, on the ground that the Kitson light was still in an experimental stage. The committee had also considered the question of the desirability of driving by gas-engines using Mond gas, and they recommended that the original proposals providing for steam-engines be not departed from. The committee have received a number of tenders for the electric lighting loan.

London Gazette.—The estate of B. Symmons (trading as B. Symmons and Co.), 2, North-street Quadrant, Brighton, has been released from trusteeship. The partnership subsisting between A. C. Brackstone and A. McTavish, electricians, 24A, High-street, Bath (trading as Brackstone and Co.), has been dissolved by mutual consent. Mr. C. W. Provis, jun., chartered accountant, 3, Mount-street, Manchester, has been appointed liquidator to the Electrical Inventions and Manufacturing Company, Limited, to whom particulars of the debts and claims are to be sent. Mr. M Fletcher, 47, Lichfield-street, Wolverhampton, has been appointed liquidator to the Electric Street Car Manufacturing Syndicate, Limited, to whom particulars of debts and claims are to be sent. The final meeting of the World Gas and Electric Syndicate, Limited, will be held at 27 and 28, Broad-street-avenue, E.C., on Aug. 30 at 2 p.m. The final meeting of the Electric Light Insurance and Maintenance Company, Limited, will be held at 100, St. Martin's-lane, W.C., on Aug. 27 at 1 p.m.

Bristol.—The accounts of the electrical undertaking for the year ending March 25 last give the number of consumers at that date as 1,507, being an increase of 292 during the year. The total connections to the mains are equivalent to 119,615 30-watt lamps, as compared with 91,117 at the corresponding period of last year, made up as follows—viz., 9,389 taking energy at the power rate, 104,985 taking energy at the lighting rate, and 5,241 representing the public street-lighting; this being an aggregate increase equivalent to 28,498 lamps, as follows: power connections, 6,619; private lighting, 21,799; public lighting, 80 (the increase in private lighting alone exceeding the total additions of any previous year). The number of units sold was 2,191,559, being an increase of 379,048. The use of electric motive power has continued to increase, and the committee are pleased to find that the sale of current for that purpose has more than doubled during the year. The gross receipts amounted to £37,398. 8s. and the gross expenditure to £25,725. 19s. 8d., leaving a gross profit of £11,672. 8s. 4d.

American Copper.—Copper production in the United States in June again showed a slight decrease from last year's total, and for the half-year ended June 30 the total production was 133,394 tons—1,183 tons, or 0·8 per cent., less than the output for the first half of last year—so that the rate of production was practically stationary. The apparent consumption of copper in the United States in the period has, according to the *Engineering and Mining Journal*, been much greater than in the corresponding half of 1900. Deducting exports from production, the quantity of copper retained in the country this year was 85,367 tons; in the first half of last year it was 44,348 tons. Last year's phenomenal exports have not been repeated. The exports, says the *Journal*, show the present stagnant condition of business outside the States, since they were only 48,027 tons, against 90,229 tons—a decrease of 42,202 tons, or 46·9 per cent. In spite of this falling off the copper seems to have been absorbed, as there do not appear to be any large accumulations of metal, nor is there any complaint of difficulty in disposing of copper.—*Financial News.*

Poole.—The Town Council have adopted a report of the Lighting Sub-Committee, stating that a letter had been received from the Board of Trade in reply to the request of the Council to the Board to revoke the Poole and Branksome electric lighting order, enclosing copy of a letter received by them from the Bournemouth and Poole Electric Supply Company, Limited, and stating that, in view of such letter, the Board, as at present advised, were not disposed to revoke the order, and the committee recommended that the town clerk be instructed to write the Board of Trade and point out many inaccuracies contained in the company's letter, in consequence of which it is presumed that the Board arrived at the determination not to grant the request of the Council. The committee further reported upon the letter received from the Branksome Urban District Council asking the Council to light the lamps in Ashley-road during the whole of the year that, inasmuch as the Council have for several years past decided not to light the lamps throughout the borough during the summer months, it would be inadvisable to make a distinction between different parts of the borough.

Dundee Telephones.—A scheme for a system of municipal telephones is now before the Town Council in the form of a printed report by the sub-committee appointed in connection with the question. The first part deals with the visit of enquiry to Glasgow, and figures are given relating to the municipal telephones in this city. The committee have also received the following letter from an eminent firm of telephonic engineers in Manchester: "Failing the decision of Dundee to put down a municipal exchange, we are in a position to introduce a firm of strong financial stability who would be willing to do this work. The inclusion rates to subscribers to not exceed £5 per annum, or alternative rate of £3. 10s. per annum, with ½d. per outward call. The Corporation to have the right to take over the whole undertaking at the termination of any year. Under the Telephone Act the subscribers would have all the privileges now enjoyed by the National Company's subscribers in the Dundee area, or over the Post Office trunk wires with any other exchange in Great Britain." The sub-committee are of opinion that at a £5. 5s. rate the undertaking would form a great public convenience, and prove to be a sound commercial undertaking. They advise the Council to proceed, and to circularise the town for subscribers.

Eccles.—At the last Council meeting, a report of Mr. C. H. Wordingham upon the scheme of the borough electrical engineer for the extension of the electric light undertaking was submitted containing the following recommendations: "Speaking generally, I concur with the report of your resident engineer—that is to say, I recommend you to undertake the supply of electrical energy for traction, and to put down the plant on the site of your present station. I agree with the modification of your lighting system, whereby transformers in sub-stations will be substituted for those in consumers' premises where possible. I think the general scheme for enlarging the station whereby more land is required and the present roadway is done away with, is the best that can be devised under the circumstances. I must point out, however, that neither detailed drawings nor specifications have yet been prepared, so that my remarks apply only to the general arrangement. Finally, I think it is justifiable to increase the charge for public street-lighting, and that the price named is a fair one. The suggestions which I have made do not affect the general scheme, but if they are carried out they would, I think, improve it, and enable you to work the combined undertaking with increased economy." The town clerk was instructed to apply for sanction to the borrowing of £20,500 for the extension of the electric light undertaking in accordance with the scheme of the borough electrical engineer and the recommendation of Mr. Wordingham. The borough electrical engineer was instructed to prepare the necessary plans for the extension of the

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electric light undertaking, on the lines of his report and the recommendations of Mr. Wordingham, for the consideration of the committee at an early date.

Hammersmith.—At Wednesday's meeting the Electricity and Lighting Committee reported that since the last Council meeting eight additional consumers had been connected, representing a maximum of 192 8-c.p. lamps; these added to the number previously reported showed a total of 915 consumers taking current from the mains. On May 22, 1901, the Council resolved to enforce the provision of the provisional order which authorises the Borough Council to make a minimum charge to consumers of 13s. 4d. per quarter. Having received several letters from consumers asking that the matter might be reconsidered, and consider that the Council's decision may be somewhat modified, the committee recommended that the minimum charge of 13s. 4d. per quarter be not enforced in cases where the average of the current quarter's account and of those for the previous three quarters of the year exceeds that amount, and that the resolution of May 22 be construed accordingly. They also recommended the Council to approve of the principle of the Bill which the County Council propose to introduce into the next session of Parliament, empowering local authorities supplying electric light to wire premises and put fittings therein to enable persons who desire to use the electric light to do so, and authorising the local authorities to obtain from the Council loans to enable them to carry out such works. A number of tenders for the supply of six 50-kw. transformers, which appear in another column, have been received, and the committee stated that having received a report from the engineer to the effect that the British Electric Transformer Company supplied three years ago 12 transformers, which, although they gave a little trouble at first, have since been working satisfactorily, they recommended that the tender of the British Electric Transformer Company be accepted. With reference to the tenders for supplying electricity meters, the engineer has been instructed to obtain samples of the meters quoted for by the contractor whose tender is the lowest, and a further report upon the subject will be submitted after the recess.

Manchester.—The report of the Electricity Committee of the Manchester City Council for the year ended March last states that the number of consumers at the close of the year was 3,790, an increase of 550 on the previous year. The total number of lamps connected was: incandescent (of 8 c.p.) 279,860, arc 2,316, as compared with 237,145 and 2,139 respectively. In addition to these, there were 672 motors in use, representing 6,560 h.p., being an increase on the next preceding year of 172 motors, equivalent to 4,510 h.p. The total output of electricity from the works during the 12 months amounted to 9,639,973 units. The quantity measured and accounted for was 7,944,540, showing a loss of 1,695,433 units, or 17·58 per cent., due to loss in distribution. There was a net profit on the year's working of £3,515. 10s. 6d. This surplus, plus the amount withdrawn from the reserve fund (£484. 9s. 6d.), makes up the amount (£4,000) which was paid to the city fund in aid of rates. The following statement shows the financial position of the undertaking at March 31, 1901: total capital expenditure, £863,293. 1s. 2d.; mortgage debt, £722,273. 7s.; amount of mortgages redeemed to date by action of sinking fund, etc., £67,837. 13s.; balance at credit of reserve fund account, £13,172. 2s. 11d. Since the appointment of Dr. Kennedy in January last to design and equip the Stuart-street generating station and the various sub-stations connected with it for the first installation of 15,000 h.p. rapid progress has been made. Tenders have been accepted for the whole of the engines, generators, boilers, etc., required for this installation, and it is expected that a proportion of this plant will be erected and ready to supply current by May 31, 1902. At the Bloom-street station the iron and steel work of the first pair of boilers and a portion of the first engine and generator are now in position. Tenders have been obtained to the specifications of the chief engineer (Mr. G. F. Metzger) for the various plant required to complete the equipment of these works, and it is anticipated that one set of generating plant will be in readiness for the output of electricity at the beginning of October to assist in meeting the heavy demands for current during the winter. Applications from new customers cannot be considered until the committee are advised that this station can be made available for next winter's work. Upon the completion of the work at Stuart-street and Bloom-street stations the committee will be in a position to provide the energy required for working most of the tram routes which the Tramways Committee are preparing to work electrically in May next year, and also to furnish an efficient supply of current to several of the out-districts whose electric lighting orders have been taken over by the Corporation.—*Manchester Guardian.*

Stowmarket.—We extract from the *East Anglian Daily Times* the following description of the new works of the Anglian Engineering Company, Limited: "The factory of the Anglian Engineering Company is the first and only undertaking of this kind in the county. The firm are fortunate in being able to make a speciality of a patented design of continuous-current enclosed electric motor—a description which means that the motor is constructed in such a manner that all its moving and vital parts are enclosed and protected within its own cast-iron or steel body, and may on this account be subjected externally to almost any amount of rough treatment without sustaining any damage. It is specified in the rules of nearly all insurance companies that only motors of this description may be employed, except when the motor is situated in a building expressly set apart for electrical machinery. The reason for this, of course, is the immunity of the enclosed motor from fire risk, as compared with the so-called 'open type' of motor, which it has practically superseded. By the patentee this particular form of motor has been named the 'Bull' motor. The title is intended to be symbolical of strength, and in this respect it appears to be in every way well chosen. A 2-n.h.p. 'Bull' motor is daily, for some 10 hours per day, week in and week out, driving single handed in one of the company's shops, without the least fuss, splutter, or spark, no less than four lathes of various sizes, a large boring machine, a 3ft. planer, a large radial drill, a milling machine, two small drilling machines, and sundry small tools, besides some 70ft. of overhead countershafting, numerous belts, etc. A 3-h.p. motor made by another firm, we are informed, would not drive the planing machine alone. Several other 'Bull' motors are employed in the company's factory for different and various purposes. Some are suspended from the ceiling and driving lathes direct, the 'Bull' motor being so constructed that it may be fixed in almost any position, according to the space available. From 70 to 80 motors and dynamos of this and other types, ranging from ½ h.p. to 60 h.p., are in course of construction in the factory. One 500-16-c.p. capacity dynamo, we understood, is being manufactured for a well-known Ipswich firm, and it appeared to be in every way a high-class machine. The company are daily receiving orders and enquiries from all over the country. Another branch of the business, which is under separate management, but akin to the foregoing, is electrical installation work. The company have installed the electric light during the past few years in from 300 to 400 buildings, and practically carried out also the entire town lighting contracts at Felixstowe and Diss for the Suffolk Electricity Supply Company, Limited, including the supply and erection of the generating machinery, mains, and other apparatus employed."

Stoke Newington.—At a special meeting of the Borough Council last night the Electric Light and Sites Committee reported that they had arranged with the Hackney Borough Council to submit to the Council the following proposal with a view to the installation of electric light in the High-street, Stoke Newington, on the west side (which is in the borough) simultaneously with the installation which the Hackney borough will make on the eastern side of that street, and which it is anticipated will take place in or about October next—viz., that the Hackney Council supply the Council with electricity in bulk in the High-street at the following rates: for the first 100,000 units, 3d.; for the next 150,000 units, 2½d.; beyond that, up to an additional 250,000 units, 2¼d.; for power, per unit, 2d., less 5 per cent. The arrangement to exist for one year certain from the commencement of the supply, and to be determined by either Council at any time after the commencement of the supply, at the expiration of 12 months after the giving of notice. The electrical engineer of the Hackney Council submitted to the joint committees of Hackney and Stoke Newington an estimate of the cost of the proposed installation on the western side of the High-street at £4,100, which the committee consider ample to cover the expenses of the following works—viz., the supply of the necessary number of lamp standards to light the High-street from Castle-street to Manor-road, and to provide and lay the necessary mains for public and private lighting, and other incidentals. The cost of distribution to private consumers and of collection would also fall on this Council. It is proposed to supply the electricity to consumers at practically cost price. It is considered that in order to extend the adoption of electric light by private consumers, powers should be given for free wiring on consumers' premises. With regard to the supply of electrical energy in the South Hornsey Ward of the borough, the committee, after communicating with both the Board of Trade and the London Government Act Commissioners, were advised that the Council should apply for a new provisional order extending its powers to that ward. An intimation has been given to the Council that it is intended by the Provincial Electric Supply and Traction Company to apply for a provisional order extending to this borough. The committee recommended acceptance of the proposal, subject to the Council being able to obtain a loan for the necessary expenditure of £4,100, and that it be referred back to them to settle a formal agreement with the Hackney Borough Council for carrying the arrangement into effect, to obtain the necessary sanction to the loan, and to obtain tenders for the necessary work. Application is to be made at the earliest practicable time for a provisional electric lighting order available in all those parts of the borough to which the existing Hackney electric lighting order may not extend. The committee also recommended that the proposal to acquire powers for free wiring be supported.

Bedford Telephones.—Mr. Bennett's report is being considered by the Telephone Committee of the Town Council. He recommends the Corporation to apply for a license, and under it construct and work a telephone system of their own. The following estimate of revenue is taken from the report: "Under the Post Office license the Corporation would be bound to offer its subscribers the option of subscribing on a toll rate—*i.e.*, a small annual payment—with ½d. or 1d. for each call. It is usual, therefore, to have an inclusive annual rate to cover everything and either one or two toll rates. If the service were restricted to Bedford and three miles around, an average annual receipt per line of £4. 10s. would suffice to render it remunerative with only 300 subscribers. This might be attained by adopting the following tariffs: (No. 1) £5 per annum to cover an unlimited number of calls; (2) £3. 10s. per annum and ½d. per call; (3) £2. 10s. per annum and 1d. per call (payable by caller only). With 300 lines yielding an average of £4. 10s. per annum, the revenue would be: 300 lines at £4. 10s., £1,350; 5 per cent. commission on telegrams, etc., telephoned to the Post Office for transmission, £10—total, £1,360. The working expenses, including Post Office royalty, interest on capital at 3½ per cent., and depreciation and sinking funds of a 300-line exchange would be: constructed according to estimate No. 1 exchange, £1,338. 2s.; constructed according to estimate No. 2 exchange, £1,283. 17s. With a 500-line exchange the average annual receipt need be only £4 per line; 500 lines at £4 per line, £2,000; 5 per cent. commission on telegrams, £15—total, £2,015. The working expenses, including Post Office royalty, interest on capital at 3½ per cent., and depreciation and sinking funds of a 500-line exchange would be, constructed according to estimate No. 3 exchange, £1,972. 3s.; constructed according to estimate No. 4 exchange, £1,876. These working expenses are esti-

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mated on a liberal scale, and would probably be less, as they were in the case of Guernsey, which successively passed through the 300 and 500 line stages. The working expenses depend to a large extent on the cost of construction, which in view of the falling prices for copper, iron, etc., are likely to be less than estimated. With regard to estimate No. 5, 100 subscribers in all the villages is a very small number to reckon upon, but these at £4. 10s. per annum each would produce £450 per annum—more than sufficient to pay the capital charges on the expenditure of £3,280 involved, as well as wayleaves and maintenance. If the villages were joined up, a considerable revenue from call offices might be depended upon, in addition to the payments from subscribers. In Guernsey the call office revenue amounts to nearly £180 per annum ; and in the Bedford area it would probably be more, as the places are far apart, and a 2d. charge would be a great saving on a 6d. telegram. It would not, of course, be necessary to undertake the whole system at once."

Watford.—Colonel Luard has held an enquiry into the application of the Urban District Council for sanction to borrow £34,000 for the purposes of electric lighting. The Hon. Sydney Holland, for the Urban District Council, said that in 1898 an enquiry was held at Watford by the Local Government Board, and in July sanction was given to the Urban District Council to borrow the sum of £21,000 for the purposes of electric lighting. It was found that it was quite impossible to do the work for that sum, and the demand for electricity had been far greater than they expected. They contemplated at the commencement that they would only have 414 public lamps, but already they had no less than 800 to light, and the demands for private lighting were so great that it had been quite impossible to meet them. The result was that, the Council found themselves in the invidious position of being cursed on all sides because they could not supply light. When the Council started with the electric light, they erred on the side of trying to do it too cheaply, and that perhaps was the greatest mistake they made. They thought that if they began in a small way they could develop into a larger scheme, whereas if they had begun on a larger scale they would not have had to come again to borrow money. Now the Council asked for leave to borrow £34,000. That was £8,545 to meet the deficiency on the first contract, certain small expenses amounting to £500, and £25,000 which it was estimated by Major Cardew would be required to be spent in making the extension to the works. The £8,545 which was spent above the estimate on the first contract was not due to the carelessness of the engineer, but that after the work was begun they had a great deal more to do than was estimated. At the present time the population of Watford was 30,000, and Major Cardew said they might reasonably expect to have one lamp per head, which would give them 30,000 lamps. By the scheme which was now suggested they expected to work 12,000 lights at £100 per year profit. At the present time there were 8,000 private and 800 public lights, which was really more than the machinery could properly do. If the plant now suggested could be put down at once, they would be able to supply 12,000 lights. The Council were absolutely compelled to spend a sum of £5,092 on the present works. They were strongly advised that it was necessary for this money to be spent. They had not obtained the sanction of the Local Government Board for this money to be spent, but the amount was included in the enquiry that day. Major Cardew stated that the generating station required remodelling in some respects, and that the whole system of distribution should be remodelled. The main feature of the suggested alterations was the enlargement of the plant so as to be able to meet the existing demand, and the probable increasing demand for some years. Another alteration was that in the event of a fault in the circuit, they could locate and deal with it without cutting off the supply to the other part of the town. Under the present arrangement, in the event of a fault in the circuit, the whole of the town had to be shut off, but this would be avoided by the adoption of the proposed alteration to the distributing system. In his opinion, the total amount they would have borrowed, £55,000, was not excessive for a population of 30,000. In many cases he had investigated the scheme had been started with too great a regard for what was considered economy, and being unable to meet the demand the promoters could not show any profit, and so long as they were unable to show any profit, it was difficult to get the feeling of the town in favour of electric lighting. If they provided a scheme such as would meet the demand, it reduced the cost of the generation, and the promoters were able to show a profit.

London County Council.—Permission has been given to the Postmaster-General to carry nine cables into the vacant space on the existing brick piers in the Queen Victoria-street subway. The following report of the Highways Committee gives the particulars of the negotiations *re* the electric lighting order of the Lewisham and District Electric Supply Company in respect of the borough of Lewisham, within the county of London, and of the parish of Penge, outside the county : "The Council upon our recommendation decided to suggest to the Board of Trade that that part of the area within the county of London which was included in the application of the company, and which was covered to a very large extent by the order granted to the Lewisham District Board, the predecessor of the present Borough Council, in 1899, should be omitted from the order applied for. The Board of Trade having considered the matter decided to grant two orders for Lewisham and Penge respectively, which have been scheduled to one Confirmation Bill, in which a provision is inserted, with, we understand, the concurrence of the Borough Council, repealing the Lewisham District Order, 1899. The parts of Lewisham and Penge already covered by the Blackheath and Greenwich and the Crystal Palace district orders have been excluded from the areas under the orders now granted. Under the orders in the form in which they were forwarded by the Board of Trade to the Council for its observations, the Lewisham and District Electric Supply Company, to which the orders are granted, will, after the passing of the Confirmation Bill, be enabled to supply electricity (*a*) in a portion of Penge, which is outside the county of London, and (*b*) in a portion of Lewisham, which is within the county. It will therefore be possible for the company to place its electricity generating station outside London, and to give what may be described as a 'bulk' supply to the area within the county under the Lewisham order ; or if, on the other hand, the generating station should be placed within the county, the local authority, should it decide to purchase the undertaking within its area, might be saddled with a possible liability to supply energy in the area outside the county of London, under the Penge order. The Lewisham order contains a clause prohibiting its supply of energy beyond the area under the order ; and a clause to a similar effect in the Electric Lighting (Clauses) Act, 1899, is incorporated in the Penge order. In both cases, however, the prohibition is qualified by the use of the words, 'otherwise than under the authority of Parliament or under a license granted by the Board of Trade under the principal Act.' The undertakers will thus have power to supply energy in both Lewisham and Penge ; but it seems doubtful whether the local authorities would have power, after acquisition of the portions of the undertaking within their respective districts, to supply energy outside their own districts. The undertakers may, for the purposes of either of the orders, erect or lay down electric lines and works beyond the area of supply, without apparently the authority of Parliament or license from the Board of Trade. It would seem, therefore, that the undertakers could erect a generating station either in the Penge area or in the Lewisham area, or outside both those districts for the purpose of supplying under both the orders. It seemed to us, therefore, not unlikely that when the time shall arrive for the purchase of the undertaking, either under the Electric Lighting Act of 1888 or under the special clauses contained in the orders, difficulties might arise owing to the local authorities being able to purchase the mains but not the generating station. These difficulties might, perhaps, although it does not appear clear that they would, be met by provisions of the Act of 1888 and the special purchase clause enabling the Board of Trade to determine any question which arises with reference to the purchase which is not to be settled by arbitration. We thought it right to draw the attention of the Board of Trade to these points, and asked whether it can see its way to insert in the orders any clause or clauses to meet them. The Board of Trade, in reply, suggests that the same difficulty will arise whenever, as is frequently the case, a company is supplying energy from one station for use in the areas of more than one local authority, and further points out that the question of the generation of electricity is not dealt with in the orders. In the circumstances, the Board states that it is of opinion that the question raised should be determined under the provisions of the special clause inserted in the orders, and that it does not see its way to suggest the insertion of any further provision in the orders. In view of this decision of the Board, we do not consider that any further steps can be taken advantageously in the matter, and we now report the facts for the information of the Council." Notices from the Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Orders, 1897 and 1899, of intention to lay mains of high and low tension (*a*) along Court-road, West Chislehurst-road, High-street, Eltham, Park-place, North-park, Victoria-road, Southend-road, Foots Cray-road, and Eltham road and green ; and (*b*) along Foots Cray-road, Southwood-road East and West, Green-lane, Bexley-road, West Mount-road, Elderslie-road, Greenholm-road, Wellhall-lane, Craignton-road, Grangehill-road, Earlshall-road, and Greenvale-road were disapproved of, as the Woolwich Borough Council objects strongly to the Blackheath and Greenwich Company laying any further mains or doing any further work in the parish of Eltham, having regard to the fact that on June 11 last the Woolwich Council gave the undertakers notice in writing, under the terms of Clause 65 of the company's order of 1897, requiring them to sell to the Council so much of their undertaking authorised by their order, and such of their works as were at the date of such notice in the parish of Eltham, which is part of the borough of Woolwich. The following notices were approved : the Charing Cross and Strand Electricity Supply Corporation of intention to lay extra high-tension mains along Whitechapel High-street, Whitechapel-road, and Mile End-road ; County of London and Brush Provincial Electric Lighting Company, under the Southwark Order, 1892, and the St. Saviour's District Order, 1896, of intention to lay low-tension mains across Newcomen-street, and along Bowling-green-lane, Mermaid-court, Borough High-street, Marshalsea-road, Harrow-street, and Vine-yard ; by the Kensington and Knightsbridge Electric Lighting Company, under the company's order, and the Kensington and Knightsbridge Electric Lighting Act, 1893, of intention to lay mains along the east side of Trevor-square ; from the Metropolitan Electric Supply Company, under the West London Order, 1889, of intention to lay low-tension mains along Lisson-grove, Outer Circle (Regent's Park), New-street, Paddington-street, George-street, Upper George-street, Seymour street and place, Oxford-street, Marylebone road and lane, Nottingham-street, Weymouth-street, Welbeck-street, James-street, Mandeville-place, Millhill-place, Chandos-street, Bickenhall-mansions, Upper and Lower Berkeley streets, Old and New Quebec streets, Duke-street, Brunswick-place, Northumberland-street, Thayer-street, Orchard-street, Burying Ground-passage, Baker-street, Upper Baker-street, Gloucester-street, Park-road, High-street, Bulstrode-street, William-street, Little Barlow-street, Blandford-street, Portman-square, York street, place, and gate, David-street, Montague-place, Upper Montague-street, East-street, Dorset-street, Manchester-square and street, Wigmore-street, Paradise-street, North-street, and South-street. These works were approved by the Council on July 31, 1900, but as the works are not yet completed, and as the Council's approval will expire 12 months after it has been given, the company has to ask for the Council's further approval of the works. At the last meeting of the Council on Tuesday, prior to the summer recess, it was agreed to lend the Poplar Borough Council £1,500 for the purchase of electric light meters ; the Southwark Borough Council £700 and Hampstead Council £2,810 for the same purposes ; Hamp-

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stead Borough Council £19,529 for electric light installation, electric light meters, etc.; and the Stepney Borough Council £3,000 for the purchase of electric light meters. The following report of the Fire Brigade Committee, which was agreed to, is rather interesting to builders of motorcars and those who desire to become such: "On April 30, 1901, we reported that after carefully considering the question of the means of traction of fire appliances, we had come to the conclusion that in the near future it would be found expedient to adopt some more rapid method of traction than was afforded by horse power. In accordance with our instructions the chief officer has made enquiries with a view to obtaining a motor fire-engine, but it appears that the price of an experimental engine supplied by a firm would probably be very high, and the chief officer thinks that a more satisfactory and economical arrangement would be for him to build such an appliance, certain necessary parts to be purchased by him outright, and to be put together in the brigade workshops under his supervision. The suggestion meets with our approval. A sum of £600 is provided in the estimates for the current financial year for experiments with self-propelling appliances, and the chief officer states that, although he expects that in order to attain his object more than £400 will be required, that sum will be sufficient to enable him to do the bulk of the work. We recommend that an expenditure not exceeding £400 be authorised in connection with the construction, under the chief officer's supervision, of a motor fire-engine, the necessary parts to be purchased by him outright and put together in the brigade workshops."

PROVISIONAL PATENTS, 1901.

JULY 22.

14844. Shunt telephonic transmitting and receiving key. James Wright, 154, St. Vincent-street, Glasgow.

14864. Improvements in or relating to electrical wall plugs. Sidney Alfred Hunter, 128A, Queen Victoria-street, London.

14893. Improvements in or in connection with tramway and other cars that are propelled by electricity. Joseph Hunter, Ernest Griffiths, and William Franceys Green, 6, Lord-street, Liverpool.

14897. Improvements in electric meters. Paul Rieunier, 24, Southampton-buildings, Chancery-lane, London.

14901. Improvements in trolley arms for electric tramcars and like vehicles. Arthur Bergtheil, 1, Queen Victoria-street, London.

14919. Improvements in wireless telegraphy. Harry Shoemaker and Gustave Paul Gehring, 40, Chancery-lane, London. (Complete specification.)

JULY 23.

14930. An improved safety device for trolley poles and the like used in connection with overhead electric railways and tramcars. Joseph Parsons, 22, County-road, Walton Liverpool.

14931. Improvements in and relating to electric meters. William McWhirter, 96, Buchanan-street, Glasgow.

14943. Improvements in electrical brush-holders. Thomas Wilson and Archibald Wilson, Leith Electric Works, Prince Regent-street, Leith. (Complete specification.)

14946. Improvements in and connected with electrolytic apparatus. Max Haas, 4, Corporation-street, Manchester. (Complete specification.)

14963. Improvements in electric arc lamps. John Allen Heany, 55, Chancery-lane, London. (Complete specification.)

14967. Improvements in apparatus for refining metals by electrolysis. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Anson Gardner Betts, United States.) (Complete specification.)

14996. Improvements in electric motors. John Allen Heany, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14997. Improvements in electric motors. John Allen Heany, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14998. Improvements in electric arc lamps. John Allen Heany, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15014. Improvements in and relating to surface-contact systems of electric traction. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (La Société Rouaix Volatron et Cie., France.)

JULY 24.

15036. Improvements in and in connection with aerial telegraphic apparatus. John Gardner, 70, Market-street, Manchester.

15041. Improvements in trolleys for electric tramways and the like. Stephan Kempner, 42, Jacobstr., Görlitz, Germany.

15045. Improvements in electric arc lamps and in optical apparatus in which electric arc lamps are employed. Robert Cecil Turle Evans, 118, Maroon-street, Limehouse, London.

15048. Improvements in and relating to electrical current-regulating and controlling devices. Hermann Herberts, 18, Cavendish-terrace, Clapham Park, London.

15067. Improvements in electric percussion drills. Frederick Henry Loring, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15069. An improved lead fuse for electrical plant. Frederick Henry Krebs, 36, Chancery-lane, London.

JULY 25.

15118. Improvements in lampholder switches for electrical incandescent lamps. Harry William Cox, 8, Quality-court, Chancery-lane, London.

15130. Improvements relating to electric stoves or heaters. Arthur Edwin Greville, 27, Chancery-lane, London.

15146. Improvements in trolley stands for electric cars. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (Eugene John Parker and Alexander Sinclair Paton, United States.) (Complete specification.)

15149. Improvements in and connected with the protection or covering of underground cables. Otto Wilhelmi, 37, Essex-street, Strand, London. (Complete specification.)

15154. Improvements relating to adjustable holders or brackets for carrying incandescent electric lamps and other articles especially applicable for display purposes in shop windows or the like. Hugo Hirst and Henry Holland, 165, Queen Victoria-street, London.

15155. Improvements in and relating to conduits for carrying electric conductors. Hugo Hirst and Frederick Boyes, 165, Queen Victoria-street, London.

JULY 26.

15167. A lifeguard for electric and motorcars for the safety of the public. George Richard, 79, West Regent-street, Glasgow.

15190. Improvements in systems of control for electrically-propelled trains. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

15192. An improved secondary battery for electric lighting or other purposes. John William Elliott and George Hacket Jefford, 45, Southampton-buildings, Chancery-lane, London.

15195. Improvements in supporting conductors in conduit systems of electric railways. William Chapman, Westinghouse-building, Norfolk-street, Strand, London.

15196. An improved electric safety lamp for miners' use. John William Elliott and George Hackett Jefford, 45, Southampton-buildings, Chancery-lane, London.

15206. Improvements in safety devices for overhead conductors for electric traction, lighting, and the like. Herbert William Cafferata, George William Gaskell, and Joseph Alexander Kerr, 6, Lord-street, Liverpool.

JULY 27.

15239. Improvements connected with electrical cut-outs, and partly applicable to electrical switches. Ernest Edward Bartlett, 10, St. George's-crescent, Liverpool.

15242. Automatic self-righting motion for swivelling trolley wheels on electric tramcars. Thomas Beaumont Birkby and Frederick Ernest Birkby, Woodfield Mills, Liversedge, Yorkshire.

15258. Improved means for raising and lowering arc lamps. John Thomas Irwin and Willans and Robinson, Limited, 24, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 17.

1900.

7471. Electric telegraphy. Brown.

13472. Telegraphic transmitting, receiving, and translating arrangements. Muirhead.

15001. Electric measuring instruments. Honig.

15193. Method or means for adjusting electrodes enclosed in vacuum or other tubes. Reynolds.

15874. Means or apparatus for controlling electrically-driven lifts, hoists, cranes, pumps, or air compressors, and for analogous purposes. Björnstad.

15907. Electric arc lamps. Booker.

16667. Working of electric or other tramway or railway points. Stewart.

17234. Means for generating variable electromotive force. Miller. (Date applied for under International Convention, March 1, 1900.)

17262. Electricity meters of the electrolytic type. Wright and Reason Manufacturing Company, Limited.

22362. Construction of dynamo-electric machines. Feeny. (Allgemeine Elektricitäts-Gesellschaft.)

1901.

691. Resistance coils. Johnson. (Electric Controller and Supply Company.)

692. Arc rupturing devices for brush-holders and the like. Johnson. (Electric Controller and Supply Company.)

5964. Electric railway signals. Boult. (Price and Council.)

8716. Continuous-current dynamo-electric machines. Zander and Ingeström. (Date applied for under International Convention, Oct. 12, 1900.)

9097. Means for electrically controlling and igniting and extinguishing gas from a distance. Borchardt.

11949. Electric telegraph apparatus. Littlefield.

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12786. High-potential electric switches. British Thomson-Houston Company, Limited. (Emmett, Hewlett, and Badeau.)

12790. Electric cables for three-phase alternating currents. Esson.

12770. Apparatus for automatically regulating the tension of electric currents. Imray. (Lindner.)

12896. Device for use within electric ceiling roses and the like. Stones.

12947. Electric telegraph code. Lake. (Burke.)

13062. Process for the reduction of ores or compounds by means of the electric current. Irvine.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	July 27	1,081	975	+ 106	—	—
Birmingham Tramways	,, 27	4,637	4,637	—	131,179	— *b*
Blackburn Corporation	—	—	—	—	—	— *b*
Blackpool Corporation	,, 27	1,038	1,351	- 313	4,231	4,592
Blackpool-Fleetwood Tramways	—	—	—	—	—	—
Bolton Corporation	,, 28	1,482	1,481	+ 1	42,716	33,325*b*
Bradford Corporation	,, 28	990	592	+ 398	22,471	12,977*b*
Bristol Tramways Company	,, 26	4,675	3,545	+ 1,130	—	—
Carlisle Tramways Company	,, 27	208	213	- 5	917*b*	885
Central London Railway	,, 27	5,956	—	—	24,398	—
City and South London Railway	,, 28	1,906	1,610	+ 296	7,550	5,904
Cork E. T. and L. Company	,, 25	560	526	+ 34	13,380	11,615*b*
Darwen Corporation	,, 26	179	140	+ 39	5,440	4,474
Dover Corporation	,, 27	269	270	- 1	5,933	5,563*b*
Dublin & Lucan Electric Railway	,, 28	134	123	+ 11	578	490
Dublin U. T., electric cars	,, 26	3,953	4,001	— 48	—	—
Dublin S. District, Electric	,, 26	1,108	1,252	— 144	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 27	11,439	8,511	+ 2,928	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	,, 27	1,013	714	+ 298	15,789	12,119
Hull Corporation, E. S.	,, 27	1,689	1,359	+ 330	6,979	5,407
Liverpool Corporation	,, 26	10,302	8,863	+ 1,439	252,076	215,961*b*
Liverpool Overhead Railway	,, 28	1,608	1,671	— 63	6,906	6,864
Oldham-Ashton-Hyde Tramways	,, 19	547	578	- 31	14,072	13,644*b*
Portsmouth Corporation	—	—	—	—	—	—
Potteries Tramways	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 28	3,658	—	—	—	—
Southampton Corporation	,, 25	968	746	+ 222	—	—
Southport Corporation	—	—	—	—	— *d*	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. *b* From Jan. 1. *d* From April 1 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £178 decrease.
Barcelona Ensanche y Gracia, £57 decrease. Barcelona, £272 decrease.
Brisbane, £45 increase.
Buenos Ayres and Belgrano Electric, £612 increase.
Calcutta, £155 increase.
Cape Town (month of June), receipts, £13,119; expenditure, £6,380.
Mexico Electric (month of June), receipts, £18,465.
Perth Electric, £1,250 increase.
Port Elizabeth (month of June), receipts, £2,983; expenditure, £1,800.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	¾-¼
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	9 16-11/16
—— Ordinary, 1-125,000	1	⅜-½
British Electric Works, Ordinary, 50,001-95,000	1	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108	85-90
British Insulated Wire, Ord., 1-70,000	5	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5	6-6¼
—— 5 per cent. Mortgage Debentures	100	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	4½-5
British Electrical Engineering, Ordinary	2	1½-1⅝
—— Non. Cum., 6 per cent. Pref.	2	2-2¼
—— 4½ per cent. Debenture Stock	100	103-108
—— 4½ per cent. 2nd Debenture Stock	100	99-102
Callender's Cable, Debentures	100	107-111
—— Ordinary	5	14-15
—— 5 per cent. Pref.	5	5¼-6
Crompton and Co.	3	3¼-4
—— 5 per cent. Debentures	—	100-105
Edison and Swan United, Ordinary	3	0-¼
—— 5 per cent. Debentures	5	1½-2¼
—— 4 per cent. Deb. Stock, Red.	100	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	—	88-92
Electric Construction, Limited, Nos. 1 to 112,100	2	1¾-2¼
—— 7 per cent. Cumulative Pref.	2	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	99-102
W. T. Henley's Telegraph Works, Ordinary	5	15¾-16½
—— 4½ per cent. Preference	5	5¼-6
—— 4½ per cent. Debentures	100	109-113
India Rubber, Gutta Percha, and Telegraph Works	10	21-22
—— 4 per cent. Debentures	100	101-104
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	101-104
Telegraph Manufacturing, Ordinary	5	10¾-11½
—— 5 per cent. Cum. Pref.	5	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	95-100
Bournemouth and Poole, Ordinary	10	12-13
—— 4½ per cent. Cum. Pref.	10	11-10
—— Debenture Stock, Red.	100	101-104
Brompton and Kensington, Ordinary	5	7¾-8¼
—— 7 per cent. Preference	5	8¼-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7¾-8¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½ xd
,, ,, £10 Ord.	6	10¾ xd
Charing Cross and Strand	5	9-10
—— 4½ per cent. Cum. Pref.	5	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	103-105
Chelsea Electricity Supply	5	5¼-6
—— 4½ per cent. Debentures	100	107-110
City of London, Ordinary	10	8-9
—— 6 per cent. Cumulative Pref.	10	12½-13¼
—— 5 per cent. Debenture Stock	100	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	99-101
County of London and Brush Provincial, Ordinary	10	8¼-9⅛
—— 6 per cent. Cum. Pref.	10	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	5¼-6
—— 6 per cent. Cum. Pref.	5	5¼-6
—— 4½ per cent. First Mort. Deb.	100	102-105
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5¼-5⅜
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7⅛-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	11-12
—— 4 per cent. Debenture Stock, Red.	100	102-105
Kensington and Knightsbridge and Notting Hill	100	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10¼
London Electric, Ordinary	3	1¼-1⅜
—— 6 per cent. Pref.	5	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190	96-100
Metropolitan, Ordinary	10	13-14
—— ,, 85,001-98,769	5	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	108-111
—— 3½ per cent. Mortgage Debenture, Red.	100	94-97
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9¼
—— Preference	4	6¼-6½
Notting Hill Electric Lighting	10	15-15
Oriental, 1879	1	1½-1⅝
—— £5 Shares	5	7¼-7⅜
—— £4½ Shares, New	4½	6¼-6⅜
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5¼-6¼
—— 4 per cent. Debenture Stock	100	99-102
River Plate Electric Light and Traction, Deb.	100	65-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	2-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2¼-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	14¼-15¼
—— 7 per cent. Pref.	5	8¼-9¼
—— 3½ per cent. Deb.	100	97-10
Westminster, Ordinary	5	11¼-12
Electric Railways.—		
Central London, Ordinary	100	98-101
—— 4 per cent. Pref.	100	99-102
—— ,, ,, deferred	100	97-100
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	113-118
City and South London, Consolidated Ordinary	100	53-55
—— Ordinary	10	5¼-5⅜
—— 4 per cent. Debenture Stock	100	112-117
—— 5 per cent. Pref. Stock '91	100	132-137
—— ,, ,, ,, '96	100	126-130
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	90-93
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100	124-129
Blackpool and Fleetwood Tramroad	10	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-4⅜
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	101-103
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	6¼-7
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9¼-9⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	13¾-14¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12-12¼
—— 5 per cent. Perpetual Debenture Stock	100	123-126
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅝-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100	102-105
—— Prov. Cert., all paid	100	96-99
Cape Electric Tramways, Nos. 1-400,000	1	1⅛-1⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5¼-5⅜
—— 4 per cent. 1st Mortgage Debentures	100	103-106
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	98-102
Imperial Tramways, Ordinary	all	22-22¼
—— 6 per cent. Cum. Pref.	all	14¼-15¼
—— 4½ per cent. Deb. Stock	100	112-114
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	105-107
New General Traction, Ordinary	5	3-3¼
—— 6 per cent. Cum. Pref.	10	4¼-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	10¼-10¾
—— 5 per cent. Cum. Pref.	10	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10	12-13
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	105-108
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	6s.	5/16
—— £50,000 ,, ,,	1	1
—— £500,000 4½ per cent. Debenture Stock	30 p.c.	30 p.c.
Wolverhampton Tramways Company	—	—
Telephones.—		
National Telephone, Ordinary	5	3¼-3¾
—— 6 per cent. Cum. First Pref.	10	11-13
—— 6 per cent. Cum. Second Pref.	10	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	4¼-4⅝
—— 4 per cent. Deb. Stock, Red.	100	89-92
—— 3½ per cent. Deb. Stock, Red.	100	94-97
Oriental Telephone and Electric Company	1	⅛-1

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NOTES.

Board of Trade Appointment.—The President of the Board of Trade has appointed Colonel Sir Herbert Jekyll, R.E., K.C.M.G., to be an assistant secretary to the Board (Railway Department) in place of Mr. Francis Hopwood, C.B., C.M.G., now permanent secretary.

American Electro-Therapeutic Association.—We are asked to state that this association will hold its eleventh annual convention in Buffalo on Sept. 24, 25, and 26, this year. Its headquarters will be at Hotel Niagara, and its place of meeting at the armoury of the 74th Regiment.

Tramway Congress.—We understand that the Permanent International Tramway Union of America has accepted the invitation of the Tramways and Light Railways Association of England to hold its twelfth general assembly in London next year. An interesting adjunct to the congress, which will take place from July 1 to 4, 1902, will be an exhibition of tramway machinery and apparatus.

Practical Engineering.—At the invitation of the directors yesterday a large party visited the Crystal Palace Company's School of Practical Engineering on the occasion of the announcement of the summer list of certificates awarded by the examiners. Mr. Wm. Shelford, C.M.G., took the chair in the lecture theatre at 12 o'clock, and on the conclusion of the proceedings a number of visitors took this opportunity of inspecting the several departments of the school.

Automatic Generator for Automobiles.—An invention which, it is claimed, will supplant petroleum as a motive power, and will make stopping to take on a supply of electricity unnecessary for automobiles, is the work of a French scientist, one S. North. The device consists of an automatic generator of electricity which takes up very little space, and makes electricity as the automobile proceeds on its journey. Only a small quantity of water is required for generating the electricity, and this can be easily carried in a bottle. It is stated that the French Government has under consideration the advisability of adopting this new invention for submarine boats.

Electrical Stations and Factory Legislation.—We are pleased to see that the Legislature have at last brought "electrical stations" within the purview of the Factory Acts. The Bill for the amendment and consolidation of the Factory and Workshop Acts has now been published as revised by the Standing Committee on Trade, and for the first time the schedule includes amongst non-textile factories "electrical stations," which are described as "any premises or any part of any premises in which electrical energy is generated or transformed, either for the purpose of supply by way of trade, or for any purpose incidental to any other business except the transmission of signals or messages."

Junior Engineers' Summer Meeting.—The Institution of Junior Engineers will hold its summer meeting this year at Plymouth and Devonport, from Monday, the 12th, to Saturday, 17th inst. Among other works and places of engineering interest in the neighbourhood, the following will be visited in the course of the week: H.M. dockyard, Devonport; H.M.S. "Cambridge" (gunnery ship), and H.M.S. "Defiance" (torpedo school ship); Keyham Dockyard extension works; Keyham Steam Yard and Royal Naval Engineering College; Royal William Victualling Yard; and Saltash tubular bridge. The summer dinner of the institution takes place at the Hotel Continental on Friday, the 16th.

Tramway Fatalities.—Great as has been the outcry in some quarters against the number of accidents which are said to mark the introduction of electric tramways into a locality, the experience of the last two years in the case of Liverpool has shown that there is less risk of fatal accidents with electric traction than with horse traction. During 1900 one person was killed under horse traction to every five million passengers, while under electric traction the proportion of fatal accidents was one in 10 millions. In 1898, the last year when horse traction was general, the fatalities at Liverpool numbered one in six millions; in 1899, with mixed traction, one in eight millions; in 1900, one to 7,500,000; and in the first half of the present year one in nine millions.

Electric Tramways in India.—We note that a scheme is on foot for introducing electric traction in the Baroda State in India. The proposal is to construct a tramway from Chital to Amreli and Challala, and to work the same by electrical power to be generated by harnessing the Khodia Matta Falls of the Shetranji river. The project is at present under consideration by Mr. Graham R. Lynn, M.I.C.E., chief engineer to the Durbar, who, it is said, was much struck with electric locomotion during his recent visit to England and the Continent. We also hear that a draft order under the Indian Tramways Act, 1886, has been issued authorising the construction of tramways in the town of Mandalay. The order has been obtained by the Burma Electric Works Syndicate, which is empowered to carry out the scheme.

Electrical Contractors' Association.—On the 16th ult., at Buffalo, the United Electrical Contractors' Association of New York State held what we believe to be its first convention since its inception. As a matter of fact, the proceedings, although apparently of a thoroughly enjoyable character, served as a preparation for the formation of a new body—viz., the National Electrical Contractors' Association. The inauguration ceremony was very successful, and it is argued in support of the national body that as the local organisations all over the country have proved a good thing, why should not the national organisation? It will be remembered that it is only a few months ago now that a National Electrical Contractors' Association was formed in England, and we believe that the membership roll of this body continues steadily on the increase.

Pneumatics for Electromobiles.—A series of experiments has lately been conducted in France by Mr. Michelin with different kinds of pneumatic tyres for electric cabs. The conclusion to be drawn from the results of these tests apparently is that there is a considerable saving of electrical energy, together with a gain of speed, in the use of pneumatic tyres for electric automobiles. In the first place, an electric cab was run a distance of about 1¼ miles on a hard, smooth road with ordinary wheels at an average speed of 13·94ft. per second, and the electrical energy consumed in the journey amounted to 1,037,680 watt-seconds. The same cab, with four pneumatic tyres, performed the same journey on the same day and at the same speed for a consumption of 817,840 watt-seconds. In a somewhat similar trial the use of pneumatics led to a saving of 17·9 per cent in energy and a gain of 5·3 per cent. in speed.

The Aluminium Industry.—It is stated that negotiations are proceeding between the principal aluminium producing company on the Continent and the leading enterprise in the United States with a view to the establishment of a convention ostensibly for the improvement of the aluminium industry. The concerns in question are the Aluminium Company of Neuhausen, Switzerland, and the Pittsburg Aluminium Production Company, which is said to dominate the American market. In the event of

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the convention being formed it is intended to at once proceed with an increase in the prices of aluminium. Such a course, however, would, we believe, be detrimental to the industry itself, which instead of receiving an impetus, as is intended, would rather show a falling off in prosperity. It is undoubtedly far the better policy to increase the output by the general adoption of low prices than to seek to augment the profits by enforcing high tariffs. It is not stated whether it is proposed to include the English aluminium companies in the movement or not.

The Electrolytic Separation of Lead from Manganese. — The *Journal* of the Chemical Society gives a short abstract of a paper by Ivar Moltke-Hansen showing how lead may be precipitated by electrolysis as dioxide free from manganese by operating as follows: If the solution, which should contain about 0·2 grm. of lead in 150 cubic centimetres, contain also an amount of manganese not exceeding 0·03 grm., the liquid should contain 25 to 27 cubic centimetres of nitric acid of specific gravity 1·42, or 55 to 60 cubic centimetres of acid of specific gravity 1·19, and should be electrolysed at 70deg. with a current of two amperes. The lead is completely precipitated in 35 to 40 minutes. If the amount of manganese reaches 0·04 grm. fairly accurate results may still be obtained by adding 35 cubic centimetres of nitric acid of specific gravity 1·42 and using a current of 2½ amperes, or, better still, by adding the same amount of nitric acid as before, and afterwards a little oxalic acid to redissolve any precipitate of manganese dioxide. A few more cubic centimetres of nitric acid may then also be added.

Silent Electric Discharge. —Mr. S. Leduc contributes to a recent issue of *Comptes Rendus* an article describing some remarkable properties of the silent electric discharge, or electric effluvium. This is obtained by rapidly charging and discharging a condenser, consisting of a metallic sphere on the one hand, and a sheet of aluminium, with a central perforation, on the other hand, separated by a plate of glass or celluloid. The central portion of the plate is on both its faces the origin of violet and ultra-violet rays, which can be concentrated by a quartz lens. These rays produce an intense fluorescence on a platino-cyanide screen without concentrating the beam, and photographic effects are obtained which surpass in intensity those produced by sunlight. The rays are particularly valuable for Finsen's treatment of anæmic tissues. These are compressed by means of a quartz plate contained in an ebonite frame, which directly adjoins the aluminium sheet forming one armature of the condenser. The diseased tissue is thus exposed to rays which have only to traverse a thin plate of quartz. The apparatus may be worked with an induction coil or an influence machine.

Electric Traction on Mountain Railroads.— We understand from the *Railway and Engineering Review* that the Colorado and Southern Railway management is seriously considering a plan for running several of its lines by electricity. The lines in question are situate in the mountainous districts around Denver, which do a considerable business and pleasure traffic. Investigations are now being made by representatives of the engineering department of the railway company as to the best system of electric traction to be adopted, and if the reports from these studies be favourable to the scheme, the work will be carried out on modern ideas of heavy electrical operation. The authorities have been led to contemplate the introduction of electric traction on some of their lines principally by the fact that excursions, business and other pleasure travel, into the mountains as at present conducted are not as satisfactory as they might be, owing to the smoke and cinders from the locomotives. With regard to the generation of electrical energy, no definite plans have yet been made, nor has the general scheme of transmission and operation been as yet taken up.

The X-Rays.—According to an article in the *Comptes Rendus*, the use of the Röntgen rays on the body sometimes gives rise to mortification of the skin. When the tubes are driven by influence machines it does not happen, but then the activity is reduced, and the presence of moisture and the necessity of an earth connection may prove to be inconvenient. The difficulty, however, would appear to have been successfully met by one, R. Demerliac, who has found that tubes worked by alternate currents of high frequency and high tension never produce erythema, and that, on the contrary, the rays so obtained possess the curative properties recognised in electro-therapeutics since the experiments of D'Arsonval, Oudin, Dourner, and others. He, therefore, employs the Oudin resonator, which, with certain precautions, may be made to work X-ray tubes. They light up on connecting them with the upper knob of the apparatus. A broad concave cathode and a small anode or an annular anode are used. The cathode is joined to the resonator, and the anode may be left free or put to earth. The discharge is most effective when it proceeds in one direction only. A cathode valve should, indeed, be useful. The tubes may be brought quite close to the skin without risk, and thus any loss of penetrative power is effectually counteracted.

Towpath Electric Traction.—Certainly, so far as this country is concerned, towing by electricity along river banks is quite a novel application of electric power Yet we hear that the experiment is to be tried in the northern suburbs of London. The River Lea, which runs through Walthamstow, Tottenham, Enfield, and numerous other places in that district, is quite a busy little river, with a very considerable barge traffic, and it is now proposed to develop this traffic and stimulate manufacturing industries along the river banks by introducing a system of electric towing. It is stated that no electrical apparatus whatever will be used on the barge itself, which is to be connected by rope with an electrically-propelled vehicle on the path working on the overhead trolley system. The idea, after all, is simple enough, and we assume the construction on the banks will take the form of an electric tramway. Provided the land at the side of the river be suitable, we see no difficulty in the way of carrying out the scheme successfully. It should greatly facilitate navigation and cheapen transport, and, if well organised, we may expect to see the system taken up in other parts of the country. We understand that Mr. Chas. Tween, the engineer to the Lea Conservancy Board, is actively interesting himself in the project, while considerable local attention is attracted by the novelty of the experiment.

Motorcars as Luggage.—Although the question of carrying bicycles as passengers' luggage is still disputed in England, the point was decided in the States some few years ago in such a manner as to give general satisfaction to the cycling public. The point, however, has now assumed a different aspect, and the railway companies in the States have to say whether they will carry tricycles and quadrocycles of the automobile order on the same terms. Our Chicago contemporary, *Railway Age*, naturally takes up an attitude favourable to the companies. "There is no reason," it says, "for treating as baggage a passenger vehicle propelled by legs, electricity, gas, or steam than one propelled by horse or ox power, and yet some kindly passenger agents are disposed to favour carrying motor vehicles as excess baggage, while they would refuse to check a cart and horse, to say nothing of a coach and pair. The automobile is coming, has come, to stay, but it ought to come

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on its own legs, and not ask the railway carriage to take up and carry it when it is tired. It is too big an infant for this already, and the statement that Mr. Vanderbilt has imported a machine that runs 70 miles an hour and weighs 40 tons raises the question whether the automobile will not eventually be big enough to carry the railway car. When that time comes, will the mobile passenger agent be disposed to check the (steel) tired passenger car as baggage? If not, why not?"

Mechanical Engineers at Barrow.—Further details are to hand of the doings of the Mechanical Engineers at Barrow last week in connection with the summer meeting of the institution. Among the papers read on this occasion was one on the development of the motorcar by Mr. M. Holroyd Smith. That motorcars had passed the experimental stage, he said, was generally admitted. There, however, was still much room for improvement, and perhaps there was no subject at present occupying the serious attention of a larger number of engineers. It was to be regretted that many motor vehicles produced by English makers consisted of numerous parts collected mostly from France, and assembled together here. It was a prudent course, but hardly creditable to English engineers. The author also explained in detail the construction of a motorcar with the aid of a number of plates illustrative of the working parts, and described the results he had obtained from actual experience. On Wednesday evening the usual summer dinner was held in the town hall, when Mr. Wm. H. Maw, the president of the institution, presided over a large assemblage. This was preceded on the same day by a luncheon at the old town hall given by the Corporation of Barrow. Numerous excursions to engineering works and places of interest in the neighbourhood were also enjoyed by the members, including visits to the shipyard of Messrs. Vickers, Sons, and Maxim, the Barrow Hematite Steelworks, and the Barrow Steelworks.

Three-Phase Hauling Plant. — The *Scientific American* gives a good illustrated description of a three-phase hauling plant worked in the Comstock district. The power for the mines in question is obtained from the Truckee River 33 miles away, where two 750-kw. three-phase generators are installed. The energy is transmitted to the mines at 24,000 volts, where it is reduced down to 2,300. A good number of mines are supplied from this one central station. The hauling plant, the description of which we have before us, is used for a vertical lift of 1,175ft. The cage when loaded up with trucks and rock weighs 3,650lb. With a maximum rope speed of 600ft. per minute the lift is accomplished in 2 minutes 10 seconds. It requires some eight seconds to accelerate the load, and from the wattmeter reading it was found that 88·40 is the average horse-power used. According to the weight in lift some 66·4 h.p. is required, so that the over-all efficiency of the hauling plant is about 75 per cent. The voltage actually used with a three-phase motor is 525 normal. In order to secure the necessary wide variations in speed with an induction motor the engineers found that they required to use a non-inductive resistance, both in the main circuit of the motor and also in the rotor circuit. In fact, the lift motors are controlled by a modified form of street car controller. When switched on, the motor causes a drop of 7 per cent. in the supply voltage, which is quickly restored to its usual value. The variation provided by the resistance is such that the speed of lifting can be reduced to one-third of its normal without any trouble.

The Pacific Cable.—At the end of last week was published "A Bill to provide for the construction and working of a submarine cable from the island of Vancouver to New Zealand and to Queensland." This measure is backed, among others, by Mr. J. Chamberlain, Mr. Austen Chamberlain, and the Chancellor of the Exchequer, and gives full particulars for the construction and working when completed of the Pacific cable. The preamble states that it has been arranged that the amount required for these purposes (including interest at the rate of 3 per cent. on borrowed money) shall, so far as not covered by receipts, be ultimately provided as to five-eighteenths by his Majesty's Government and as to thirteen-eighteenths by the Governments of Canada, of the States of New South Wales, Queensland, and Victoria, and of New Zealand, and that any profits arising from the cable shall be divided in the same proportion. The Treasury is authorised to provide the necessary sums out of the Consolidated Fund to an amount not exceeding £2,000,000, and powers are taken to borrow money during construction at the rate of 3 per cent. by means of terminable annuities. The construction and working of the cable will be placed under the control and management of a Board, the constitution of which is detailed in a schedule attached to the Bill. The representatives of the Home Government are: Sir Spencer Walpole, K.C.B. (chairman), Mr. G. E. Y. Gleadowe, C.M.G., and Mr. W. H. Mercer. Lord Strathcona and Mount Royal and Mr. Alexander Lang represent the Government of Canada. The Hon. Henry Copeland and the Hon. Sir Andrew Clarke, G.C.M.G., represent the Governments of New South Wales, Victoria, and Queensland, and the Hon. W. P. Reeves represents New Zealand. A message from Ottawa states that a proclamation has been issued bringing into effect the Act of Parliament of last session guaranteeing Canada's share of five-eighteenths of the cost of the new cable.

Scottish Automobile Trials.—Two or three events of special interest to engineers will mark the course of the first week in September at Glasgow this year. On Monday, Sept. 2, the first function in connection with the International Engineering Congress will take place, and the same day will see the commencement of some interesting motor-car tests which are to be conducted at Glasgow that week. The Automobile Club of Great Britain and Ireland, with the co-operation of the Scottish Automobile Club, have organised the trials in connection with the Glasgow Exhibition, and these include a 500 miles' trial of motorcars on the road and some hill-climbing competitions. There will be three sections—namely, a section for vehicles entered by manufacturers or agents, a section for private owners, and a third section for parts of motor vehicles. The first section will be divided into five classes: Class A, for cars at a selling price of £250 or less; Class B, for cars at a selling price of more than £250 and not more than £350; Class C, for cars at a selling price of more than £250 and not more than £500: Class D, for cars at a selling price of more than £500; Class E for motor cycles carrying two or more persons Sir J. H. A. Macdonald, Lord Justice Clerk of Scotland, has consented to act as chairman of the judges' committee Five gold and five silver medals will be given in Section 1. As already stated, the trials will begin on Monday, Sept. 2, and continue until Friday, Sept. 6. Each day the competing cars will leave Glasgow and make a tour of about 100 miles, returning to Glasgow at night. The maximum legal limit of speed in Scotland being 10 miles per hour, no speed in excess of this will be allowed, and stringent regulations have been laid down to discourage high speeds and to render this a trial only of reliability and absence of breakdowns.

Electricity in Manufacturing Work.—A paper presented at the recent Milwaukee meeting of the American

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Society of Mechanical Engineers, by Mr. Wm. S. Aldrick, sets out in concise form a number of the most important advantages of electricity as the motive power in manufacturing work, not only where the future of the installation cannot be foretold, but where the gradual development of a plant or system of workshops may be in contemplation. In one part of the paper the author states that future areas of work may be planned and arranged for with the utmost freedom and entirely irrespective of power considerations. They can be located, as desired, on separate floors, in various departments, or in detached buildings. Original provision for prospective development is not necessary in the electric system, but is required by shafting transmission. There is no expense for contemplated additions till they are actually installed as required. Permanent additions to the electric generating plant and the distributing system are made with a gradual and *pro rata* outlay of capital, instead of in disproportionate blocks of new equipment, as required by mechanical transmission. Extensions of electric transmission and new centres of power distribution may be established at any time and of reasonable capacity, anywhere and at any distance, at minimum cost for labour and material. There is no crowding, overloading, or interference with existing conditions, or with the daily progress of routine work. Temporary extensions, to meet sudden demands for power at any point, are quickly made by running to the desired location electric wires or cables. These are easily removed when no longer required, and as readily used elsewhere for similar purposes The shifts are made with the least expense of time and labour in handling, and with no accompanying waste of material to suit different conditions. Auxiliary power is always at hand for emergencies and to almost any reasonable extent, on account of the reserve nature of the electric supply.

Electric Decomposition of Carbon Dioxide.—Dr. J. Norman Collie, Ph.D., F.R.S., contributes to the *Journal* of the Chemical Society a very interesting paper on the decomposition of carbon dioxide when submitted to electric discharge at low pressures. During some experiments which were being made on the relative resistance of gases at low pressures in vacuum tubes to the passage of the electric spark, carbon dioxide was found to exhibit peculiarities. As these pointed to decomposition of the gas the literature bearing on the subject was consulted, and as the evidence was conflicting an enquiry into what occurred seemed necessary. As it did not seem difficult to obtain the gases from the interior of a vacuum tube in sufficient quantity for analysis, the following investigation was made: In the apparatus used the distance between the two electrodes, which were of stout aluminium, was 25in.; the capillary tube joining the two ends of the vacuum tube was of 1mm. bore. Pure carbon dioxide, made by heating sodium hydrogen carbonate, was introduced into the tube in the ordinary manner, and dried by passing over a layer of phosphoric oxide. Connected with the vacuum tube was a mercury gauge to measure the pressure of the gas. In the first set of experiments some of the pure carbon dioxide was sparked during a period of from one to ten minutes under a pressure of 5mm. It was found that the residual gas when pumped out was largely insoluble in caustic soda, and that the carbon dioxide, in amounts varying from 60 to 70 per cent., had been decomposed. This residual gas when submitted to an electric spark under the ordinary pressure exploded, and then was soluble in caustic soda. Large quantities were, therefore, experimented with in order to obtain a greater volume of the residual gas. Altogether the original volume of the carbon dioxide experimented with was 1·633 cubic centimetres, and of this 1·133 cubic centimetres was decomposed, which is equivalent to 69 per cent. Several other experiments were made and always with the same result, the amount of decomposition varying from 65 to 70 per cent. Carbon monoxide, however, seems to be far more stable. When subjected to the same treatment with an ordinary powerful spark, the current may be left on for half an hour with no appreciable result; moreover, the gas gives no turbidity with baryta water. If, however, the current is sufficiently strong to make the negative electrode red hot, a very small amount of carbon dioxide is produced too little to measure, but sufficiently great to cause a white precipitate with baryta water, and small specks of something black—presumably carbon—collect on the positive electrode.

Water-Power Development in America.—The first complete electrically-driven plant in Georgia, one of the Southern States of America, was started up for the first time on Independence Day at a new cotton mill in the city of Columbus. Until very recently the development of the vast water power in the State of Georgia for commercial purposes had made little or no progress, and the city of Columbus was one of the first places in the south to develop a water power on an extensive scale. The mill in question is furnished with electric current for driving its power plant by the Columbus Power Company from its new plant, a quarter of a mile distant. From an illustrated description of the electrical installation at the mill in *Dixie*, we gather that the power plant consists of two General Electric revolving-field, two-phase, 60-cycle, synchronous motors, wound to operate upon the full line pressure of 6,000 volts. The motors have a capacity of 400 h.p. and 600 h.p. respectively, and are so arranged that either one or both may be connected with the shaft carrying the big sheave wheel by means of friction clutches. The transformer-room contains four 15-kw. General Electric transformers, and also a switchboard consisting of four General Electric standard blue Vermont marble panels, upon which are mounted the high-tension oil switches for controlling the current, and the high-tension fuses which blow and automatically shut off the current in case of trouble. Mounted upon the back of the switchboard are the recording attachments which register the amount of power used in the mill. Here are also located the large transformers which supply current at 125 volts for lighting purposes. From this room 12 heavily-insulated cables are carried down to the motor switchboard, which is situated immediately below the motor-room. This switch board also consists of four panels, two main and two exciter panels. Mounted upon the main panel are two double-pole high-tension oil switches for controlling the current to the motors, four high-tension fuse blocks, one Thomson inclined, coil alternating-current ammeter which shows the amount of current the motor is taking, the rheostat and double-pole knife switch which control the current used and energise the revolving field, and the synchronising lamp which indicates when the motor is in step with the generators at the power-house. The exciter panels carry two double-pole high-tension oil switches for controlling the two-phase induction starting motors used to bring the large motors up to speed, and which are operated from current taken from the transformers in the transformer-room at a pressure of 575 volts. Upon these panels are also mounted the rheostat and voltmeter and ammeter of the exciters, which are small four-pole direct-current dynamos driven by a belt from the shaft of the synchronous motors, and whose purpose is to supply direct current at 125 volts pressure to the revolving fields of the motors. There is also another switchboard, which controls the incandescent lights in the mill, and upon which is mounted the double-pole switches,

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automatic circuit breakers, fuses, and indicating instruments. The mill is situated on a high plateau just outside the city limits, and an electric pump is employed at the river bank, about 100 yards west of the property, to supply the 350,000-gallon reservoir in the mill yard.

Electro-Deposition of Alloys. –The *Electrical World* of New York abstracts in its digest for the 27th ult. a paper on this subject by Lehfeldt, in which some particularly instructive points are brought out. The methods which have been proposed for the practical preparation of alloys by electrolysis may be grouped into two classes, according as the metals forming the alloy are deposited together, or one of them is used in liquid form as cathode, the other being deposited on to it. The latter process is well known as a method of preparing amalgams. It has also been used by Walter for obtaining alloys of lead by using an electrode of melted lead under fused salts. These processes require certain precautions, as continuous stirring and security against oxidation. This method, however, requires impractically high temperatures in many cases, and therefore Walter proposed to take advantage of the fact that the melting point of an alloy is always lower than that of the pure metals composing it. If the temperature of the fused salts composing the electrolyte be kept below the melting point of the cathode metal when pure, but above that of the alloy to be formed, then the cathode metal can be used in the solid form, and as it alloys it will fuse off and expose fresh surface to be alloyed. This process was actually carried out for the preparation of a silicon-bronze. Here copper is used as a cathode, and since silicon cannot be liberated directly it was obtained by the reduction of a silicate by sodium. The electrolyte therefore consisted of sodium silicate—to which sodium chloride or other salt was added in order to lower the melting point—and the temperature was maintained above the melting point of the desired alloy. The copper cathode and carbon anode were both inserted into the electrolyte from above. On passing a current, sodium is produced at the cathode. This reduces the silicate, and the silicon forms alloys with the copper. The silicon-bronze melts and falls to the bottom of the vessel, exposing a fresh surface to the action. He then makes some theoretical remarks on the production of an alloy by electrolytically depositing both metals simultaneously. Practice is here ahead of theory. He gives some information about the method of Baker of producing brass, and of the process of Cowper-Coles of producing cadmium silver alloys. He finally gives a note on iron. It had been thought that electrolysis offered a means of preparing perfectly pure iron. That is far from being the case, however, as hydrogen is always deposited along with it. Houllevigne found that the most favourable conditions for this were the use of a mixture of ferrous chloride and ammonium chloride as electrolyte, and a somewhat large current density (40 milliamperes per square centimetre). In this way he obtained very regular deposits containing about one atom of hydrogen to 12·5 atoms of iron, and the metal thus prepared possessed the properties of a cast iron or hard steel—hardness, specific resistance, magnetic qualities, etc.; indeed, he attributes the quality of steel, as distinguished from soft iron, rather to the structure of the molecule, as determined by the proportion of foreign matter present, than to the nature of the foreign matters. Later he found that under some circumstances it is possible to obtain carbon also in the electrolytic iron

The Cultivation of Rubber.—At the Agricultural Conference recently held at Barbados, an interesting paper was read giving the results of some experiments carried out by Mr. J. H. Hart in the West Indies with a view to determining, among other things, the yield and quality of rubber obtained from rubber trees under special conditions, the trees most suitable for the climate and soil, the best methods of planting, the cost of establishing, and the financial return which may be anticipated. All the most important rubber-yielding trees have been supplied to the West Indian Botanic Gardens by the authorities at Kew, and those under observation in Trinidad include the Central American tree (Castilloa elastica), the Para tree (Hevea brasiliensis), the Ceara tree (Manihot Glaziovii), the East Indian or Assam tree (Ficus elastica), several species of African rubber vines (Landolphias), and the West African or Lagos silk rubber tree (Funtumia elastica, previously known as Kickxia africana). The yield of rubber from Ficus elastica is small compared with that from the other trees, so that its cultivation in the West Indies is unlikely, while the climbing habit of the Landolphias renders them unsuitable for the purpose. The other four trees are much more likely to give satisfactory results, and have consequently received most attention. The Central American tree grows very freely in Trinidad, being most suitable for plains at low elevations. The largest tree in the gardens is over 75ft. high, with a girth of 6ft. at 3ft. from the ground, while in a small field at the experiment station, planted in July, 1898, the five best trees now average nearly 18ft. in height and 12in. in girth. Experiments have been made to determine the yield and quality of the rubber, but the tapping was very carefully carried out so as not to affect the seed-bearing power of the trees. Under these conditions one of the largest trees gave 2·14lb. of latex, from which ·69lb., or 32 per cent., of clean rubber, worth 3s. per pound, was obtained. An attempt to tap the younger trees led to an interesting result, for the latex so obtained was found to contain little or no rubber, but yielded 25 per cent. of a putty-like mass, devoid of elasticity, which became hard and brittle. This product would be of no value, and it appears that eight years is about the lowest age at which the tree will yield good rubber—a matter of considerable interest to planters. A curious point is that in places where the roots of a tree have become exposed, it has been found possible to extract large quantities of rubber from them. At present there are several trees of Hevea confusa growing in the gardens, but the rubber yielded is valueless, being yellow and sticky, but it is possible that the quality may improve with the age of the tree. The West African rubber tree, although a comparatively recent introduction into Trinidad, appears to be a most promising plant, growing very freely at the experimental station, where three-year-old trees now average 13½ft. in height and 7in. in girth. They look as if they would speedily become large trees, and even at present yield latex freely, the rubber from which is of excellent quality and keeps well. That rubber trees will thrive in Trinidad is therefore well established, and under fairly similar conditions of climate and soil there is no doubt that they would also flourish in the other islands as well, especially as confirmatory results have been obtained in Jamaica, Dominica, and Tobago. The particular tree will have to be selected in view of local conditions, but Castilloa elastica, Hevea brasiliensis, and Funtumia elastica are the three most suitable for general cultivation. The cost of planting can only be approximately estimated, but it is certain that it would not be as much as for cacao, which ranges from £12 to £15 per acre, and in most cases half these amounts would probably suffice. In cultivating rubber trees a very important point is to obtain clean and straight stems, which greatly facilitate the tapping process, and the best method of attaining this is to plant closely at first, afterwards thinning out the weaker trees.

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GLASGOW ELECTRIC TRAMWAYS.

(Concluded from page 83.)

Sub-Stations (*Concluded*).

As has been already mentioned, each rotary converter has a three-phase induction motor rigidly connected to the shaft. This motor is for starting up the converter, as the starting up from the alternating-current side direct would cause a disturbance on the system, and owing to the necessity of starting up with the field induced by the armature magnetism, there is a considerable danger of reversal of the magnetism and, consequently, the polarity of the converter; also, heavy currents would pass through the armature while running it up to synchronous speed. The use of the induction motor (which is capable of giving out about 20 h.p. for short periods) obviates the above difficulties. In practice a rotary is started up by switching on the high-tension current to the three transformers corresponding to the rotary to be started up. The low-tension three-phase current is then switched on to the induction motor. This motor has two poles less than the number of poles in the converter, and its synchronous speed is therefore correspondingly higher. The motor and converter run up to a speed of about 740 revolutions per minute, which is rapidly reduced to something near the synchronous speed of the converter (500 revolutions per minute) when the field of the latter becomes fully excited off the continuous-current side of the armature. By varying the field of the converter the proper speed is obtained, and this is checked by the low-tension voltmeter reading obtained from the converter armature. When synchronism is obtained (as indicated by the synchronising lamps on the converter panel becoming black) the three main switches are closed, and the induction motor thrown out of action by opening the switch. To assist in bringing the converter into step there is a switch on the converter panel, which throws a resistance across two of the slip rings of the converter. This has the effect of varying the speed, but in practice it is generally found to be unnecessary to use this resistance, the varying of the excitation supplying all the speed regulation which is required.

The equipment of the high-tension feeder panels is as follows: Each panel is provided with a three-phase reverse and overload relay cut-out switch (on the same principle as those at the generating station end of the feeders, but acting instantaneously), three ammeters reading up to 200 amperes, and plugs for the high-tension voltmeters, which read up to 7,500 volts. The converter panels have each a maximum cut-out, three 1,200-ampere switches (one on each conductor leading to the collecting rings of the rotary), three ammeters reading up to 1,200 amperes, the three-pole switch for the induction motor, switch for inserting resistance across one phase of the rotary armature, low-tension voltmeter plugs, and synchronising plugs and lamps.

It will be noticed that the converters are not run in parallel on the low-tension alternating side. This is owing to the instability which is experienced with rotary converters when run in parallel, as they cannot be relied upon to divide the load equally, and owing to the currents which circulate between the armatures the instruments are disorganised, rendering it very difficult to know exactly what each converter is actually giving ont. Hence it is preferable to run each converter as a separate unit on the alternating-current side of the system, each on its own transformers. On the continuous-current side, of course, the rotaries are run in parallel without any difficulty being experienced.

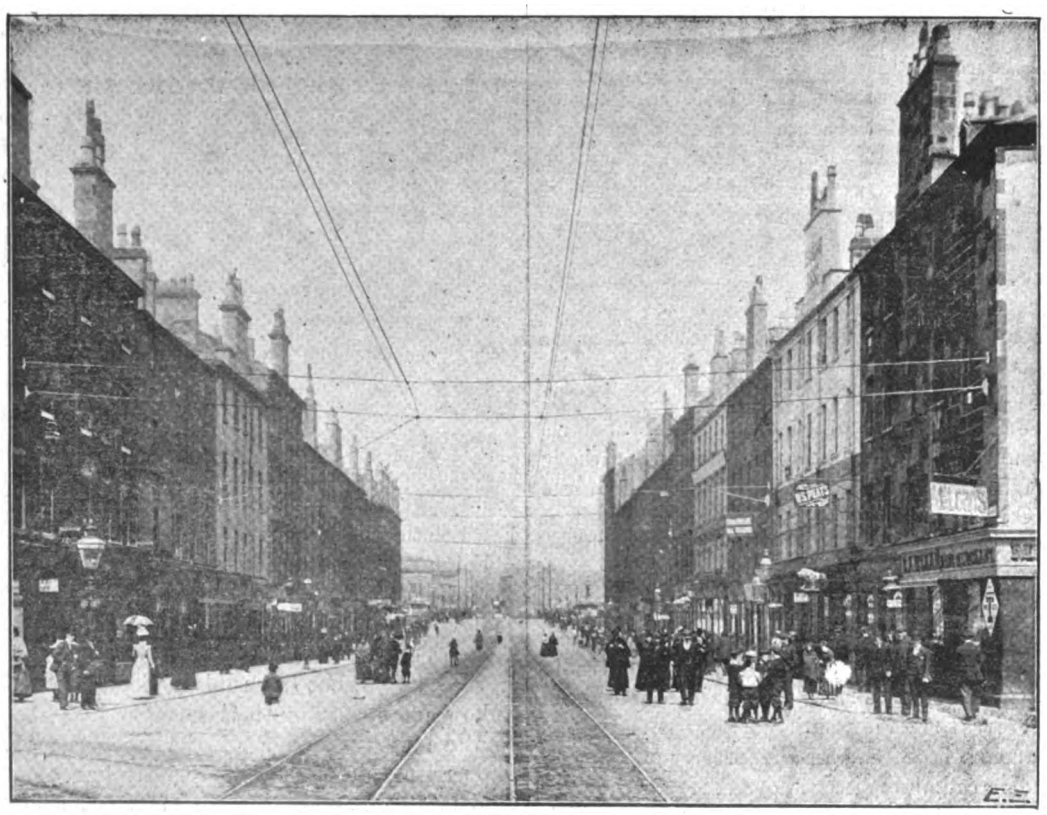

FIG. 21. View at Crown Street and Albert Bridge, Glasgow, showing Rosette Construction.

The continuous-current switchboard is all equipped with the Westinghouse Company's standard apparatus. Each of the traction feeders is taken off the 500-volt positive 'bus bar through a single-pole change-over switch, a circuit breaker adjustable to cut out from 800 to 2,000 amperes, and an ammeter. Immediately below the traction feeder panels are two pairs of 'bus bars with plugs for connecting any feeder in series with any of the booster fields. This is effected by throwing over the single-pole change-over switch mentioned above from the upper contact (which connects the feeder directly with the positive 'bus bar) to the lower contact, which puts the feeder current through the particular booster field which may be desired according to the arrangement of the plugs on the 'bus bars. This arrangement allows of any feeder which is taking a heavy current to be utilised for bringing up the voltage of the booster which is dealing with the return current from the rails corresponding with the particular section supplied by the feeder in question, and thus obviating any undue drop on the return circuit due to the extra heavy current. The booster armatures are connected to plug bars immediately below the rail return panels, and are capable of being plugged on to any of the

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return feeders from the rails. The drop in the return circuit is kept very low, and will never exceed three volts. Each booster is capable of giving out 30 kw. or 600 amperes at 50 volts. Like the rotary converters, it is capable of running at double its normal load.

The continuous-current connections from each converter are led to a panel provided with an automatic cut-out, main switch, ammeter reading up to 1,500 amperes, field rheostat, field ammeter, a voltmeter reading to 750 volts, and an integrating wattmeter reading the whole output of the machine. On the positive 'bus bar, between the rotary armature connections and the traction feeder connections, there is a shunt-actuated ammeter measuring the total current going out to the lines, and on the negative 'bus bar, between the rotaries and the rail returns, there is an integrating wattmeter measuring the total output of the sub-station. The traction feeders, it may be mentioned, are each provided with a Wurts patent lightning arrester, which is placed behind the board at the back of its corresponding feeder panel. At one end of the board are placed the Board of Trade panels for recording the leakage current and the voltage between the rails and earth.

The sub-stations are all identical in equipment, except as regards the number of units installed, and the switchboard arrangements are the same, which renders it possible to change the staff of sub-station attendants from one station to another with no fear of causing confusion, as the work is the same in each case. The number of line feeders and return feeders, of course, varies with the output of the station. Although each sub-station is arranged to supply a separate and distinct section of the tramway area, these sections can be connected together if desired, thus providing alternative feeding points in case of breakdown.

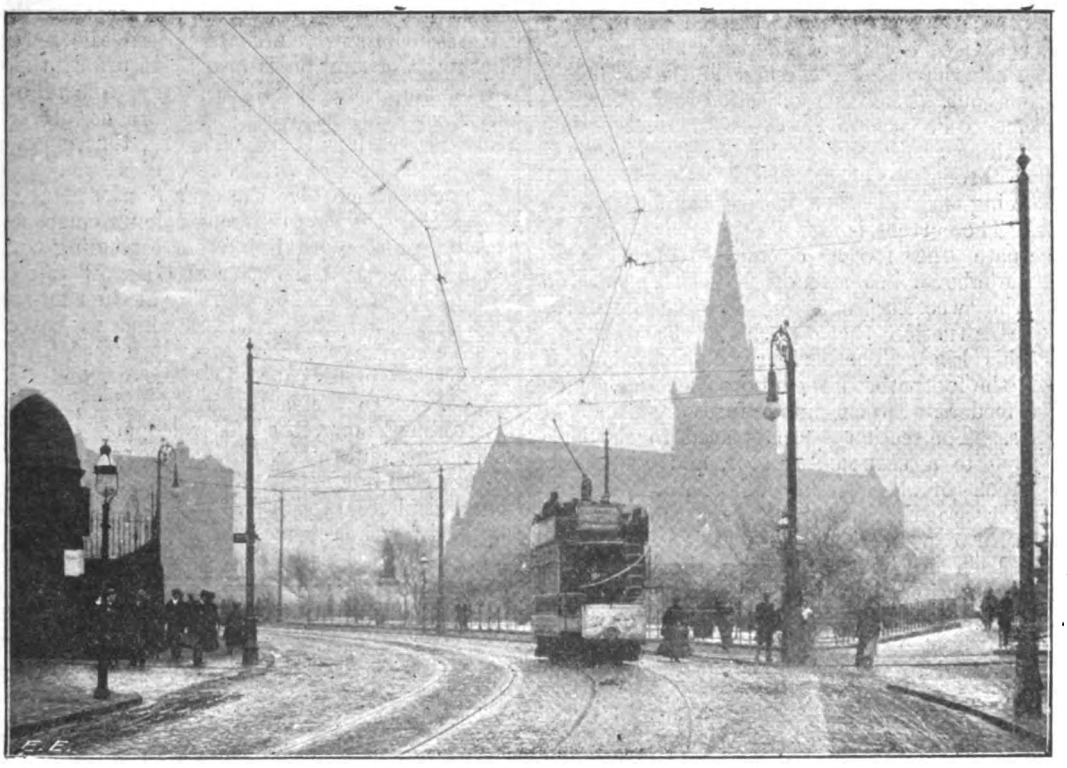

FIG. 22. Span Wire Construction at Glasgow. The Cathedral appears in the background.

Cables.

As already stated, four high-tension three-core feeder cables are taken from the generating station to the five sub-stations, making in all 20 cables. These high-tension feeders are paper-insulated and lead-covered, the lead sheath being $\frac{3}{16}$in. thick. The sectional area of each conductor is ·15 square inch in the case of the feeders to sub-stations A and E, and ·10 square inch for the other sub-stations. Taking the total sectional area of the 20 high-tension feeders, it will be seen that 2·40 square inches total feeder area suffices for the transmission of a possible maximum of 20,000 h.p., which gives an idea of the saving in copper due to the adoption of a high voltage at the generating station. It may be noted here that one of the three conductors in each feeder is earthed through a fuse at the station, and in the event of a leakage to earth developing on either of the remaining two conductors, the fuse blows on the artificially earthed cable, which has the effect of altering the conditions, so that the faulty cable is the earthed one, the other two being insulated. The 500-volt traction feeders from the sub-stations to the overhead lines are, of course, very much greater in sectional area than the high-tension feeders, ·6 square inch being the size mostly used. These feeders are also lead-covered, the insulation being fibrous and non-hygroscopic. All the low-tension feeders are insulated with a uniform thickness of dielectric $\frac{1}{8}$in. in radial depth, and sheathed with a lead covering $\frac{3}{16}$in. thick. The high-tension cables were subjected to a test of 20,000 volts, alternating, after 24 hours' immersion in water, and to a pressure test of 15,000 volts after laying and jointing. The low-tension feeders were subjected to test pressures of 2,500 and 2,000 volts respectively before and after laying. Return feeders are laid, varying in size and number according to where they are placed. These return feeders are also paper-insulated and lead-covered. All the cables are drawn into conduits, which in some parts of the system consist of fireclay tubes and in the remaining part of the National Conduit and Cable Company's cement-lined tubes. All the cables in the streets, including high and low tension feeders, feeder pilot wires, rail pilot wires, and telephone cables, have been supplied by the above-mentioned company, who also carried out the drawing-in and jointing of the cables. For carrying the high-tension feeders and the low-tension auxiliary feeders from the generating station to the sub-stations a tunnel had to be bored under the Forth and Clyde Canal, as all the sub-stations are on the opposite side of the canal from the generating station. This tunnel is lined with cast-iron tubes built of plates bolted together. The vertical shafts have an internal diameter of 8ft., and are built up with rings 3ft. wide, each ring consisting of six plates. The horizontal tunnel is 5ft. 6in. in diameter, and is formed of rings each 3ft. wide and consisting of five plates.

The conduits for the feeders are all laid between the tracks, the number of ducts varying from six to fifty. Manholes are situated at distances apart convenient for drawing the cables in or out, the maximum distance between any two manholes being 500ft. Three standard sizes of manholes are adopted—viz., 4ft. by 4ft., 6ft. by 6ft., and 8ft. by 8ft. The depth in each case is 6ft. 6in., which

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provides ample room. These manholes are built of brick, with steel girders across the top to support the roadway, and heavy cast-iron ventilating covers. They are connected to the drains by means of a trap.

Overhead Construction.

The span-wire system of construction has been adopted wherever possible, the spans being supported by rosettes on the buildings where these are available, and by side poles where necessary. On a few short lengths of the track centre poles have been employed, where the street is extra wide, and crossing Glasgow Bridge over the Clyde. The trolley wires are of No. 00 B. & S. gauge hard-drawn copper, with a breaking strain of over 5,000lb. The wires are suspended immediately above the centre of each track, and are at a height of 20ft. 6in. above the street. Earthed guard wires are erected wherever there are telegraph or telephone wires crossing the track. The guard wire is supported at a height of 2ft. above the trolley wire, and 8in. further from the centre of the street. The span wire supporting the guard wires is of $^{7}/_{14}$ S.W.G. galvanised steel stranded wire, having a breaking strain of 2,000lb., while the guard wire itself is of No. 7 S.W.G. The trolley span wire is of seven strand No. 12 S.W.G., having a breaking strain of 4,000lb. It may be noted here that the guard wire construction for the Springburn experimental route was all on the insulated system, but owing to the action of the Board of Trade all the guard wires in this route have been earthed and metallically connected throughout. The chief objection to the earthed guard wire seems to be that in the event of a guard wire breaking and falling across the trolley wire, the latter is very apt to fuse through and break at the point of contact, owing to the arcing effect at the defective contact between the two wires. The current is not likely to be sufficiently heavy to actuate the feeder circuit breaker. One instance of the above has already happened, but no doubt after the weeding out of possible defective parts in the construction there ought to be very few breakages of this kind. The switch pillars are placed at the edge of the footpath, and contain the switches for the trolley-wire feeders. No cut-outs or fuses are employed in these pillars. The section box is placed in the base of the pole opposite a section insulator, and contains a 200-ampere quick-break switch. Messrs. Macartney, McElroy, and Co. are the contractors for the whole of the overhead wire construction. A complete telephone installation has been erected, connecting the head office to the generating station, the sub-stations, the car depôts, and the street telephone pillars. The generating station is also connected direct to the sub-stations, and each of the latter is connected to the feeder switch pillars in its own area of supply.

Permanent Way.

The standard rail now adopted by the Corporation weighs 100lb. per yard, and is laid in 60ft. lengths. The gauge throughout the whole system is 4ft. 7½in., which admits of railway wagons being run over the track if necessary, the rail grooves being 1¼in. wide and 1¼in. deep, which takes the flange of an ordinary railway truck. The other dimensions of the rail for straight track are: depth, 7in.; width of sole, 7in.; width of roll, 2in.; width of lip, ⅝in.; over-all width, 3⅞in. The rail used for curves weighs 105lb. per yard, the lip being 1in. thick. The fishplates used weigh 74lb. per pair, and are 31in. long. They are secured by eight 1in. bolts. Steel tie-bars, 2in. by ⅝in. in section, are employed 5ft. apart to tie the rails to gauge. Daniel's bonds are used throughout, consisting of two long No. 0000 B. & S. solid copper bonds with Daniel's terminals, extending over the fishplates, and two flexible bonds of the same section in the base of the rail. The rails are laid on a bed of Portland cement concrete, 6in. in depth, and extending to 18in. beyond the outer rails. The track is laid with granite setts, which are thoroughly grouted with bitumen and granite chips. In the busier parts of the city chilled cast-iron paving blocks are laid on each side of the rails alternately with the granite setts. These have been supplied by Messrs. Miller and Co., of Edinburgh, and have been put down with a view to lessening the wear and tear of the track next the rails owing to the heavy traffic. The rails were supplied by the Leeds Steelworks, Limited, and Messrs. Bolckow, Vaughan, and Co., Middlesbrough. The work of laying the track has been carried out in sections by the following firms: A. Stark and Son, A. and J. Faill, Macartney, McElroy, and Co., Limited, Daniel Murray, and James Cameron—all of Glasgow. The bonds were supplied by Messrs. R. W. Blackwell and Co., Limited, but the actual work of bonding the track was carried out by the Corporation staff.

Cars.

The cars are of the double-deck type, on Brill trucks, and have nearly all been constructed at the Corporation car works, Coplawhill. The Springburn route was first equipped with the American centre-vestibule pattern, eight-wheeled type of car, with single deck, but this type has been abandoned for the four-wheeled double-deck type. Practically all the car equipments are by the Westinghouse Company, and consist of two of their standard motors, with series-parallel control, for each car. About 100 of the old horse cars have been converted for electric traction, but all the other cars (about 300) are new throughout. The guards employed consist of a V-shaped board at each end of the car, the bottom of the board being about 3in. above the level of the street. We are pleased to see that the absence of advertisements which characterised the horse cars of the Glasgow Corporation is also a feature of the electric cars. This example might with advantage be followed by some other corporations whose cars are so placarded with the virtues of various soaps, pills, etc., that it is with difficulty that "the stranger within the gates" manages to find out the notice which give the car's destination. By a system of painting the cars different colours corresponding to the various routes, with lights corresponding to these colours for night work, the native of Glasgow can tell what car he wants, often without looking at the route indicator.

In concluding this article, in which we have endeavoured to give a comprehensive description of the large undertaking just inaugurated in Glasgow, we have to express our thanks to the consulting engineer, Mr. Parshall; to Mr. John Young, the general manager of the Glasgow tramways; and to Mr. M. B. Field, the electrical engineer. We are also indebted to the various contractors for information and photographs relating to the plant which they have supplied for the scheme.

BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.

The laying of the corner-stone of the Westinghouse Works at Trafford Park, Manchester, by the Right Hon. the Lord Mayor of London, supported by the Lord Mayor of Manchester and Sheriffs of London, took place on Saturday last. The works now in course of erection are situated on a portion of the old Trafford Park Estate, and occupy some 130 acres. The works are adjacent to both the Ship Canal and the Bridgwater Canal, and are also in direct connection with the main-line railways. In their construction some 15,000 tons of steel and 10,000,000 cubic feet of timber will be required. About 3,000 workmen are engaged in pushing the work rapidly forward. The workshops consist of six buildings, at the present moment only partly finished, of rectangular form, and arranged side by side, where plant will be installed capable of turning out and handling similar castings to those made at the Pittsburg Works, Pennsylvania. The ironfoundry is 170ft. wide by 580ft. long, and next to this come the brassfoundry, malleable-iron foundry, pattern shop, steelfoundry, and forge. The two last are built end to end, forming a building of 170ft. wide by 580ft. long. The machine shop is 430ft. wide and 900ft. long, which is to be equipped with the most modern machine tools, all electrically operated. In addition to the buildings before mentioned, the offices for the clerical staff, drawing offices, and shipping department will consist of one building 50ft. wide and 250ft. long, and the stores another 60ft. wide by 270ft. long. Upon the

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completion of the works, we are given to understand that about 5,000 men will be employed, and for the accommodation of these workmen's dwellings are being erected on the estate. The works will be devoted to the manufacture of the well-known types of Westinghouse electric power machinery, including dynamos and motors for

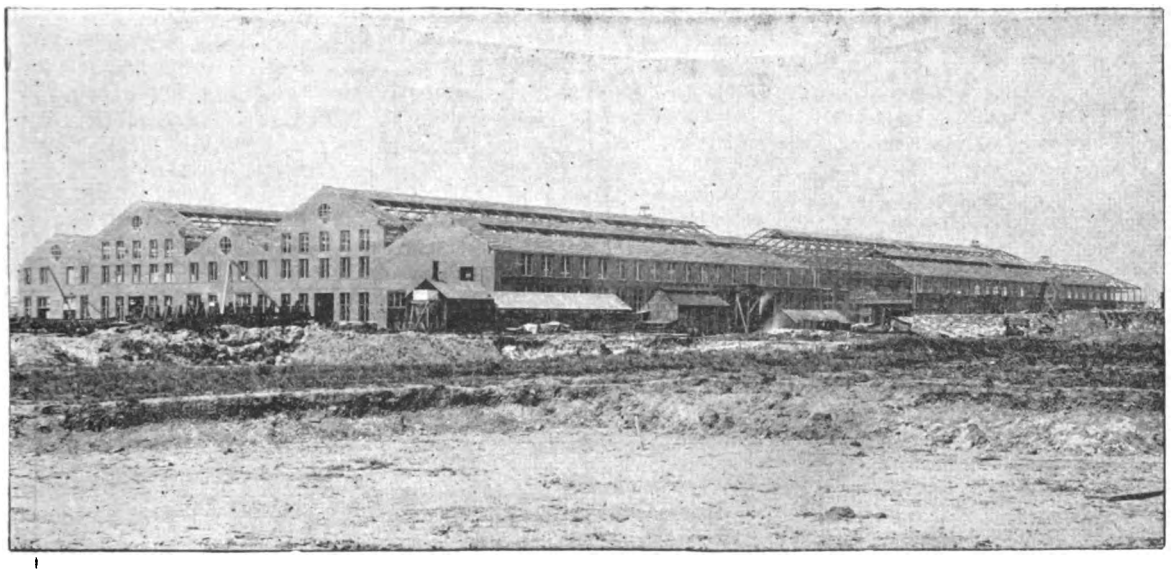

FIG. 1. View of the Westinghouse Works.

both alternate-current and direct-current working, tramway and railway motors, rotary converters, switchboards, etc. A considerable portion of these works will also be given up entirely to the manufacture of the Westinghouse three-cylinder gas-engine, several of which of 650 h.p. capacity are already in use. These engines are, we learn, also being built in larger sizes up to 1,5000 h.p. It may be mentioned

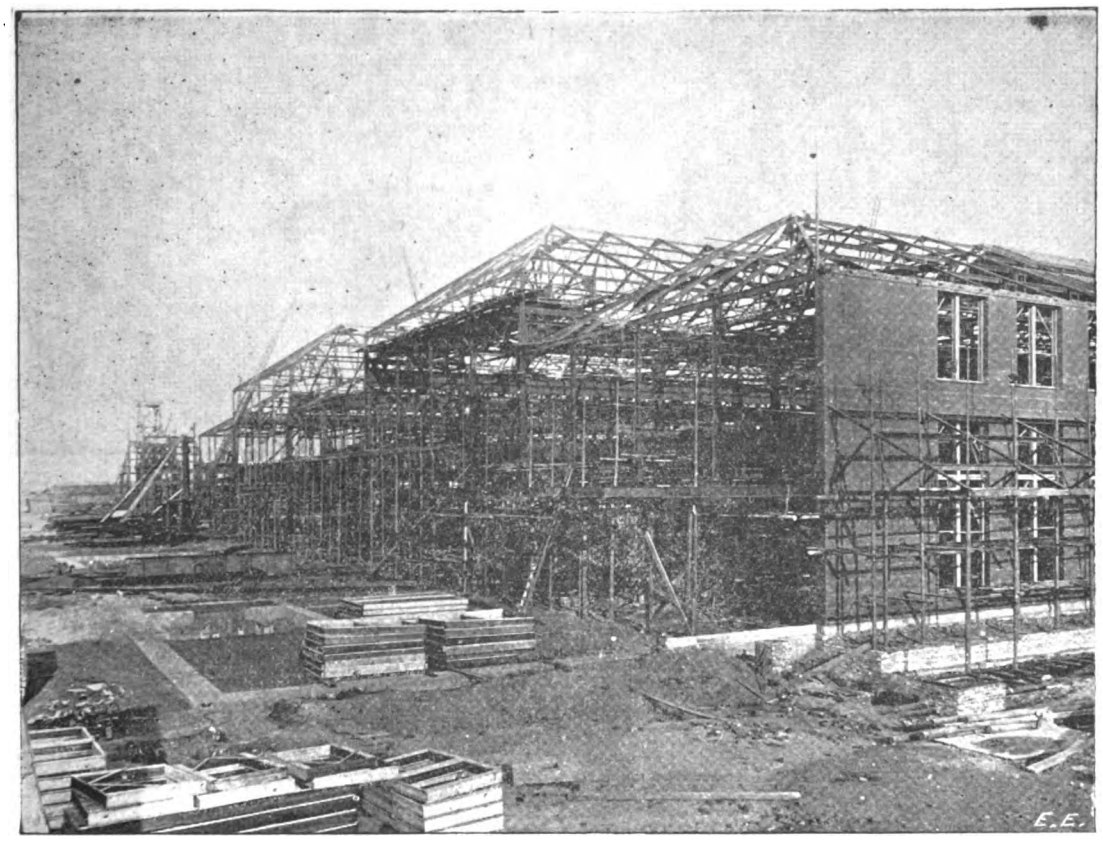

FIG. 2.—The Machine Shop at the Westinghouse Works, from a photograph taken in June last.

that as regards railway communication, railway tracks in direct connection with the main lines run the full length of the workshops. One of the points in American building practice appears to be that all the flushing, cornice gutters, down pipes and other roof fastenings are made of sheet copper. The cornice gutters are moulded and laid in a horizontal line, the necessary fall to down pipes being given by an inside lining of the same material. The whole of this portion of the work is being carried out by Messrs. Donovan and Co., Limited, Broughton Bridge, Salford. Special arrangements for the comfort and convenience of guests from London attending the ceremony were made, of which many connected with electrical engineering in this country availed themselves, and last Saturday's function at Manchester partook of all the pomp attending those of civic state with which Londoners are familiar, and from the interest and curiosity of the inhabitants will no doubt be handed down to posterity as a red-letter day in Cottonopolis.

It was to lay the corner-stone of this great undertaking, now in process of completion, that the Lord Mayor of London, and the distinguished party accompanying him, visited the park on Saturday afternoon. Preparations on an extensive scale had been made for a fitting reception of the visitors. From the covered platform decked with flags

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and cloth of scarlet, shown in our illustration, the important business of the day was transacted. The presence of the Lord Mayor, wearing his robes of office, and the attendant sheriffs, with all their equally gorgeous paraphernalia, lent animation to the ceremony, which attracted a large crowd of ladies and gentlemen. Amongst the directors and others connected with the company present were Mr. C. W. Benson (deputy chairman), Mr. Lemuel Bannister, Mr. Ph. Ferd. Kobbe, Mr. J. H. Lukach, Mr. J. Annan Bryce, and Mr. J. F. Mason; Mr. Arthur E. Scanes (secretary), Mr. W. H. Wells (business manager), and Mr. J. C. Stewart (building manager). Amongst the other guests who had seats on the platform we noticed Sir William Bailey, Sir Leader William, Sir Joseph Leigh, M.P., the Mayor of Salford (Alderman S. Rudman), Mr. George Renwick, M.P., Sir Henry Bemrose, Mr. John Bythell (chairman of the Manchester Ship Canal), Mr. J. G. Groves, M.P., Mr. J. H. Rider, Mr. Turnbull, and Mr. Chattock, while a number of prominent firms were also represented at the function.

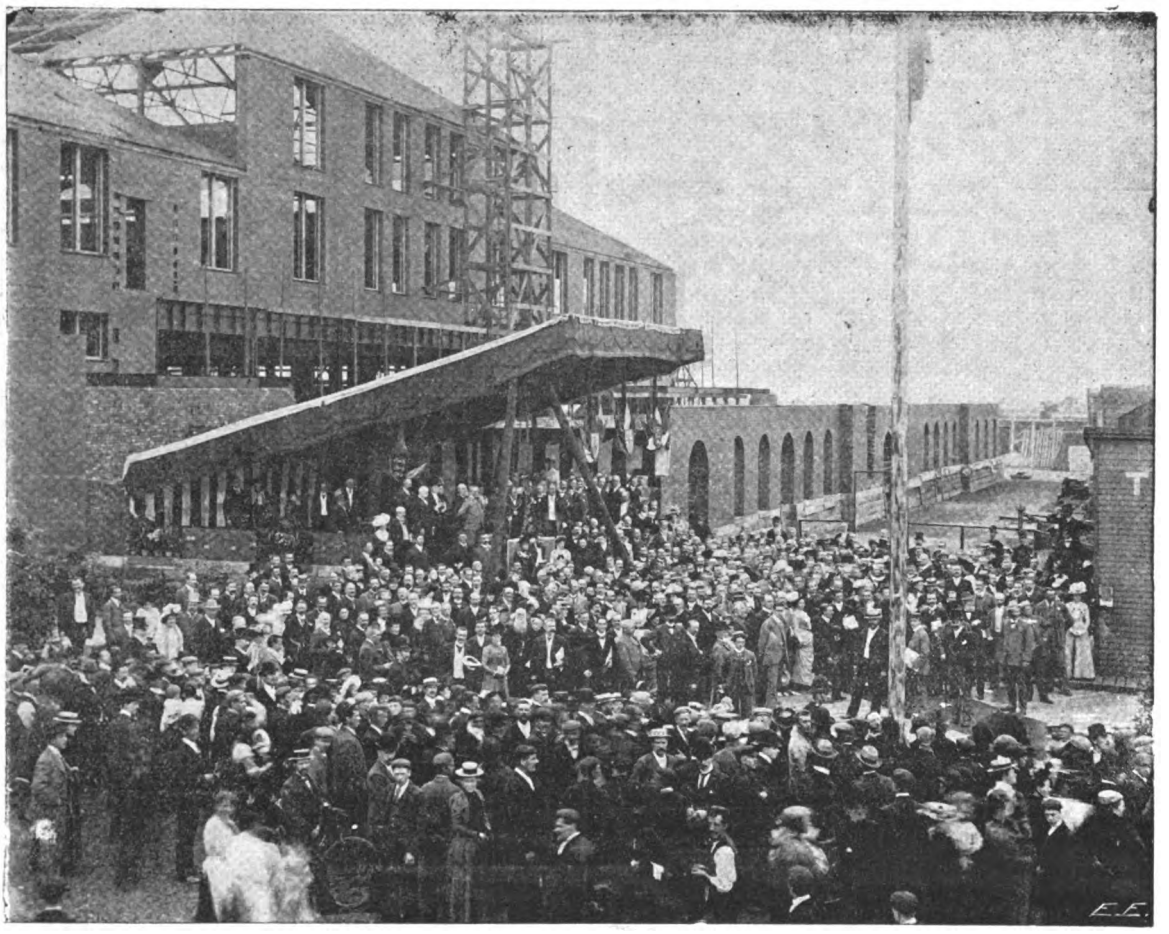

Fig. 3.—The Opening Ceremony.

The Lord Mayors on their arrival were welcomed by Mr. Benson. He informed their lordships that the directorate hoped within the course of two months to show a great alteration in the appearance of the buildings. In erecting them they had the benefit not only of English money, but American knowledge.

The Lord Mayors then laid the foundation stones, and the Lord Mayor of London was presented by Mr. J. C. Stewart with a silver trowel, and the Lord Mayor of Manchester was the recipient of a souvenir of the occasion in the shape of a mallet.

Mr. Sheriff Lawrence, M.P., in the unavoidable absence, through illness, of Mr. George Westinghouse, the chairman of directors, was deputed to move a vote of thanks to the Lord Mayors. He said that the industry to be carried on in those works was a new departure in the manufacture of electrical appliances. The capital which had been invested in the land and buildings, and which was still further to be invested in other buildings, was almost entirely British. It had been found by some of the leading capitalists in London, from Lord Rothschild downwards. Whilst the inception of this great enterprise was essentially American, the details and the future development of it were to be entirely in British hands. They hoped to send out from those works electrical plant and appliances which would astonish the world. The company had expended or committed themselves to an expenditure of no less than 1½ millions sterling, and possibly another half million might be necessary before the magnificent design was completed. They fully believed that on that large outlay they were going to get a very handsome return, and they believed they should in time, if not surpass, at least equal the production of the finest works of Germany and America. Already the products of the Westinghouse Company were known throughout many parts of Great Britain, thanks largely to the enterprise and administrative skill of Mr. Westinghouse and the brilliant band of men who surrounded him. This old country, much as they loved it, needed a bit of stirring at times, and it was going to get stirred up if Mr. Westinghouse was prepared to remain amongst them. They were engaged on a scheme to enable the company to commence with the employment of 5,000 men, and the Board, with far-seeing patriotism, had selected young men with chemical and electrical skill from the public schools and universities, and had paid the expense of sending them to Pittsburg in order that they might have, free, two or three years' practical training in the shops there, so that when they came back to this country they might be foremen and superintendents of the works.

Mr. R. H. Porter, chief of the United States Census Department, seconded the vote of thanks.

The resolution was carried with acclamation.

The Lord Mayor of London, in response, desired that large assembly to believe him when he said that he deemed it a great privilege and honour to have taken even a small part in that day's enterprise. With Mr. Porter he felt that the combination of American intellect and British capital, to which he alluded, was an assurance that the vast undertaking was on a safe foundation, and they might safely anticipate that the directors would have, what to them would be their greatest reward—viz., the pleasure of paying.

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good dividends to the shareholders. He hoped the stone he had the honour of laying would prove a true foundation stone of one of the greatest and most important commercial enterprises in this country and even in this new century.

The LORD MAYOR OF MANCHESTER also briefly responded, and expressed his delight at hearing that many English young men had been sent to the Pittsburg works to obtain a thorough training of the work they would be required to perform there. These great works would bring a vast amount of money to be paid in wages in that district. Where wages were plentiful there was prosperity.

The outdoor proceedings closed by the whole company singing the National Anthem, after which the guests were entertained to tea in a spacious building which had been ornately decorated for the occasion. The distinguished party left for Manchester later in the evening.

ANTARCTIC ELECTRIC LIGHTING.

There have been several references in the daily papers to the wind-power installation of electric lighting plant with which the ss. "Discovery" has been equipped. Through the courtesy of Messrs. Bergtheil and Young, who designed and supplied the apparatus in question, we are able to give a technical description of the same. The ship in question does not carry an unlimited quantity of coal from which to obtain electric light, and hence there was a need felt for a wind-power plant which should render the would-be "Discoverers" independent of coal storage for their lighting. The work of equipping the ship was superintended by Mr. Arthur Bergtheil, who adopted the following devices for securing constant voltage at the lamps, in spite of wide variations in the speed of the dynamos.

The apparatus (Fig. 2) consists of a dynamo having a capacity of 1·25 kw. at 50 volts, and another dynamo having a capacity of about 1 kw. at about 40 volts. These two generators are connected in series, the smaller machine opposing the larger. A shunt field switch is included, and provided with a solenoid controlling gear. The excitation is taken off the main terminals. In the normal position of exciting switch on No. 1 contact the following action takes place: The windmill drives the armatures of both the dynamos at, say, 500 revolutions per minute, at which speed the large machine will give 60 volts. With the shunt regulating switch on contact 1 the full excitation is on large generator while all the resistance is in shunt of small generator, which results in 60 volts being obtained on the main terminals. An automatic switch then closes the circuit to the cells, which are charged up. Should the speed of wind increase, the E.M.F. on large generator will go up, consequently the solenoid on the regulating switch will overcome the weight and put resistance into the large

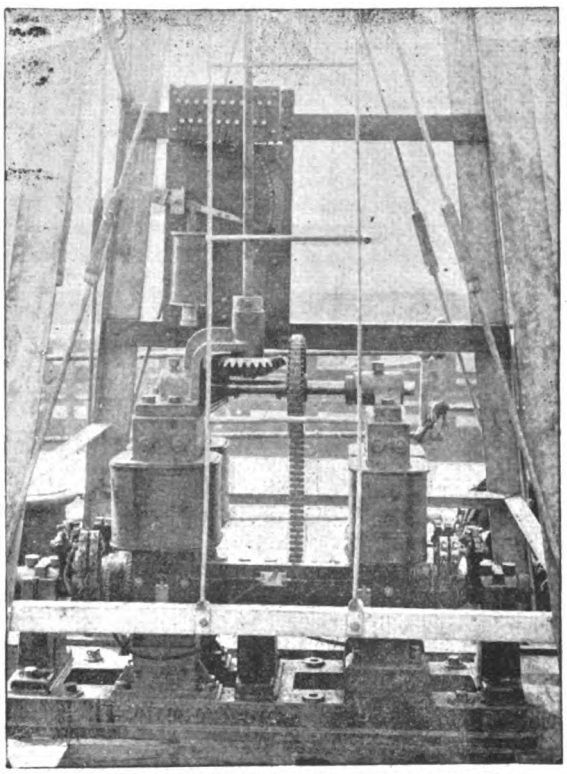

FIG. 2.—Detailed View of the Dynamos and Controlling Gear.

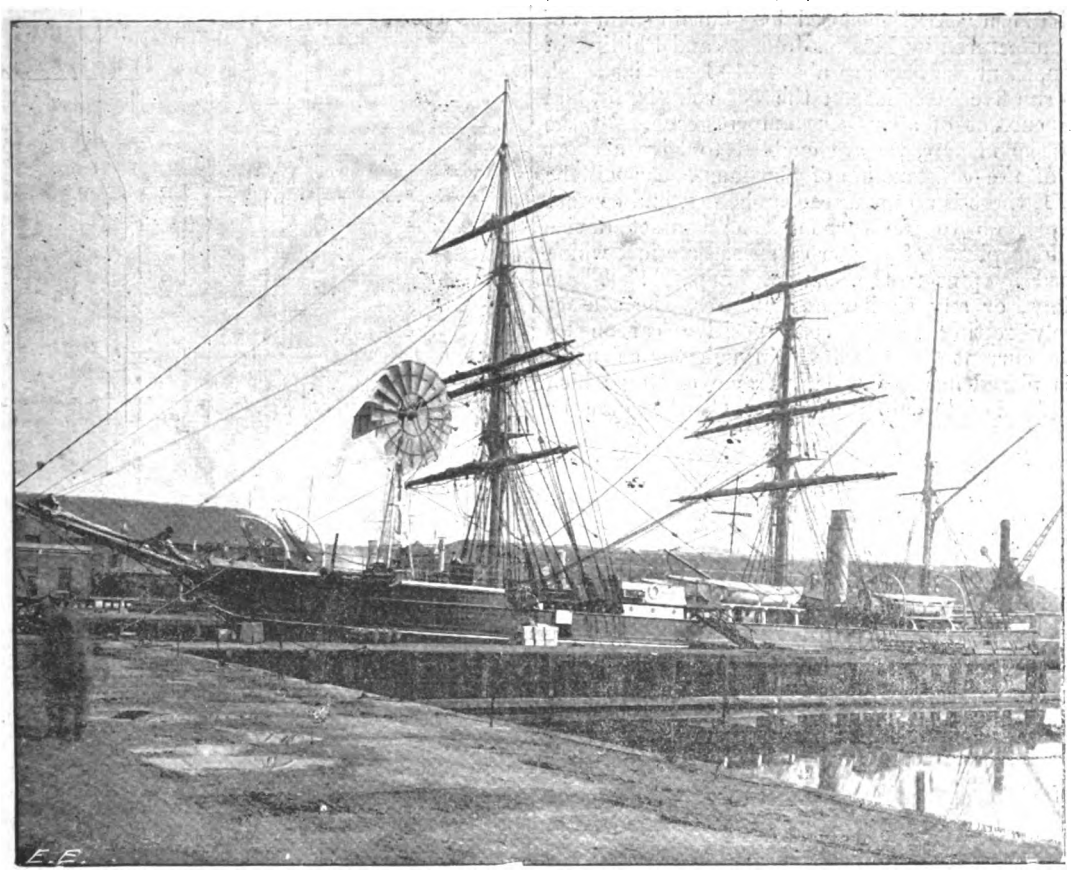

FIG. 1.—View of ss. "Discovery" showing the Windmill for Driving Dynamo.

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dynamo field, and cut some out of the small dynamo field. This has the effect of again adjusting the voltage to normal. By this arrangement a practically constant voltage is secured with a range of speed varying from 500 to 2,000 revolutions per minute. This range was actually obtained on trial in the London Docks before the "Discovery" went to sea.

The entire plant is extremely compact, and is so designed that it can be stored away in the hold of the ship until she arrives at her destination. In the event of it becoming necessary to light observation cabins or instrument sheds in the vicinity of the vessel, flexible cables have been provided with lamps attached so that these may be illuminated from suitable plugs placed about the ship. The windmill is so designed that it may be placed complete with its dynamos at a distance of 200 yards from the vessel for the purpose of obtaining the very best results from the wind, and connected to the vessel by means of a large armoured cable wound on a drum. The windmill is 20ft. high, with a driving wheel 12ft. in diameter, developing in a 15-mile wind something like 3 h p., geared to drive the vertical shaft at 200 revolutions per minute, and the driving wheel of the generator at 500 revolutions per minute. The windmill was manufactured specially for this plant by Messrs. Alfred Williams and Co., of Old Ford-road, Bow, and is of American type, so constructed that it can be easily shifted from one point to the other or packed away in a small compass. The dynamo was built specially for this installation by the Newton Electrical Works Limited, of Taunton.

The conclusion we come to in this matter is that Messrs. Bergtheil and Young have arranged a combined windmill and dynamo which will be of great service to Commander Scott, and which will serve to brighten the gloom of the Antarctic winter.

EAST HAM ARC LIGHTING.

The arc lamps used for the public lighting at East Ham are the well-known "Ark" enclosed long-burning lamps of the type manufactured by Messrs. Johnson and Phillips, of Old Charlton, Kent. There are about 140 lamps installed, arranged to run five in series on the 500-volt circuit, and they take a current of about five amperes each. By the kindness of the makers, we are enabled to give a short description of the construction of the lamp. As will be seen in Fig. 1, there is no upper carbon-holder, and contact is made direct on to the carbon. The contact device consists of four pieces of copper of special section, which are connected by pins to the contact frame, A. There are no springs, or any similar contrivances, the contact pieces merely resting against the positive carbon by gravity. On current being passed through the solenoid, B—which is placed inside the lamp-frame casting which carries the fixed internal pole-piece, C—the core or armature is raised slightly, causing the four clutch cams, which are connected to the armature, D, by the pins, E, to grip and raise the carbon, thus striking the arc. The armature descends as the carbon is consumed, thus releasing the grip of the clutch cams on the positive carbon and allowing it to slide through and feed itself. The contact pieces, F, are placed inside and at the bottom of the dash-pot, and when the carbons have burnt down to a certain point they automatically cut the lamp out of circuit.

The body or frame of the lamp is in one piece, and great strength and rigidity is thereby secured. The whole lamp is of very solid and durable construction, with simplicity carried to a degree that can only be realised by an inspection of the lamp itself; and, incidentally, this feature enables the lamp to be produced cheaply. The trimming device is also very simple, and can be performed with a minimum of trouble.

The lamps at East Ham have the automatic cut-out placed in the top of the lamp case, the line resistance also being inside. Separate switches and substitutional resistances for each lamp are placed in neatly designed cast-iron switch boxes, which are ornamented with the arms of the District Council, and are clamped on to the posts about 8ft. above the ground. These switch boxes, etc., were also manufactured by Messrs. Johnson and Phillips. Fig. 2 is a photograph of the lamps installed at Barking-road. It will be seen that they are placed on alternate poles, the total distance between each lamp being 240ft. The streets, however, are amply illuminated. Taking into consideration the amount of current consumed per lamp, the results are in every way excellent, although it must not be forgotten that as the lamps are of the "enclosed" type the light is naturally spread over a larger area, owing to the long arc and to the characteristic feature that the lamp gives out its light at a better angle for distribution over a wide area. This, however, would not suffice to give the good results above mentioned were it not that the regulating mechanism is well designed, and the light therefore very steady, and, further, special light-diffusing globes are employed. It

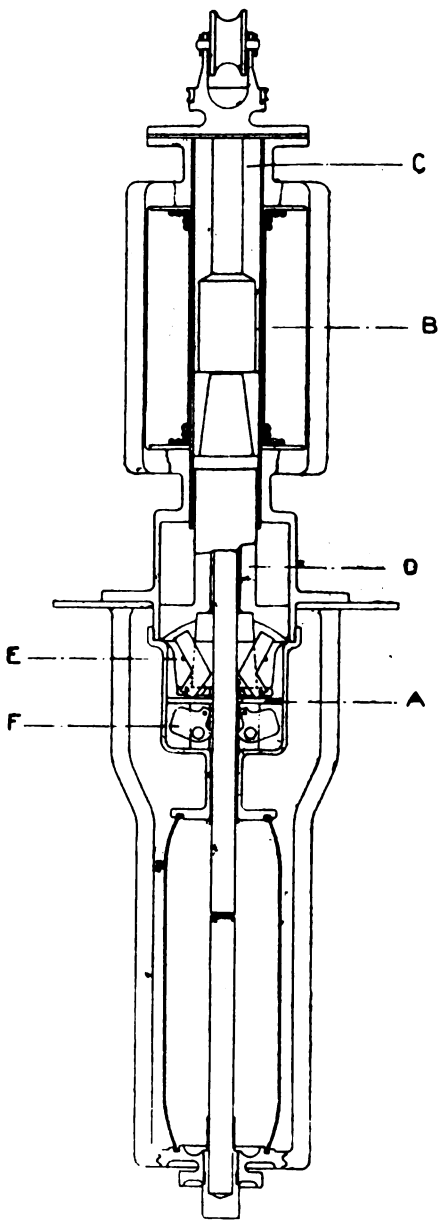

Fig. 1.—Section of J. and P. "Ark" Lamp.

is interesting to note that the lamps are "suspended from the arms carrying the trolley wires, and arranged to be as near the centre of the street as possible, saving the cost of separate poles, or even "carriers,' which are generally employed when lamps are "erected" on the trolley poles.

The "enclosed" type lamp appears to be rapidly gaining ground, and is being more generally used for street-lighting as well as private illumination; and in this respect we appear to be following the lead of our progressive friends in the United States, where practically all street-lighting is done with the enclosed type of lamp, and where the great economies of carbon consumption and labour in trimming have been fully gasped. The lamps were supplied through Messrs. Dick, Kerr, and Co., who received the contract

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for this installation, whilst to Mr. W. C. Ullmann, M.I.E.E., borough electrical engineer, belongs the credit of the general arrangement of the scheme.

THE BRITISH THOMSON-HOUSTON COMPANY'S MANUFACTURING WORKS AT RUGBY.

The electrical works of the British Thomson-Houston Company, Limited, at Rugby, of which bare mention has been made from time to time, are now so far advanced as to merit a more extended review than has been heretofore possible, and we are in a position to give our readers a brief outline of what, when completed, will be an up-to-date modern works. Much care and thought has been spent on laying-out the works, and the best experience of the Continent and America has been drawn upon in planning them. Due to the inability of the contractors to secure building material more promptly than anticipated, the works are not in that forward state of completion that it was expected they would be by this time. It is now, however, anticipated, if no unforeseen difficulties arise, to have work begun on patterns in about two months' time, and in the machine shop by the end of November, the entire works to be in operation in six months.

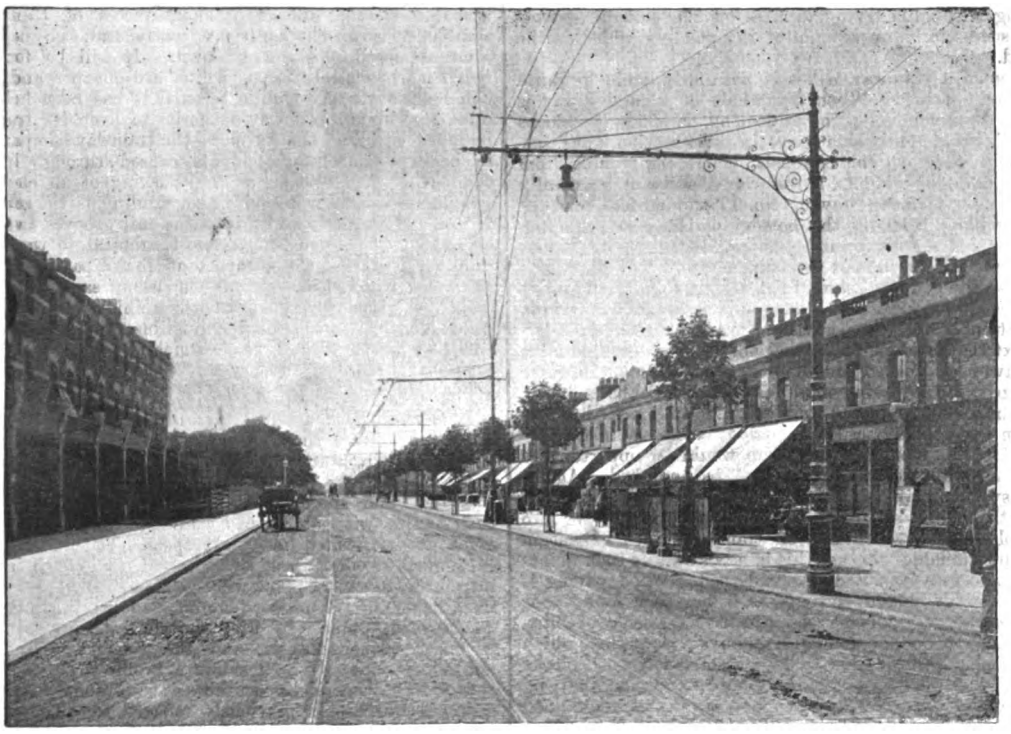

FIG. 2. View of the Arc Lighting at East Ham.

The works are splendidly situated, on land which was formerly the glebe farm, lying north of the London and North-Western Railway Station, and west of the Brownsover-hill-road, running north to the historic Avon, from which a plentiful supply of water will always be available for steam generating purposes. The site comprises 24½ acres, of which eight acres will be covered by roads and buildings, the latter having a total floor space of 200,000 square feet, most of which is under cover. As extensions of the works are required from time to time, the buildings are so planned that they can be made without in any way interfering with production, so that both extensions and production can be carried on simultaneously. The British Thomson-Houston Company have made a private road from the Brownsover-road leading into the works. By the side of this road a viaduct is built and fenced off, which connects with a siding of the London and North-Western Railway. Both the London and North-Western and the Midland Railways are to be connected with the works, so that the facilities for handling material will be ample, the canal on the north-east furnishing more facilities for the transportation of materials and plant. The buildings at present completed, but not fully equipped with machinery, are the power-house, steel stores and smithy, punch and annealing shop, office building, gate house, pattern-shop, and pattern stores. Those partly completed, and more or less roofed in, are the brassfoundry, ironfoundry, machine shop, the stores, and warehouses. The construction of these buildings is of steel and brick throughout, and they are practically fireproof. On all buildings requiring the maximum of overhead light glass roofs have been erected, while large windows in the sides of the buildings give ample side light. The artificial lighting will, of course, be by means of electric arc and incandescent lamps. All the buildings will be heated in winter by means of hot air propelled by powerful blowers, and which will also at the same time provide the necessary ventilation The lavatory accommodation for the operatives is designed on a scale to compare most favourably with the best works on the Continent or America, there being in all of the shops hot and cold water for washing, in addition to which each operative will have a locker allotted for keeping his clothes, etc., in, experience having demonstrated that those workmen that are most cleanly in their habits are more skilful and careful in their work. All the machine tools, which are of the most modern and up-to-date English, American, and Continental makes, are to be electrically driven, the large tools by direct connection to individual motors, and the smaller tools, conveniently grouped, by short lines of shafting. A new feature in tool driving will be the large 84in. planers which are to be operated by the British Thomson-Houston magnetic clutch drive, which permits the motors to continuously rotate in one direction, the reversing of the machine being accomplished by the magnetic clutch.

The buildings have been so situated as to have the work pass in at one end, and continue through the various operations progressively, until it reaches the testing department, the finished article, with the minimum of handling in its progression through the works. In the buildings where heavy pieces of machinery are to be handled, overhead travelling cranes, of which there are 11, are to be installed with capacities from 2 to 40 tons. These are distributed as follows: ironfoundry, one 30-ton and two two-ton cranes; machine shop, one 40-ton and three five-ton cranes; stores and warehouse, one five-ton crane each; steel stores, one two-ton and one three-ton crane. In the annealing shop a new form of Siemens's annealing furnace is erected, for which great economy is claimed. The office

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building is the most forward towards completion of all the buildings, and will be occupied by the staff in the course of a week or so. The next nearest completion is the power-house, the smoke stack of which is 200ft. high, and partly built of steel, and acts as a landmark to the surrounding country.

The steam-engine is nearly set up, and generators are also on the ground ready for erection, steam being expected to be turned on in the course of the next month. As soon as the new works are in operation we propose to publish a more full and detailed description of them, with illustrations of the arrangements.

PERMANENT WAY FOR ELECTRIC TRAMWAYS.*

BY W. HOWARD-SMITH, A.M.I.C.E.

(Concluded from page 94.)

Expansion and contraction are particularly objectionable on tramways: the first tends to spread the gauge, while the latter, by opening the joints, allows surface water to penetrate to underbed. Within the author's experience the expansion of wood paving proved so great on a tramway only 3ft. 6in. gauge that cars could not be run, the tiebars were found burst, and the gauge spread over 1in. for long lengths of track, which had to be relaid; and he has learnt of several similar cases. He has also seen soft wood blocks risen 1½in. above rail surface, and men working with adzes trying to dress off the protuberances—though not very successfully, on account of the grit embedded in the fibres of the wood.

The construction of a tramway makes it peculiarly liable to cause expansion in wood paving. When the whole of a carriageway is paved with wood, the cement screeding or floating, on which the blocks are laid, usually forms a continuous curve in cross-section, thus conducting the surface water to the channels, where any trouble from expansion is made manifest; but in a tramway a series of practically watertight troughs are formed (Drawing No. 17) for surface water if admitted to accumulate, soaking the bottom of the wood, the top surface being perhaps at same time subject to great sunheat—conditions which not only cause expansion, but are detrimental to the life of the material. All possible means should be taken to prevent water penetrating to underbed, therefore a clause such as the following from a recent specification is not to be advised: "At the rail joints the paving blocks next the outer fishplate shall not be pitch-grouted until after the lines have been opened and at work for two months, after which the loose part of the paving shall be lifted, the fishbolts finally tightened, and the paving replaced and grouted up." With these loose joints, open probably for a long period before completion of track, and then for two months after, there would be opportunities for any quantity of water to find admittance to underbed. Again, rail grooves are systematically watered to liquefy the grit; with open joints much of this water is likely to percolate. In one or two instances wood blocks have been laid on tramways with expansion joints, but it is questionable whether this is advisable, as such joints allow surface water to pass even easier to underbed. Wood paving is not permissible with the conduit system, as it has been found that its expansion closes the slot; for this reason its use has been prohibited on the proposed London County Council tramways. A method which has been tried on some tramways is to lay creosoted soft wood blocks with a serrated or "hit-and-miss" course of hard wood next abutting on each side of rails. This, however, has not proved an unqualified success. At the present time, on a South London tramway, relaid on this method some three years since, there may be seen humps over 1in. in height on each side of the rails, and in wet weather the wood between tracks rises and forms an arch, giving forth a hollow sound under horse traffic. Where the whole width of carriageway is wood paved, much less trouble is experienced from expansion between the rails, the haunches forming counteracting buttresses. Tramways usually have paved margins 18in. in width. When these adjoin macadam it is best to lay the setts with a straight edge, as with a serrated edge the macadam cannot be properly rolled into the serrations—these become filled with mud, which, when dry, leaves hollows between the setts, and latter become rounded, making a noisy road. Where a wood-paved margin abuts upon macadam, it is desirable to lay a single course of stone setts between the wood and macadam. Whether grouting should be of bitumen or cement depends upon local circumstances, and upon the particular paving material used. In either case it should be carefully run so as to solidify the paving and exclude all water soaking through. Trouble is frequently experienced by cement or bitumen grout getting into rail grooves and adhering to the metal, from which it is difficult to detach, but this may be avoided if the rail head be previously whitewashed.

Tar macadam has to a limited extent been used for paving tramways. Examples may be seen at Sheffield, East Ham, and Poole. The latter has a length of about four miles constructed under the author's direction. He is of opinion that it forms a suitable material for suburban or interurban tracks on which vehicular traffic is light. Very great care is, however, necessary in the selection and laying of the materials. It is not desirable to use less than 1in. stone for top coating, and much depends upon thorough consolidation. To ensure this, the author devised, for use on tracks constructed under his direction, a special form of roller (see Drawing No. 18). When this material is used for tramway paving on a road where there is vehicular traffic, it is requisite to use setts next the rail on each side, as the macadam is of too soft a nature to withstand the "rutting."

Ordinary macadam has been used on a few interurban lines with little vehicular traffic, setts being laid next rails. It is not a desirable material, as it has little permanency of wear, and the dust caused through disintegration in dry weather, besides being objectionable to the passengers, is apt to get into the mechanism of car; loose stones, grit, and mud also get into rail grooves. Very great care is necessary in rolling. If surface is left too flat, hollows form for the accumulation of surface water; while if laid with a full barrel, experience has shown that there is a likelihood of the life-saving guard, or fender, catching against loose stones and forcing them into the surface, which may be ploughed up to a serious extent and much damage caused before car is stopped. The fenders or guards are usually only some 2in. or 3in. from surface, and project beyond extreme end of overhang of car. When car has only a single truck, the rocking brings the guard almost touching road surface.

Asphalte has not been found suitable for tramway paving. It quickly wears into ruts, and the tremor of rails causes disintegration, which in turn allows moisture to penetrate to concrete bed, and in frosty weather the asphalte is lifted therefrom.

Several other forms of paving have been tried on tramways. Among these are Staffordshire blue bricks; "McDougall's blocks," which are made by oak studs being let into blue bricks; "sanitary blocks," made from a mixture of broken stone and bituminous asphalte compressed; and basalt lava setts. The latter—a non-slippery and noiseless stone—are coming much into favour, and they appear to possess in a high degree most of the qualifications necessary for a good tramway paving. The effect of much wheel traffic passing along rails is to cause "guttering" or "rutting" in the adjoining paving, especially when of wood. As a preventive, chilled cast-iron chequer blocks or short pieces of thin rolled joists are sometimes used, but both are costly and become noisy when the alternate wood blocks wear down. It will be found preferable to insert narrow steel strips, which are cheaper and have proved of equal efficacy. At Dublin recently it has been held that the usual obligation upon a tramway authority to keep its track in good order includes sanding the surface—the tramway company being mulcted in heavy damages for accidents caused through horses slipping on the sett paving. So far as the working of an electrically-propelled system of tramways is concerned, sanding is the reverse of desirable, as much of the grit works into the rail grooves, where its presence, as previously pointed out, is most inimical to the proper working of the line. It is therefore important that a paving material should be employed which will, without the use of sand, afford a safe foothold under all atmospheric conditions. Whinstones and basalts, or so-called granites, are quite inadmissible, and most of the Norwegian and some of the Scotch, Leicestershire, and other granites become exceedingly slippery under wear.

Wheel Tyres.

It is essential that wheel tyres shall be of a design suited to the rail head. From the use of unsuitable wheel tyres, and especially of flanges, constant friction, binding, and undue wear take place, these effects being particularly apparent on curves, and at points, crossings, and special work. The wheels should be pressed upon their axles with absolute accuracy; the general practice leaves much to be desired in this respect. Within the author's experience much trouble has been experienced from car wheels being inaccurate to gauge. The wheel gauge should be ⅜in. less than the track gauge, and a proper template should always be used to test the accuracy of fixing. By the adoption of this course there would be fewer broken flanges, and the tongues of points would last longer. Drawing No. 19 shows a profile of a wheel tyre which the author would suggest as suitable as a "standard," to conform to the standard rail design previously referred to. The flat end of flange gives strength, and would be found an advantage when flange runs upon dirt or upon the raised groove or liners often used at open points and crossings. The shape of rail tread and that of wheel tyre should accord—a most important point too often lost sight of. Frequently the rail tread is horizontal, whereas wheel tyre is invariably coned or bevelled. In these cases, until such time as the wheel tyre has worn away the rail tread to conform to its own profile, the wheel has only a partial bearing and can exercise but little tractive effort or obtain full electric contact. The result is that a liberal use of sand becomes necessary, especially on gradients, which again helps to wear away the rails and tyres, and it sometimes happens, especially with a new track, that so little adhesive effect can be obtained that a car cannot be properly braked when going down a grade, or obtain proper adhesion when going up one. When rail and tyre profiles are not in accord, the rail tread, being the softer, wears away the quicker, and by the time a full bearing is reached an appreciable portion of the life of the rail has been lost. The tyres also suffer much, especially when skidded on emergency stops. When rail tread and wheel tyres are each coned, car axles are maintained at right angles, cars are kept better centered on track, and it is possible for wheels to travel at different rates without slipping, as is necessary when passing round curves. With 30in. wheels travelling for a quarter of a circle of 50ft. radius, the outer wheel has to travel 7ft. 4¾in. further than inner wheel.

Life of Rails.

From the limited experience in this country of the effects of wear etc., from electric traction, it is difficult to determine with any degree of definiteness what may be generally calculated upon as a fair average period for rails to last before requiring renewal. Many factors enter into the question. As much depends upon the suitability of profile and of the chemical constituents of the rails and their accessories, and the manner in which they are laid, as upon the amount of traffic they have to carry. It particularly centres itself round the life of the joints, these forming the weak link in the whole chain. The

* Paper read before the annual meeting of the Incorporated Association of Municipal and County Engineers, at Leicester.

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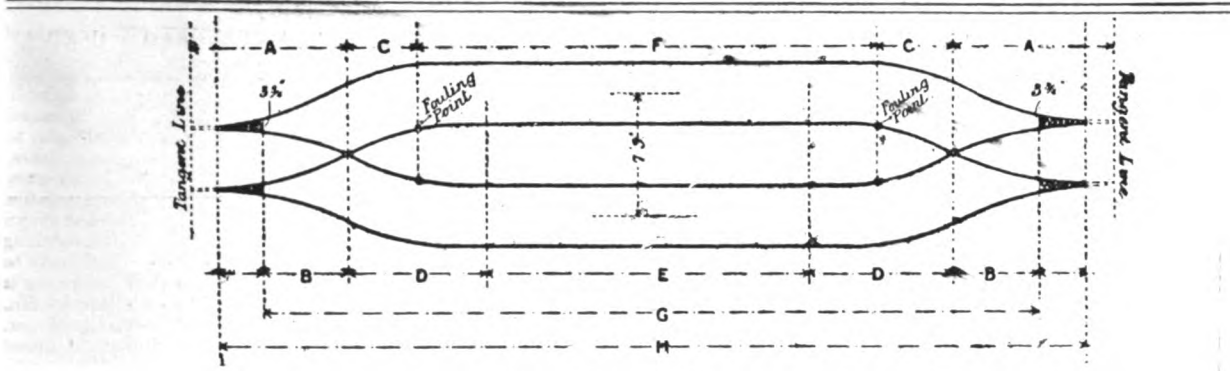

PASSING-PLACES—3FT. 6IN. GAUGE.

(1) *Diamond turnouts.* (2) *Centres between tracks, 7ft. 9in.* (3) *Fouling point, 3ft.*

Angle of crossing in units.	Angle of crossing in degrees.	Length of curve lead—*i.e.*, distance from tangent point to frog.	Length of crossing lead—*i.e.*, distance from heel of points to frog of crossing.	Radius of curve lead.	Distance from centre of frog to fouling point.	Distance from centre of frog to straight.	Length of straight.	Length between fouling points.	Length of P.P. from heel to heel of points (open 3¾in.).	Approximate total length of passing-place. Nose to nose of points.
	deg. min.	**A** ft. in.	**B** * ft. in.	ft. in.	**C** ft. in.	**D** ft. in.	**E** ft. in.	**F** ft. in.	**G*** ft. in.	**H** ft. in.
1 in 3	18 54	21 0	14 10¾	126 0	11 8	25 6	62 4	90 0	143 2	149 0
1 ,, 3½	16 16	24 6	17 4½	172 0	13 8	29 9	57 9	90 0	152 0	158 0
1 ,, 4	14 14	28 0	19 10¼	224 0	15 7	34 0	53 3	90 0	160 11	168 0
1 ,, 4½	12 40	31 6	22 4	284 0	17 6	38 3	48 8	90 0	169 9	177 0
1 ,, 5	11 26	35 0	24 9½	350 0	19 6	42 6	44 0	90 0	178 8	187 0
1 ,, 5½	10 24	38 6	27 3½	424 0	21 6	46 9	39 5	90 0	187 6	196 0
1 ,, 6	9 32	42 0	29 9	504 0	23 5	51 0	34 10	90 0	196 3	206 0
1 ,, 6½	8 48	45 6	32 3	592 0	25 3	55 3	30 1	90 0	205 0	215 0
1 ,, 7	8 10	49 0	34 8½	686 0	27 3	59 6	25 5	90 0	213 10	224 0
1 ,, 7½	7 38	52 6	37 2½	788 0	29 2	63 9	20 10	90 0	222 9	233 0
1 ,, 8	7 10	56 0	39 8	896 0	31 1	68 0	16 3	90 0	231 6	242 0
1 ,, 8½	6 44	59 6	42 2	1,012 0	33 1	72 3	11 8	90 0	240 6	252 0
1 ,, 9	6 22	63 0	44 8	1,134 0	35 0	76 6	7 0	90 0	249 4	261 0

PASSING-PLACES—4FT. 8½IN. GAUGE.

(1) *Diamond turnouts.* (2) *Centres between tracks, 7ft. 9in.* (3) *Fouling point, 1ft. 10in.*

1 in 3	18	54	28	3½	20	7	169	0	10	0	18	3	73	8	90	0	151	3	157	0
1 ,, 3½	16	16	32	11½	24	0¾	232	0	11	9	21	3½	70	11	90	0	161	8	168	0
1 ,, 4	14	14	37	8	27	6	302	0	13	6	24	4	68	3	90	0	171	11	179	0
1 ,, 4½	12	40	42	5	30	11½	382	0	15	2	27	4½	65	6	90	0	182	3	190	0
1 ,, 5	11	26	47	1½	34	5	470	0	16	10	30	5	62	10	90	0	192	9	202	0
1 ,, 5½	10	24	51	10	37	10	570	0	18	6	33	5½	60	3	90	0	202	9	212	0
1 ,, 6	9	32	56	6	41	3	678	0	20	3	36	6	57	6	90	0	213	0	222	0
1 ,, 6½	8	48	61	3	44	8½	796	0	21	11	39	6½	54	10	90	0	223	4	232	0
1 ,, 7	8	10	65	11½	48	3	923	0	23	6	42	7	52	2	90	0	233	6	243	0
1 ,, 7½	7	38	70	8	51	7	1,058	0	25	4	45	7½	49	6	90	0	243	10	253	0
1 ,, 8	7	10	75	4½	55	0	1,204	0	27	0	48	8	46	9	90	0	254	0	264	0
1 ,, 8½	6	44	80	1	58	6	1,360	0	28	9	51	3½	44	1	90	0	264	6	276	0
1 ,, 9	6	22	84	10	61	11	1,524	0	30	6	54	9	41	4	90	0	274	9	286	0

NOTE.—In columns marked * the dimensions are given from heel of switch-point, the opening of which is taken at 3¾in.

author has for some years given attention to this matter, and he has taken a number of measurements and rubbings of worn-out rails, some of which are shown on Drawing No. 20. Space does not permit this question being dealt with at length, but, in his opinion, the rails laid on tramways under electric traction in this country will probably be found to have an average life as under :

Where frequency of car service is five minutes or less, and vehicular traffic heavy.	Eight to twelve years on straight lines, with gradients flatter than 1 in 40.
Ditto, ditto	Six to ten years on straight lines, but gradients steeper than 1 in 40.
Ditto, ditto	Two to six years on curves less than one chain radius.
Where car service is less frequent than five minutes, and vehicular traffic light.	Ten to fifteen years on straight lines, with gradients flatter than 1 in 40.
Ditto, ditto	Seven to twelve years on straight lines, with gradients steeper than 1 in 40.
Ditto, ditto	Four to eight years on curves less than one chain radius.

Local and special circumstances may either lessen or prolong life beyond these periods. The use of a thoroughly efficient joint will probably add at least 50 per cent., and much additional life may be gained by careful attention to engineering details. Herr K. Berger, engineer of the Essen tramways, at the recent Paris Congress of the International Tramways Association, showed a 90lb. rail (Drawing No. 21), having a half-lap or raised fishplate joint, which he stated was worn out and had to be renewed after three years' wear under ordinary traffic and circumstances. On some tramways the wear on curves of small radii is found so excessive that renewal of rails becomes necessary about every 12 months. The author would be glad to, at any time, receive rubbings or measured drawings of worn tramway rails, with particulars as to number of years in use, whether on curves, gradients, etc., and such other data as may be necessary to form a criterion as to comparative life. This applies to rails worn out under horse or steam traction as well as to those worn out under electric traction. He would then hope to collate such information for the benefit of this association.

COST OF CONSTRUCTION PER MILE OF SINGLE TRACK 3FT. 6IN GAUGE, SETT PAVED.

Many miles of tramways have been constructed, in various parts of the country, by the employment of direct labour under the author's direction, and the following has proved a reliable estimate of average cost of one mile of single track, 3ft. 6in. gauge, exclusive of passing-places, no allowance being made for waste, etc. Cost of construction varies according to design, current, prices of materials, local circumstances, etc.

Quantity.		£	s.	d.
145 tons	in No. 235 steel girder rails, 45ft. long, 92lb. per yard, at £6. 15s. per ton...	978	15	0
235 pairs	,, 40lb. fishplates, at £7. 15s. per ton ...	32	11	0
940 No.	,, 2lb. fishbolts and nuts, at £16 per ton	13	12	0
235 No.	,, patent "anchor" joints, complete with fastenings, at 11s. each.....	129	5	0
725 No.	,, 14lb. tiebars, notched, at £7 per ton...	31	14	0
935 No.	,, 22¼in. copper joint bonds, 4/0, at 2s. 6d. each	29	7	6
235 No.	,, 27¼in. ditto, at 2s. 9d. each	32	6	3
18 No.	,, 45in. copper cross-bonds, 4/0, at 4s. each	3	12	0
480 No.	,, Bonds fixed and painted, at 9d. each...	18	6	0
7,040 lin. yds.	Cement parging to rails, at 3d. per lineal yard	88	0	0
1,760 ,,	Laying permanent way, complete, at 2s. 6d. per lineal yard	220	0	0
1,380 cub. yds.	Excavation, at 3s. 6d. per cubic yard...	241	10	0
760 ,,	6in. Portland cement concrete, 6 to 1, at 18s. per cubic yard	684	0	0
920 tons	Granite setts, 5in. deep, at 32s. 6d. per ton	1,495	0	0
50 ,,	Pitch, at 38s. per ton	95	0	0
8 ,,	Creosote oil, at 82s. per ton.....	32	16	0
3,360 sup. yds.	Sand and cement bed for setts, at 9d. per sup. yard	126	0	0
3,360 ,,	Paving, ramming, and covering off, at 1s. per sup. yard	168	0	0
3,360 ,,	Racking and grouting (labour only), at 6d. per sup. yard	84	0	0

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ANALYTICAL PARTICULARS OF SOME OF THE MOST RECENT SECTIONS OF GIRDER TRAMWAY RAILS USED IN THE UNITED KINGDOM.

	Works section number.	Weight in pounds per yard.	Total height.	Width of base.	Width of groove.	Width of tread.	Width of guard.	Total width of head.	Depth of groove.	Depth of head outside.	Thickness of web.	Centre of web from gauge line.	Whether head is flat or coned.	Distance of guard below top of thread.	Where used.
			In.	In.	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches		Inches.	
Walter Scott, Limited, Leeds Steelworks.	1	108	7	7½	13/16	1¾	9/16	3⅛	⅞	1⅜	17/32	3/16	Coned	⅛	Wigan.
	2	98	7	7	29/32	1 9/16		3 3/32		1⅛	½		—		Huddersfield.
	4	92	6	7	⅞	1½		3		1 9/16	7/16	—	,,	—	Blackpool.
	5	98	7	7	1	1⅝		3¼		1⅜	½	—	,	3/32	Birkenhead, St. Helens.
	6	100	7	7	13/16	1⅝		3 3/16		1	15/32	⅛	,,	⅛	Leeds, Halifax, Salford.
	7	92½	6	7	1	1 9/16	17/32	3 3/32	15/16	1 6/16	15/32	1/16	,,	—	Bristol, London United,
	9	105	7	7½	15/16	1 11/16	7/16	3 1/32	1	1 17/16	½	5/32	Coned	3/32	Bradford. [Middlesbrough.
	10a	98	7	7	1 3/16	2 1/32		3 27/32	1⅛	1 11/16		15/32	Flat	—	Glasgow.
	10b	105	7	7	1 3/16	2 1/32	1 1/32	4 9/32	1⅛	1 1/16		15/32	,,	—	Glasgow, Bolton, Farnworth.
	11	95½	7	7	31/32	2 9/32	1 21/32	3 25/32	31/32	1 1/16		7/16	Coned	3/16	St. Helens, Liverpool, Halifax, Darwen, Bolton, Bootle
	12	98	7	7	15/16	1 17/32	9/16	3 1/32	15/16	1½	½	—	Flat	3/32	Manchester.
	13a	86	6	6	1⅛	1¾		3⅜	1	1½	15/32	½	,,	—	Southampton, Warrington.
	14	98	7	7	1	2 1/32		3 1/32	1	1 1/16		7/16	,,	—	Aberdeen, Farnworth.
	15	102	7	7	1½	2		3¾	1⅛	1⅛	7/16	5/16	Coned	⅛	Salford, Rochdale.
	16	95	4½	5	1 3/16	2⅛	21/32	4 7/32	1 7/32	1 15/16	7/16	15/16	,,	1/16	Blackpool.
	17	95½	7	7	1	2 1/16	21/32	3 23/32	1	1	7/16	⅜	,,	3/16	Croydon.
	18	107	7	7	1⅛	2 1/32	½	3 21/32	1⅛	1⅛	½	¼	Flat	—	Nottingham.
	19a	94	7	7	1⅛	2	17/32	3 21/32	1⅛	1	15/32	9/32	,,	⅛	Stockport.
	20	92	7	7	1	1½		3⅝	1	1⅛	7/16	5/16	Coned	3/32	Plymouth.
	22*	91	6½	6½	1 1/16	1 29/32	19/32	3 9/16	1 1/16	1	15/32	½	,,	⅛	Wolverhampton.
	23*	90	6½	5¾	1 1/16	1⅞	⅝	3 9/16	1 1/16	1	7/16	½	,,	⅛	Dudley and Wolverhampton
Lorain Company, America.	325	83	6⅝	6	1 3/16	1 23/16	½	3½	1	1 3/32	⅜	5/16	Coned	5/32	Dublin, Cork, Margate, Cheltenham.
	329	86	6	6	1	2⅛	⅝	3¾	1	13/16	13/32	9/32	Flat	—	Swansea, Aberdeen.
	347	103	7	6	1¼	1 19/32	1	4¼	1¼	1 1/16	7/16	13/32	,,	—	Glasgow, Liverpool, Manchester, Newcastle, Birkenhead.
	348*	90	6½	5¾	1 1/16	1⅞	⅝	3 9/16	1 1/16	1	7/16	15/32	Coned	¼	Gateshead, Greenock, Grimsby, Tynemouth, Middleton, Dudley, Devonport, Ayr, Blackburn, Dundee, Southend, Plymouth, Stourbridge, Ilkeston.
	349	92	6½	5¾	1⅛	1⅞	⅞ for curves	3⅝	1 1/16	1	7/16	½	,,	⅛ above	
	350	91	7	6	1¼	2¼	7/16	3 15/16	1 1/16	25/32	13/32	5/16	Flat	¼	Liverpool.
	360	93	7	6½	61/64	2 3/64	1 1/16	3 11/16	1 1/16	1	⅜	23/64	Coned	3/16	Halifax, Darwen, Dundee.
	365	98	7	6½	1¼	2	⅝	3⅞	1¼	1 3/32	⅜	13/32	Flat	—	Glasgow.
	366	103	7	6½	1¼	2	1	4¼	1¼	1 3/32	⅜	13/32	,,	—	Glasgow.
Dick, Kerr, and Co., Limited. Phœnix Works, Germany.	70	83	6	6	1⅛	2⅛	⅝	3⅞	1	1	⅜	7/16	Flat	⅛	Carlisle.
	75	87	6½	6	15/16	1¾	⅝	3 5/16	⅞	1 3/16	7/16	½	,,	—	Potteries.
	78	96	7	7	1⅛	2⅛	½	3¾	1 1/16	1⅛	⅜	7/16	Coned	3/16	Dublin.
	91	101	7	7	1	2	9/16	3 9/16	1	1 3/16	7/16	7/16	,,	3/16	Newcastle-on-Tyne.
	92	100	6½	7	1 3/16	2	11/16	3⅞	1¼	1½	7/16	7/16	Flat	—	Cardiff.
Barrow Hæmatite Steel Company, Barrow-in-Furness.	216a	98	6	7	13/16	1½	⅝	3	⅞	1¼	7/16	—	Flat	—	Plymouth, Accrington.
	217	92	7	7	15/16	1 7/16	11/16	3	⅞	1¼	½	—	,,	—	London, Manchester, Birmingham.
	233	103	7	7½	1 1/16	1⅝	7/16	3	11/16	1	½	—	,,	—	Bradford, Huddersfield.
	275	106	7	7	1¼	1½	½	3⅛	11/16	1 3/16	½	—	,,	—	Glasgow.
	354	108	7	7½	⅞	1⅝	½	3⅛	⅞	1⅛	½	5/16	,,	—	Sheffield, Bradford, Wigan.
	398	92	7	7	1	1⅝	½	2⅞	¾	1 1/16	7/16	⅛	,,	⅛	Newport.
	407	89	6½	6½	1⅛	1⅝	⅝	3⅜	¾	1¼	15/32	—	,,	—	Glasgow.
	411	98	7	7	1	1 7/16	9/16	2⅞	13/16	1¼	½	—	,,	—	St. Helens.
	415	88	6	7	1	1 11/16	⅝	3⅛	1	1¼	7/16	1/16	,	—	London United, Bristol,
	423	83	6½	6	1 3/16	1 9/16	7/16	3⅛	13/16	1	7/16	—	,,	—	Edinburgh. [Dublin United.
	439	100	6⅝	6½	1⅛	1¾	5/16	3½	1 1/16	1⅛	⅜	1/16	,,	—	Glasgow.
	455a	98	7	7	1	2	9/16	3½	1	1	7/16	11/32	,,	—	Blackpool.
	482	83	6	6	1⅛	1⅞	½	3 7/16	15/16	1 1/16	13/32	5/16	,,	—	Perth, Preston, Blackpool and Fleetwood.
	493	95	7	7	1 1/16	2	9/16	3⅝	⅞	1	⅜	7/16	,,	⅛	Liverpool, St. Helens, Bolton
	494a*	90	6½	5¾	1 1/16	1⅞	⅞ for curves.	3 9/16	1 1/16	1	7/16	½	Coned.	⅛	B. E. T. Co., Devonport, Newport, Southend, Hartlepool, Poole, Merthyr, Stourbridge,
	494b	92	6½	5¾	1⅛	1⅞		3 7/16	1 1/16	1	7/16	½	,,	⅛ above	
	496	100	7	7	1⅛	1¾	⅝	3½	1⅛	1	½	—	Flat	⅛	Oldham. [Dudley.
	503	98	7	7	1⅛	2	⅝	3⅝	1 1/16	1⅛	7/16	11/32	,,		Huddersfield.
	505	98	7	7	1⅛	2	⅝	3 11/16	1¼	1	7/16	15/32	,,	—	Wallasey.
	508a	102	7	7	1⅛	2	9/16	3⅝	1	1	½	—	,,	—	Burnley.
	509a	92½	6	7	1	1¾	½	3¼	1⅛	1 5/16	7/16	3/32	,,	5/16	Chatham.
	510a	100	7	7	1⅛	2	⅝	3½	1⅛	1⅛	7/16	5/16	,,	5/16	Manchester.
Bolckow, Vaughan, & Co., Ld. Middlesbrough.	1	92½	6	7	1	1 9/16	17/32	3 3/32	15/16	1 5/16	15/32	1/16	Flat	—	London United, Bristol,
	2	100	7	7	1⅛	2	⅝	3⅛	1⅛	1⅛	7/16	5/16	,,	⅛	Manchester. [Middlesbrough.
	3	107	7	7	15/16	1⅞	9/16	3⅜	⅞	1¼	½	⅛	,,	—	Nottingham.
	4	102	7	7	1 3/16	2 1/32	21/32	3¼	1¼	1 1/16	⅜	7/16	,,	—	Glasgow.
	5	100	7	7	1	2	9/16	3 9/16	1⅛	1⅛	7/16	¼	,,	⅛	Birkenhead.
	6	101	6	7	1	1⅞	⅝	3½	⅞	1¼	9/16	—	,,	—	Brighton.
Société Anglelle, Belgium.	9	94½	7⅛	5½	1¼	1⅝	½	3½	1 3/16	1	13/32	⅜	Flat	—	—
	10	85½	5 29/32	5 29/32	1¼	1⅞	13/32	3 13/16	1 3/16	⅝	13/32	—	Coned	5/64	
	11	86	6	6	1¼	2⅛	7/16	3⅝	1 3/16	1⅛	13/32	⅜	Flat	—	—
	12	94	6 5/16	5½	1 3/16	2	1	4 5/32	1⅜	⅞	13/32	¼	,,	5/64	—
	13	94	6	7	1	1⅝	½	3¼	1 1/16	1¼	7/16	8/16	,,	—	Great Crosby.
	14	94	6	7	1	1⅛	1⅛	3¼	1 1/16	1¼	7/16	Centre groove	,,	—	Hull, Doncaster.
	15	84	6	6	1 3/16	1⅝	½	3⅜	1⅛	1	13/32	⅜	,,	—	Dudley.
	18	84	7	5½	1 5/16	1⅞	11/16	3¾	1⅛	¾	13/32	—	,,	5/64	

* Nos. 23 Leeds, 348 Lorain, and 494 Barrow are of the same section (designed by the author); and No. 22 Leeds is practically similar.

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1,760 lin. yds.	Making good to outside edge of margins, at 1s. per lineal yard	88	0	0
1,760 lin. yds.	Watching and lighting	132	0	0
1,140 tons	Carting materials to site, at 2s. 6d. per ton	142	10	0
800 cub. yds.	Removing surplus soil and materials, at 2s. per cubic yard	80	0	0
Provisions :				
Possible interference with manholes, lampholes, etc.		50	0	0
Possible interference with gas or water mains and services		100	0	0
		£5,096	4	0

On basis of similar prices, etc., add £475 if track is 4ft. 8½in. gauge.

NOTE.—No allowance is made for use of plant, contractor's profit, or contingencies.

DISCUSSION.

The **President,** in inviting discussion upon the paper, said it was one of great value, which would repay study.

Mr. A. D. Greatorex (West Bromwich) proposed a hearty vote of thanks to Mr. Howard-Smith for his extremely useful paper. The paper would be useful to every member of the association, but more particularly to those who had tramways to lay down. It was a paper that would repay careful study before designing any tramways they had to construct.

Mr. A. E. Collins (Norwich), who seconded, thought the association should take up the suggestion made by Mr. Smith as to representation before the Standards Committee to consider the standardisation of all sections of steelwork. He was sorry that Mr. Smith in summarising his paper was not able to give a little more time to the question of joints, to which he had given much study, and in which he had made considerable improvement. With reference to the recent action at Dublin, owing to horses stepping on the sett pavement, if the tramway authority had laid the same setts as he had recently laid at Norwich they would have got out of all their trouble. It was an absolutely non-slippery sett—that was, basalt lava. His authority would not have any other sett laid.

Mr. T. H. Yabbicom (Bristol) remarked that there were times when they were obliged to have curves on a sharper radius than 50ft. He knew where they had curves of 40ft., and round these curves a raised guard rail had been placed of 1in. to 1½in. That was very objectionable, and he regretted to say that the Board of Trade inspector, when he came down to view the line, sanctioned this raised guard rail on account of the greater safety of the tramway working. He would like to ask Mr. Smith whether he had had any experience of a raised guard rail of this character. With reference to wood paving, Mr. Smith said it should not in any case be laid on gradients steeper than 1 in 18. He had used wood paving for years past on considerably sharper gradients than that, and very successfully, and he saw no reason to alter his views. Then Mr. Smith said, "A method which has been tried on some tramways is to lay creosoted soft wood blocks with a serrated or hit-and-miss course of hardwood next abutting on each side of rails. That, however, had not proved an unqualified success." He agreed with the author that that was a very objectionable practice on account of the different wearing capacity of the two kinds of wood. Then further on Mr. Smith said: "Where a wood-paved margin abuts upon macadam, it is desirable to lay a single course of stone setts between the wood and macadam." He had tried that, but he could not say that he had found it desirable, as there were different materials—steel, wood, granite, and macadam. These different materials had a varying amount of wear, and the result generally was that the granite stood up above the macadam and the wood and formed a very lumpy-dumpy road. Then Mr. Smith said, "Ordinary macadam has been used on a few interurban lines with little vehicular traffic, setts being laid next rails." Well, that was a very common practice on country roads, and he did not know how they could get over it, because no one would propose to pave the whole of a suburban road. The objection to it was that loose stones, grit, and mud got into the rail grooves and had to be cleaned out. The effect of "guttering" or "rutting" in the adjoining pavement was a trouble they all had. He did not agree with the suggestion to use chilled cast-iron chequer blocks as a preventive of rutting. Where they mixed up the materials, it tended to make a road very unpleasant to travel over.

Mr. A. H. Campbell (East Ham) said that, coming from the very thick of tramway construction, the paper appealed to him. It was a perfect wealth of information on all matters of tramway construction. With regard to paving of tramways Mr. Smith had referred to the use of tar macadam. Possibly, as most of the members of the association knew, he had taken great interest in tar macadam as a material for road construction. His experience of it as applied to tramway tracks was that tar macadam was an absolute failure. What applied to an ordinary road did not apply to a tramway track, where the traffic got concentrated and converged. He had also laid sanitary blocks, which came in halfway in the matter of cost between tar macadam and granite setts. His experience of these was very satisfactory. The clear ring of the horses' hoofs upon the pavement was clear proof of its durability. They had not all of them the privilege of living in Leicestershire, and granite was very expensive. He could not get it under 18s. a yard, and, besides the cost, its noise was objectionable. If there was a practical result from the paper in the way of getting their views before the Standards Committee it would be of great service, because a standard rail would prove a great economy in tramway construction. He would like to move that the association be represented by Mr. Smith and Mr. Wike before the Standards Committee.

Mr. S. S. Platt (Rochdale) said the paper was one of the most complete which had been prepared on the subject, and some of them would have been very much obliged if they had had all this information in their hands earlier. Mr. Smith had epitomised in a most satisfactory way some of the best tramway practice in this country, and it was unfair to Mr. Smith to ask him to gallop through the paper in the way he had done. With regard to the length of the rail, he considered that 60ft. was too long. He was using a 60ft. rail, and he found it was too long for laying. A 45ft. rail was sufficiently long for all purposes. Mr. Smith referred to the absence of fishplates at Blackpool. He (Mr. Platt) did not know whether that had had anything to do with the trouble they had met with there, but he should certainly hesitate to dispense with fishplates. With regard to passing places, he did not see any reference to interlacing and double tracks for a better electrical return. When he saw the arrangement at Blackburn he did not like it, and soon afterwards two cars happened to pass on the same interlacing track, and a serious collision occurred. In regard to paving he was very pleased to hear Mr. Collins's remark about basalt lava. He was putting down a trial length of this material in front of a place of worship in his district in place of wood. If the district was pretty extensive, and they had got patches of wood here and there in front of places of worship, it was not conducive to the temper of the municipal engineer to have to send out to sand these places on Sunday mornings in times of frost. Experience had shown that chilled iron wheels had not anything like the life expected of them, and contributed a very great deal to the damage of the track. They were supposed to run 30,000 miles, but he had seen many that were worn out which had not run 10,000 miles. Steel-tyred wheels shrunk on to a circular frame would be found preferable.

Mr. W. Nisbet Blair (St. Pancras) said while he cordially agreed with all who had spoken as to the value of the paper, there were points on which they were entitled to differ, for the author, Mr. Smith, suggested the use of chilled iron chequer blocks to prevent rutting and guttering. He agreed with Mr. Yabbicom in condemning that. These blocks were a source of great annoyance to any person living in the neighbourhood. They wore at a less rapid rate than either wood or granite, and gave out a continuous clatter, so much so that the Tramway Committee in his district called upon the tramway company to withdraw all the chilled blocks. One other suggestion was the use of narrow steel strips. Much against his will, but in obedience to directions, he put in steel strips on to each course as it was suggested that they would add to the durability of the wood, prevent the forming of ruts against the rails, and be practically everlasting. They did not. In a very few weeks they jumped loose, and in two months had to be taken out. Those were points he spoke on from experience, as a warning to anyone against adopting them on a large scale. Mr. Smith condemned, practically wholesale, all whinstones and basalt granites. Of course they knew some whinstones were very slippery, but they knew that others were non-slippery. He knew a stone which came from Barrowsford, Northumberland, which was absolutely non-slippery, though it was not so durable as Penmaenmawr stone.

Mr. Yates (Waterloo), after paying a high compliment to the paper, said he was pleased to hear Mr. Collins ask for further information as to the joints, because the joint was becoming one of the most important factors in tramway construction. The question of life of the track was now of much greater importance than in the days of horse traction. Fishplate joints had one great advantage—they could be fixed without lifting the rail after the cement foundation had been laid. With reference to the length of the rail, he did not think there was any great difference between handling a 60ft. rail and a 45ft. rail, and the use of the longer rail reduced the number of joints. With respect to the groove of the rail, Mr. Smith favoured a 1½in. groove. Personally he thought that should be an absolute maximum, because there were other things to be considered on the road beside electric traction.

The **President** said he would like to express on their behalf their very great appreciation of the time and ability Mr. Smith had devoted to this important question. He was sure they would forgive him for curtailing the discussion on this interesting paper.

The vote of thanks having been accorded by acclamation,

Mr. Howard-Smith, in replying to the discussion, said he was exceedingly flattered by the reception they had given to the paper. Mr. Yabbicom referred to rail guards 1in. or 1½in. above the rail. He had no experience of anything of the kind; it seemed to him abnormal. Mr. Collins mentioned the rail joint, and that alone was worthy of several hours' discussion, as it was the most important of all the details of tramway construction. The whole life of the track depended on the joints. The anchor plate joints had been down for some years, and had shown that they made a perfect joint, neither allowing the rail to move vertically or sideways. He had one case where the wood expanded tremendously, and the rail went out in a circle, but there was no movement at the joints. The idea of the joint was to make the rail as strong at the joint as at any part, and he thought they had succeeded. There were some 40,000 of them in use in various parts of the country, and that was sufficient to show that other engineers besides himself had faith in it. With reference to setts, he had seen the basalt lava laid on a gradient of 1 in 12 or 1 in 13, and it had given the greatest satisfaction, being non-slippery. He had no objection to macadam, though it had its disadvantages, and he would call attention to the desirability of not making the "bow" of the road too high. A question had been raised by Mr. Yabbicom as to whether wood should be laid on a gradient of 1 in 18, or more or less. He quite agreed with Mr. Yabbicom that on an ordinary road he could lay wood on a gradient of less than 1 in 18, but the responsibility was altogether different from the responsibility for slipping on a tram track. Mr. Blair had referred to chilled iron blocks, but that gentleman could not have read his (Mr. Smith's) reference to them, as he called attention to their being noisy and costly. He did not advocate them at all. He mentioned that even steel strips were preferable, though he did not advocate them, as he regarded them as a choice of evils.

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BRITISH ELECTRICAL FACTORIES.

As will be gathered from articles which appear in other parts of this issue, two large new electrical manufacturing works—the one at Trafford Park, Manchester, and the other at Rugby—are nearing completion. The actual capital to be spent in building and equipping these works is to be reckoned by millions, and the workmen which they will employ when in full operation will not be far short of ten thousand. Both these manufacturing concerns are being organised by American engineers, and we believe that the parent American companies have also been largely responsible for financing the English manufacturing undertakings. The fact that these works have been organised proves that the American manufacturers believe in the future prosperity of the electrical industry in this country. Also, with such large works, one cannot expect to find a market for all the articles produced within the confines of the British Isles. It follows that these works will be active competitors in the Colonial markets for large orders and concessions for electrical apparatus. It is also to be presumed from the fact of the works starting, that the directors are sure that they can turn out electrical apparatus at a lower rate than is made up by adding to the manufacturers' prices in America the freight dues for transporting the same to this country. We know that a good deal of the competition by American manufacturers, and more recently by German firms, for orders in this country has resulted in work being taken at prices which are quite unremunerative. Such competition as far as America is concerned is likely to cease when these new works get under way, as manufactories practically under the same control will not undersell each other. The great advantage which as a nation we shall derive from these two large factories, and from the works of another large company recently organised and now in full swing under the supervision of an American engineer, is due to their being built on a large scale and equipped with the newest types of plant for manufacturing in quantity. The organisation of the staff and the arrangement of the shops are also such as to reduce the cost of labour to the manufacturer. In this respect even we quite expect that these new English manufacturing concerns are better equipped than those of America or of Germany. In consequence of this the companies will be able to make legitimate manufacturing profits, and to carry out work at reasonable rates as to encourage the extension of the electrical industry. It is this that is required at the present time rather than a reliance on patent rights and trade secrets. The industry has now reached a stage at which master patents have practically all elapsed. Patents for details continue to be taken out, but here again the value is only realised if the patented article can be cheaply made and sold. The reliance on master patents has sapped the energies of too many of our firms, as has lately been apparent, and it must now be realised that good work produced in large quantities at low cost is the great element of success. The whole of the details of the organisation of the above works, and of the new factories now being erected by certain of our older English companies, are arranged to that end. One result is sure to be a keener competition for work both at home and abroad. With their strong financial backing the new concerns may get some orders by assisting in promoting undertakings, but for the great bulk of the work to be given out there will be a fair field and no favour Our corporations will reap the benefit of this competition, and will be able to insist on their labour conditions being fairly conformed to by all competing for work. While we disagree from many of these conditions *in toto*, the great

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objection to the present state of things is that the labour clauses drive work out of the country, and hence they are powerless to do good to the class intended. The expected competition may be hard on some old concerns which have not kept themselves up to date in manufacturing, but with the survival of the fittest will come increased prosperity of the English electrical trade as a whole.

NEW TURBINE GOVERNORS AT NIAGARA FALLS.

We are able, through the courtesy of Mr. Alph. Steiger, M.I.C.E., to give some interesting results obtained at Niagara with the new turbine governor introduced by Messrs. Escher, Wyss, and Co., whom Mr. Steiger represents in the British Empire.

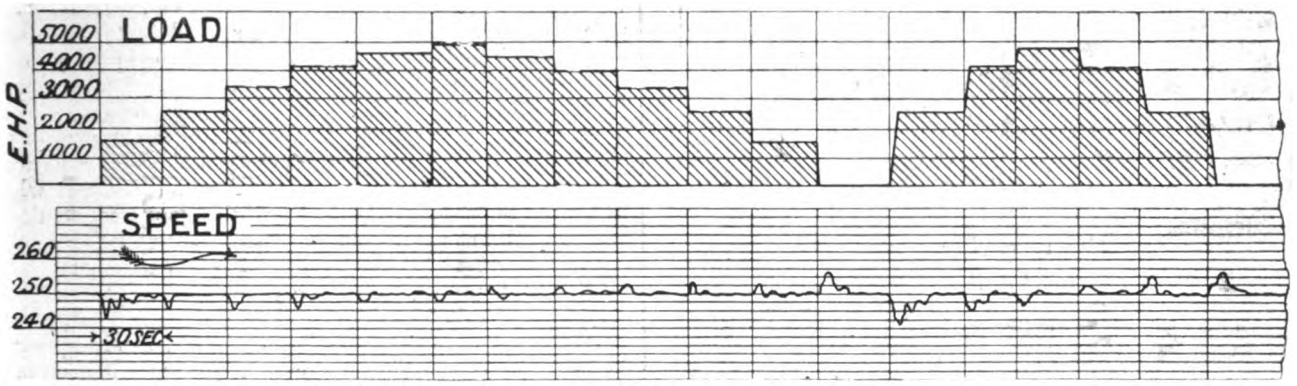

FIG. 1.

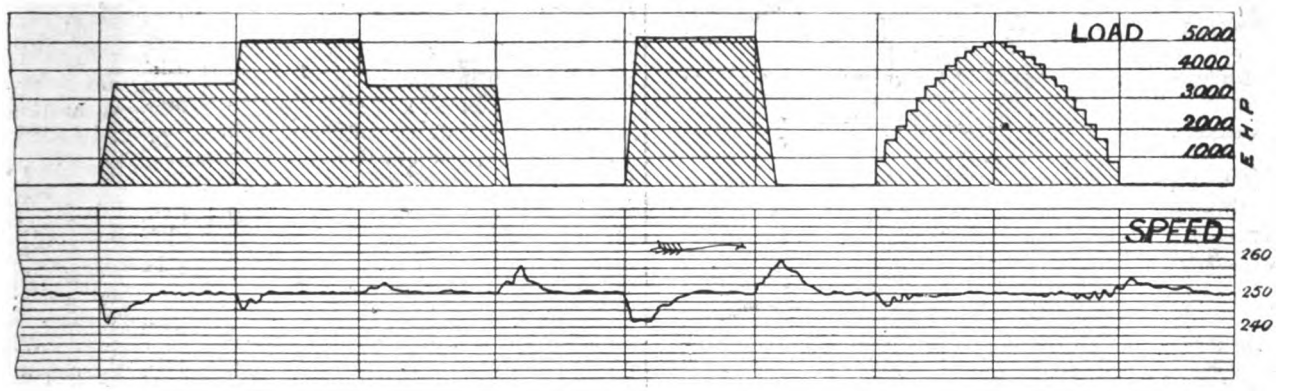

FIG. 1A.

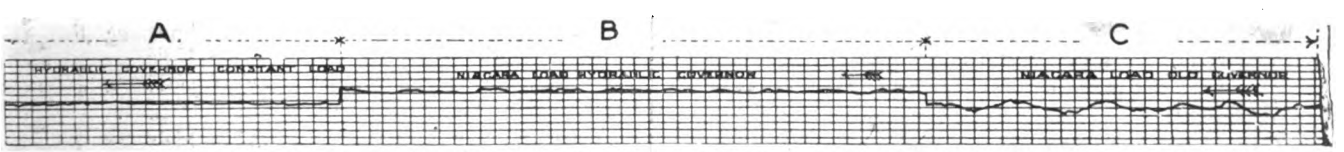

FIG. 2.

The governor was tested in conjunction with a turbine and generator capable of developing 5,000 e.h.p., and a speed record obtained when the load was purposely varied. The results of these tests are given in Figs. 1 and 1A.

It will be seen on reference to the diagrams that five tests were taken, under differing conditions, in rapid succession. In the first of these the load was thown on in increments of about 1,000 h.p. at a time, at intervals of about 30 seconds, up to a maximum load of nearly 5,000 h.p., and then thrown off in a similar manner. The normal speed of the turbine was 250 revolutions per minute, and as each division in the speed scale represents 2·5 revolutions per minute, each division corresponds to a 1 per cent. variation in speed. It will be noted that the first access of load occasioned the greatest variation—viz., one of 3 per cent.—but the load change was also greatest, being 1,500 h.p. The time taken to regain normal speed varied but slightly in this first test, and in no case exceeded 15 seconds, in several instances being as low as 7½ seconds. The succeeding tests were of increasing severity up to the fourth, in which the full load of about 5,200 h.p. was thrown on in about six seconds, and, after a lapse of just under one minute, was thrown off again in about 10 seconds. Under this most trying test the governor appears to have behaved admirably, controlling the speed to within 3½ and 3¾ per cent. respectively at the two changes of load; the time taken to regain normal speed being about 30 seconds in each case.

The performance of the governor when there are several turbine-generators working in parallel is not less satisfactory. This is evidenced by the diagrams in Fig. 2, a comparison between the portions B and C resulting very much in favour of Messrs. Escher, Wyss, and Co.'s governor. Portion B is especially noteworthy, as it shows the effect of the speed when a sixth generator governed by the new governor is put in parallel with five others governed by the old governors and run on the ordinary Niagara load. As a matter of fact the new governor, in this case, simply takes charge of the whole set of six machines, throwing the five other governors out of action by its promptitude and absence of hunting. Referring again to Figs. 1 and 1A, which show a variation reaching as much as 3¾ per cent., it has been found that although a much greater sensitiveness could be obtained by adjusting the governor, it was at the expense of steadiness, and hunting was occasioned. As it is, machines fitted with the new governor run as steadily in parallel with one another as singly; the governors can also be adjusted to divide the load equally between the machines, or in any manner that may be desired.

The governor operates the turbine gates through the medium of a cylinder and piston operated by a fluid under very high pressure. In the case of low falls oil is used, and the pressure maintained by means of a pump, a pressure of as much as 30 atmospheres being sometimes used; where the fall is sufficiently high, water under the natural

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head is used. The governor operates a valve controlling the admission of the oil or the water to the cylinder referred to, thus obtaining very prompt adjustment of the gates. In order to prevent damage to the pipe line by the sudden stoppage of the water when the turbines are at the bottom of the line, the governor is arranged so that should it shut down very rapidly, it at the same time opens a relief valve at the bottom end of the pipe line, the relief valve being designed to close automatically and slowly. By this means the pressure is prevented from rising more than 5 per cent. above the normal. On the other hand, provision is made against too rapid a flow—such as would, for example, occur in the event of a pipe bursting—by an automatic valve at the intake, which closes if the flow greatly exceeds the full-load value.

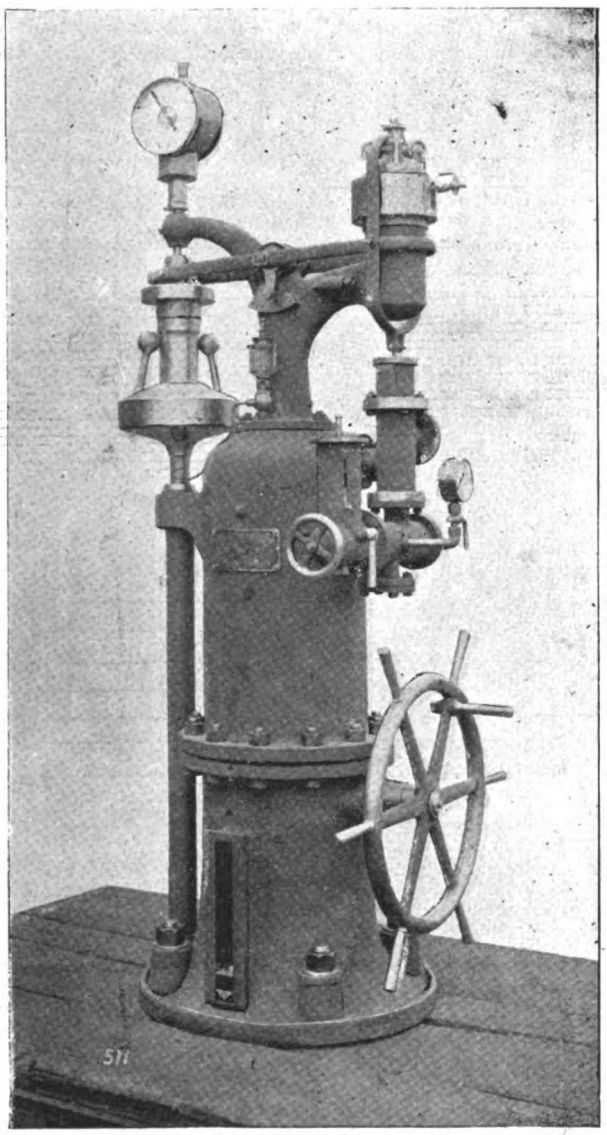

FIG. 3.—The Escher, Wyss and Co. Governors as used on the Turbines at Niagara.

Yet another valuable feature newly introduced is an electromagnetic control, energised by the exciting current of the alternator. This is so arranged that in the event of a failure of the field current, the governor instantly operates to shut the turbine right down; this occurs, of course, whether the exciting current breaks down or whether the circuit is broken at the switchboard; in the latter case the whole process of shutting down a generator may be effected from the switchboard entirely without any manual closure of the turbine gates whatever. Fig. 3 gives a very good impression of the general appearance of the governor.

In addition to the 10 turbines of 5,000 h.p. each already installed, Messrs. Escher, Wyss, and Co. have six more of 5,500 h.p. each on order, and orders for five more machines have yet to be placed. The tunnel for the power-house on the Canadian side was commenced on May 5 last, and we understand that provision is being made for 10 machines of 10,000 h.p. each. The general arrangement will be the same as that on the American side, generators being carried by a long length of vertical shaft above the turbines, as in that case.

THE ELECTRICAL COMPANY'S SHOWROOMS.

Our readers will remember that some nine months ago we gave a description of the new showrooms which the Electrical Company had opened at 162, Shaftesbury-avenue, S.W., owing to the large increase in business, especially in the fittings department. We then gave a general review of the main features of the showrooms, dealing at the same time with a number of typical fittings that were then being exhibited. Since our first visit, however, the firm have added very many new and beautiful designs to those already on view, and we therefore readily agreed to pay another visit to these interesting rooms, where an exceptionally unique collection is to be seen. A special feature has been made of oxidised silver fittings, and since the opening of the premises at the end of last year much has been done to get together a varied selection of this style of work. Oxidised fittings, to which one section of the showrooms is entirely devoted, are particularly suitable for libraries, halls, landings, dining-rooms, etc. A good feature, which will no doubt recommend them to many, is that the orthodox silk shade is dispensed with, and with the help of *repoussé* work, to which oxidised silver particularly lends itself, the manufacturers have succeeded in turning out some exceedingly handsome designs in lanterns, ceiling and side brackets, etc. Passing on, an adjoining room is especially set apart for showing dining-room counterweight pendants in polished brass and wrought iron. Several additions have also been made in this room, and an excellent selection is afforded. In order to obtain the true lighting effect, an arrangement of wall plugs and plug blocks is made by which it is possible to light any individual fitting by itself. Thus the matter of selection is made particularly simple, and at the same time the appearance of the fittings as they would be seen in an ordinary room is well preserved. We may mention here an extremely neat device in the shape of a switch cover which this firm is making. It consists of a thin metal plate, which is fastened on to the wall, allowing only the switch knobs to project. These covers, which are made in keeping with the style of fittings selected, are supplied either for two or four switches as the case may be. Many new designs have also been added in the way of bronze and terra-cotta figures. What particularly strikes one about these figures is their natural appearance. Until very recently efforts in this direction had not been attended with much success, and the models were made to hold the lights in positions which could hardly be described as natural. Art, however, has now come to the aid of the manufacturer, and the exceptionally fine collection at this company's showrooms afford good evidence of the success which has been attained.

A particularly novel little figure, which we illustrate herewith, is that of a boy in bronze holding a staff, from which is suspended a small lamp. This is especially suitable for pianos, and may be so placed that the lamp hangs directly over the music. The heavily-weighted base ensures its steadiness. Shown in conjunction with the larger figures are some especially handsome onyx pedestals. The one shown above supporting the figure of a girl will serve to indicate the artistic appearance of the same. Mounted with cast brass ornaments, it has a height of 39in. and that of the figure 32in. The Electrical Company have at present a large and varied stock of such pedestals on view, and for these alone their showrooms are well worth a visit. The firm also deal widely in French brackets especially adapted to drawing-room use, owing to their exceedingly artistic and ornamental appearance. Our attention was drawn to the "Iris" brackets, one of which we illustrate herewith. These are being made for one, two, and three lights, and in addition to their light-giving qualities they make an excellent addition to the picturesque appearance of any drawing-room. The little two-light Louis XVI. bracket shown

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below is another example of what can be done in the matter of combining science with art. A very handsome

A Group of Typical Fittings seen at the Electrical Company's Showrooms.

example of *repoussé* work is a four-light pendant with opalescent glass shades. This is made of armour-bright iron, and is designed in the Early English style. A large variety of this class of fitting is to be seen, special attention having been directed to keep the designs as much as possible in the old style. These, however, are only just a few of the beautiful things which the Electrical Company are showing at 162, Shaftesbury-avenue, and with our limited space it is impossible to do anything like justice to the high state of efficiency which has been attained in this department. The firm, however, have just issued a very handsome illustrated catalogue of electric fittings and glassware, and we would recommend the perusal of this to all interested in the subject. We may safely congratulate the Electrical Company on having at the present time one of the finest and most unique collection of electrical fittings in the country.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS

401. Is there any method of protecting an overhead telephone line, about half a mile in length, running over the tops of houses, from lightning discharges? The instruments have the ordinary arresters fitted, and evidently the lightning passes through them owing to the discolouring of the points; but a month ago during a storm the induction coil was burnt out, and a week ago, during another storm, the receiver coils were fused.—F. G. C.

402. Could any of your readers give me a description of the duties of a sea-going electrician on board a large liner?—A. B.

ANSWERS.

Question No. 395.—A fault is located to a length of cable between two disconnecting boxes. What is the quickest and best way of locating the actual position under each of the following conditions: (*a*) cable vulcanised and braided only; (*b*) cable lead covered and lead earthed; (*c*) cable lead covered and laid in compound, the lead being practically insulated from earth? The fault is of low resistance.

Answer to No. 395 (*awarded* 7*s.* 6*d.*).—The particulars given are not full enough to enable "the quickest and best" method to be definitely stated. A "fault" may mean an earth on a single or multiple cable, or a short on a multiple cable. Also the afflicted cable may be near the generating station, or it may be some distance away, with transformers intervening. It may be a distributor with half a dozen offspring between the disconnecting boxes mentioned, or it may be a barren feeder. Different methods might be judiciously used for all these different might-have-beens. However, assuming that the cable is a single feeder, that its fault lies in its earthly inclinations, that the location is too far from the station to burn it out without having to spend time in strengthening possible fuses in between, that it is in a half-mile length (with draw-boxes every 100 yards), and that there is no apparatus handy for making loop tests or for using the triangle, then the procedure should be as follows:

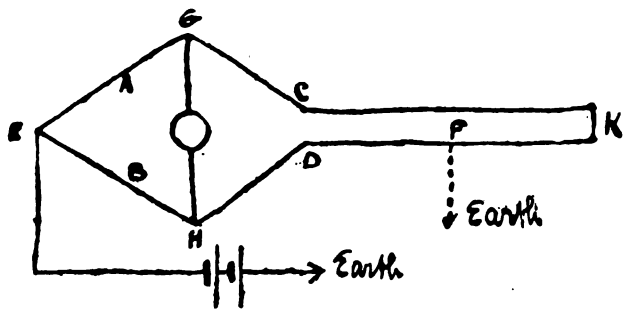
(*a*) Disconnect at live end, cut cable in the half-way draw-box, test on either side for insulation with the portable Kelvin, Silvertown, or Evershed which is in every station, note faulty side, cut half-way along this, and so on until the bad length is found between two draw-boxes. Open up ground behind one of these so that cable may be drawn out at the smallest angle to prevent damage, and examination should show the spot. If nothing visible, put one terminal of the test battery on, and, holding in one hand a wire connected to the other terminal, rub the other hand (holding a wet rag) along the cable until the current is felt.

(*b*) Disconnect at live end. Cut away all around the cable about 1in. of the lead covering at half-way box. Test for faulty half and proceed as (*a*). This does not mean cutting the cable in half, and is easier to repair than where a copper joint has to be made.

(*c*) Disconnect at live end. Proceed as (*b*), except that the lead must be earthed while testing to make a circuit to the earth of the galvanometer. It may be noted that there is practically no need to repair the fault at once, if time is of importance, as by cutting off an inch or so of the lead covering on either side of the faulty length and thoroughly insulating these denuded places with rubber and tapes, and a good supply of compound all around, the current on the lead thus isolated cannot escape to earth. And as locating this will probably take time and much digging, the above isolating method had better be adopted *pro tempora*.

The preceding trial-and-error methods are simple, and may fairly be ranked with the Manchester burning-out methods as brutal. In nine cases out of ten, however, it would be waste of space to describe more scientific localisation tests, owing to the lack of proper apparatus in most stations. Raphael's standard work deals exhaustively with these.—B. C. H. J.

Answer to No. 395 (*awarded* 7*s.* 6*d.*).—It would have simplified matters somewhat if the questioner had stated the system of supply, and whether the mains were concentric, triple-concentric, single cables, three-core, etc., and whether the fault was an earth fault or a short. If there is more than one cable or core, and the fault is an earth, one way of finding the position of it, if a Wheatstone bridge is handy, is by the loop test, as illustrated. The good and the faulty cables are looped at the one disconnecting box. The two cables are made to form the third and fourth arm of the bridge. The conductivity resistance of



the loop is first measured. In the above figure F G forms one arm, and F D + the resistance in the box, H D, forms the other. The proportionals, A and B, would have to be as low as possible. In order that balance may be obtained, resistance must be added to F D to make it = F G; then

$$\text{D F} = \frac{\text{total resistance of circuit} - \text{resistance unplugged}}{2}$$

The resistance, D F, gives the distance of the fault from the testing point by dividing this resistance by the resistance per mile of the cable. Though this loop test is very much used for underground telegraph and telephone wires it is not very satisfactory for electric light cables, as the cables have such low resistance that the difference of resistance is so small that it is difficult to get any satisfactory readings. The usual way is to try to burn the fault out by coupling it up to the mains with very strong fuses, or none at all, when there is not much load on and having some large machines working, so that no damage is done to them. If the system is alternating, the section can be disconnected from the rest, and several fair-sized transformers so as to give, say, 1,000 volts for a start, and increase the number so as to run up to 5,000 or more volts. If the fault is slight on an alternating system, a good way is to make use of people's telephones along the route of the faulty section. As soon as you hear the hum of the alternators that place is near the fault. It does not much matter what class of insulation is in use for the above-mentioned tests. It was said by a very well-known central-station engineer that he found that the best instruments for locating faults in electric lighting mains was a 500-kw. generator and a pick and shovel.—X.

Answer to No. 395 (*awarded* 5*s.*).—There is no system of laying stated in the first two questions. If the cables are feeders or distributors with no services taken off between the two boxes, and are laid in cast-iron pipes or earthenware culverts, then the quickest way of locating a fault is by drawing out the faulty cable at the same time pulling a new piece in. If this is impracticable, the best method to employ is what is known as Murray's loop test. To carry out this test, a Wheatstone bridge battery and galvanometer are required. The distance between the two boxes in yards should be carefully measured. If one of the cables has developed a fault to earth, the other main may be used to form the loop. Particular care should be taken in connecting the two cables together, as a great error might occur if

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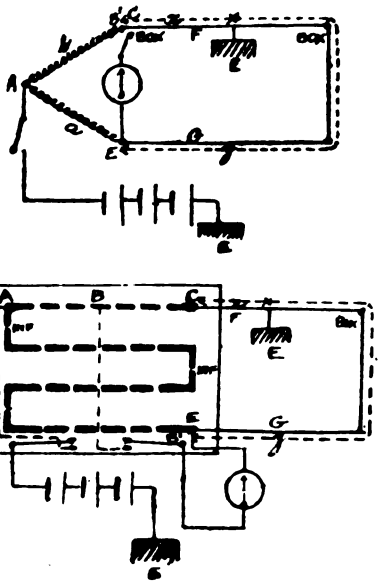
there is any appreciable resistance in this connection. This also applies to connections at the instrument end. The instrument and battery should be carefully insulated from earth. In the diagram F is the faulty cable and G the cable used as loop.



Let x be the resistance from C to fault, y the resistance from E to fault. B C should be plugged up, and A B (b) and E A (a) be adjusted until a balance is obtained. Then

$$b \times y = a \times x.$$

Let L be total length in yards of the whole length

$$x + y = L;$$

therefore,

$$y = L - x.$$

Substitute the value of y we get

$$b\,(L - x) = a \times x,$$

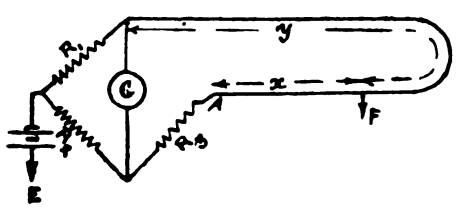
from whence

$$x = L\,\frac{b}{b+a}.$$

In the execution of this test the connections are made as shown in the figure. All the plugs between B and C must be inserted; this is necessary as the galvanometer connection is made on B¹, which is the same as B instead of C. The plugs being inserted between B and C and the other plugs being in their places, we should remove the 10 plug from between A and B, and having pressed down the key to put the battery in circuit (which should connect the zinc of battery) we should adjust the plugs between D and E, pressing down right-hand key until a balance is obtained.

With a short-circuit between two cables a conductivity test could be taken at both ends, and the proportional tests would give the distance from each box.—W.

Answer to No. 395 (*awarded* 5*s.*).—There are various methods by which the actual position of a fault in a cable can be located, which can be carried out with dispatch and ease with an ordinary Silvertown or Muirhead testing set. The test commonly used when there are other cables running alongside the faulty one is that known as the "loop test," which is as follows: The ends of the faulty cable and of one laying alongside it are connected together, the other ends being connected to testing set, as shown in diagram. Balance is obtained by adjusting the resistance, R_3.



Then

$$\frac{R_1}{R_2} = \frac{y}{R_3 + x} = \frac{L - x}{R_3 + x},$$

where L = resistance of loop $= x + y$;
x = resistance up to fault.

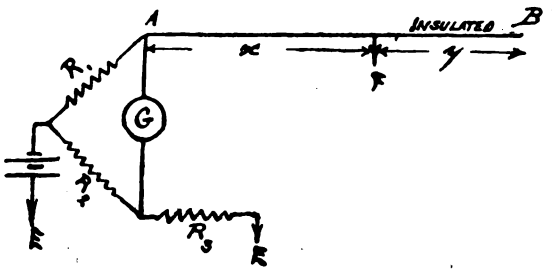
$$\therefore \text{ from the above } x = \frac{L\,R_1 - R_1\,R_3}{R_1 + R_2}.$$

Then the size of cable being known, the length corresponding to resistance, x_1, can be ascertained. As the fault is of low resistance, the length thus found will be accurate enough for all purposes, but if it was of high resistance the following correction would have to be made to be accurate:

$$\text{True distance from A} = (L_1 - 2\,x_1)\,\frac{R_1}{R_1 + R_2},$$

where L_1 = total *length* of loop;
x_1 = *length* of cable up to fault as found.

The battery is connected to earth through a gas or water pipe, or any other convenient pipe, etc., which make good earths, in the case where the cable is vulcanised and braided only. In the other two cases mentioned, the earth wire can be connected to the lead. If for any reason a cable could not be used to make the loop, the following method could be used:



Connect up as shown in diagram. Obtain balance by adjusting resistance, R_3.

Let resistance thus found $= r_1 = x + f$ . . . . . (1)

where x = resistance up to fault from A;
f = resistance of fault.

Repeat test from other end.

Let resistance thus found $= r_2 = y + f$ . . . . . (2)

where y = resistance up to fault from B.

Subtracting (2) from (1), we get

$$r_1 - r_2 = x - y = 2\,x - L;$$

where $L = x + y$.

$$\therefore\ x = \frac{r_1 - r_2 + L}{2}$$

In this case no connection is needed, whether fault is of low resistance or not.—S. L. C.

[N.B.—Will "S. L. C." kindly forward his name and address?—Ed. *E. E.*]

Question No. 396.—Give a diagram showing the connections for the starting resistance, with interlocking switch and maximum cut-out, for a three-phase motor; also the connections for reversing the direction of rotation of same, the motor to be worked off the lighting mains.

Best Answer to No 396 (*awarded* 10*s.*).—Below will be found a diagram (Fig. 1) of the motor, starting switch, main switch, reversing switch, and maximum cut-out. In three-phase or, I should say, multiphase motors or generators the fixed part (wound) is usually named the stator, the rotating part, the rotor. The stator is usually made the armature, the reason being to keep the higher voltage winding stationary so that it can all be covered. The rotor having only a difference of potential of about five volts for 200 impressed, there is no danger to life or very little to shorts if this is exposed at the ends of the phase windings. For motors of 10 h.p. or under it is unnecessary to have a starter other than the main switch, as there is very little danger of a burn-out owing to the B.E.M.F. With reference to maximum cut-outs, these are not necessary for the above reason. A fuse, however, could with advantage be put in circuit in case of short. To employ a cut-out for this purpose would be only complication, adding to the expense and waste of energy of the installation.

Fig. 1 shows the arrangement asked for. A is the starter, main switch, and maximum cut-out in one. The mains enter the switch at the contact strips under the short-circuiting bars, D, D_1, D_2. These bars are, of course, insulated from the frame. This arrangement acts as the

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main switch. The three sides of the rotor are connected up to the studs under E, E_1, E_2, the arms E, E_1, E_2 are connected to the frame, so as to form a star; this arrangement

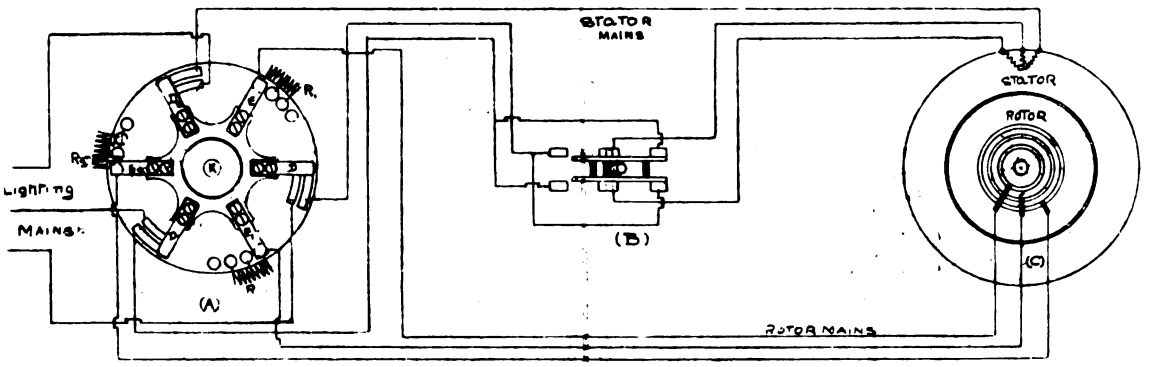

Fig. 1.

forms the starter. Under the base the cut-out is fixed, the spindle, K, going through the base (see Fig. 2). The disc, K_2, is fixed to the spindle; the pawl and armature carrier, K_4, holds the switch in the "on" position; the spring, K_5, tends to rotate the switch to the "off" position (the switch is shown in the "on" position). When the excess current comes along the coils, K_3, are energised to such an extent that the armature is attracted, and the disc, K_2, is freed,

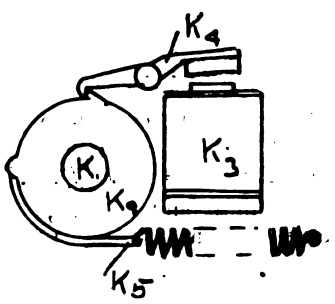

Fig. 2.

and so rotates by the spring and therefore breaking the circuit. It would, of course, be sufficient to have one coil encircled by one phase, but it would be better to have three. The reversing switch, B (Fig. 1), may be an ordinary double-pole throw-over switch. All that is necessary is to reverse two of the phases. As far as I know, the above switch is not made by any firm.—T. W. S. H.

PORTSMOUTH ELECTRICITY ACCOUNTS.

From the accounts of the Portsmouth Corporation electricity works for the year ended March 31, 1901, it appears that the total expenditure on capital account to date amounts to £179,134. The revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given herewith.

Revenue Account.

Dr.		£ s. d.
Generation of Electricity.		
Coal or other fuel	£9,670 12 7	
Oil, waste, water, and stores	1,090 6 5	
Wages at generating station	1 223 15 8	
Repairs and maintenance of buildings	122 0 4	
Engines, dynamos, and other plant	848 10 3	
	12,955 5 3	
Less received for old material	69 16 0	
		12,885 9 3
Distribution of Electricity.		
Repairs, maintenance, etc., of mains	133 3 8	
Repairs, etc., of transformers, etc.	789 3 0	
Cost of materials and lamps sold	56 2 11	
		978 9 7
Public Lamps.		
Attending and repairs	1,129 19 9	
Renewal of lamps	344 11 4	
		1,474 11 1
Rents, Rates, and Taxes.		
Rents payable	15 5 6	
Rates and taxes	499 5 1	
		514 10 7
Management Expenses.		
Salaries—viz., Engineer's department	929 8 5	
Accountant and clerical staff	296 4 2	
Salary of collector	114 11 8	
Stationery and printing	65 19 8	
General establishment charges	244 12 8	
		1,650 16 7
Special Charges.		
Insurances	9 10 0	
Interest on overdraft	201 18 5	
Auditors' fees	21 0 0	
Compensation	6 0 0	
Interests on deposits	12 19 1	
		251 7 6
Total expenditure		17,755 4 7
Bad debts during year		97 12 0
Balance carried to net revenue account		9,460 7 7
		£27,313 4 2

Cr.	£ s. d.
Sale of current at 4½d. per B.T.U., £20,978. 9s. 3d.; less allowances, £91. 17s. 1d.	20,886 12 2
Sale under contract	84 0 0
Public lighting	4,890 14 1
Rental of meters and other apparatus on consumers' premises	989 11 4
Sale and repair of lamps, arc or incandescent	66 15 10
Sale and repairs of other apparatus	196 18 10
Rents receivable	66 1 1
Part fees from pupils	49 14 6
Charging accumulators	11 9 6
Sale of ashes	33 0 4
Balance returned re Rucker's action	38 6 6
	£27,313 4 2

General Balance-Sheet.

Dr. Liabilities.	£ s. d.
Capital account—amount received	159,975 0 0
Sundry creditors	2,095 17 1
Reserve fund account—balance at credit thereof	2.725 0 0
Amount due to treasurer on revenue account	6,886 3 1
Amount due to treasurer on capital account	19,159 4 1
Amounts deposited	272 0 0
	£191,113 4 3

Cr. Assets.	£ s. d.
Capital account—amount expended for works	179,134 4 1
Stores on hand	1,536 17 6
Motors in stock, less depreciation	1,091 14 0
Sundry debtors for current supplied	8 330 7 2
Other debtors and unexpired insurances	152 9 10
Net revenue account, balance to debit thereof	867 11 8
	£191,113 4 3

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			1,920,885
Quantity sold	Public lamps	432,804	
	By contract	1,978	1,584,821
	Private consumers by meter	1.150,039	
Quantity used on works			49,816
Quantity used for magnetising current			198,280
Quantity used for motor-generators			76,978
Total quantity accounted for			1,909,895
Quantity not accounted for			10,990
Total maximum supply demanded (kilowatts)			1,506

Number of public lamps, 264 arcs, 16 incandescents.

NEW COMPANIES.

Club Garage, Limited.—Capital, £2,000. Object: to acquire under an agreement with C. H. Moore the business carried on by him as the "Club Garage," and generally to carry on the business of storers, dealers in, and proprietors of motors and other carriages, electricians, engineers, etc.

J. Carter, Sons, and Co., Limited.—Capital, £50,000. Object: to acquire and take over as a going concern the business carried on at Salford, Lancashire, as J. Carter, Sons, and Co., and to carry on the business of mechanical, electrical, and general engineers, etc.

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LEGAL INTELLIGENCE.

BRITISH ELECTRIC WORKS COMPANY.

In the Chancery Division yesterday, Mr. Justice Cozens-Hardy heard a summons in the matter of the British Electric Works Company, Limited—the Liverpool Mortgage Insurance Company, Limited, *v.* the British Electric Works Company, Limited. It was a summons in the action by which Mr. R. F. Hall, the late general manager of the defendant company, asked that he might be paid £1,200, being 2 per cent. of the price at which the defendant company was sold. The defendant company, a Birmingham firm, contended that the sum was too high. It was said that Mr. Hall was a director in addition to being general manager, but resigned as director before the arrangement for a commission on the sale was entered into.

Counsel for the liquidator said he had never seen Mr. Hall's letter of resignation.

His Lordship said he could not deal with the claim until he had seen the letter, and the summons must stand over till next sittings, and the company must pay £1,250 into court to answer the claim and costs.

On the further consideration of the action it was stated that judgment was pronounced on June 22 last in the ordinary form, and the receiver and manager was authorised to act until the 10th inst., that being a date subsequent to the day when it was contemplated that the sale of the company's business should be carried through. The sale had been completed on the previous day, and there was now in court sufficient to pay all the encumbrances in full and leave a balance for the company.

His Lordship discharged the receiver subject to the adjustment of the various matters between him and the purchasing company.

METROPOLITAN MOTOR MANUFACTURING COMPANY.

The petition of A. E. Creese for the compulsory winding-up of the Metropolitan Motor Manufacturing Company, Limited, was dismissed without costs on Wednesday.

Mr. Edmonds said it was a creditors' petition, and there was a voluntary liquidation pending.

Mr. Williams, for the liquidator, said the petitioner was the vendor to the Company, and it was alleged that he had practically ruined it. The company under his management had only produced two motors, and these would not work, and could only be sold for scrap iron.

His Lordship said there was evidence of considerable irregularities; but he thought the voluntary winding-up would satisfy the shareholders.

COMPANIES' MEETINGS AND REPORTS.

CENTRAL LONDON RAILWAY.

The twelfth ordinary general meeting of the proprietors of this Company was held at the Holborn Restaurant yesterday afternoon, Sir Henry Oakley presiding.

The directors' report for the half-year ended June 30 shows that the amount expended on capital account was £22,575. The revenue receipts from all sources amounted to £164,823. The working expenses amounted to £90,266, being 54·77 per cent. of the receipts, leaving a balance of £74,556. The traffic has made steady and satisfactory progress during the half-year, the average earnings per train mile being 5s. 1·28d., as compared with 4s. 10·28d. in the previous five months, whilst the working expenses were 0·35d. per train mile less than previously. The number of passengers carried since the opening of the railway is as follows: five months ended Dec. 31, 1900, 14,916,922; half-year ended June 30, 1901, 20,385,739—total number carried, 35,302,661. Including the balance of £3,527 brought forward from last half-year, the net revenue account shows a total of £79,496, and, after providing for interest on the debenture stock, there remains an available balance of £65,532. The directors recommend that out of this sum an interim dividend of 4 per cent. per annum be declared at the following rates of distribution: undivided ordinary stock at the rate of 4 per cent. per annum; preferred ordinary stock at the rate of 4 per cent. per annum. The result of the half-year's working is sufficient to pay dividend at the rate of 4 per cent. per annum on all classes of capital stock; but, under the Company's Acts, the dividend on the deferred ordinary stock is not payable until the result of the working of the year ending Dec. 31 has been ascertained. It is, therefore, proposed that £9,899, part of the general balance of £18,432, should be carried to a dividend suspense account (divided stock), which will be dealt with at the end of the year.

The **Chairman,** in moving the adoption of the report, said that during the six months under review the number of proprietors had increased by 232, the figures now standing at 2,800. This was the first time they had met after the completion of six months' working, and the results, although the Board by no means considered them as final, were satisfactory. Referring to the accounts, the chairman said the expenditure in the future would be comparatively trivial. They felt it necessary, however, to extend their boiler power at Shepherd's Bush by the addition of four new boilers, in order to ensure a good and sufficient supply and to provide for contingencies. All things considered, they had sufficient capital to carry out all works they had at present in hand and in contemplation, and before any other serious expenditure could be undertaken the directors must have the consent of the shareholders. They had, however, a margin of some £200,000, power to raise which sum had been obtained by the Bill promoted by the Company in this session of Parliament. Altogether during the past six months they had carried 20,385,739 passengers, of whom 2,190,000 were workmen carried at half price. These latter were not confined to any particular district of the line, but appeared to be spread practically all over the system. The obligation the Company entered into so far as workmen were concerned had, therefore, been universally and generally contributory. Those who noted the ordinary earnings of railways would see how successful this Company had been, when he stated that they had earned £950 per mile per week. If a railway company earned on an average from £100 to £130 per mile per week it was usually considered a good earning railway. This result, therefore, was very gratifying, and it was still more pleasing when they considered the possibilities in the future. Referring to the electric trams which radiate from Shepherd's Bush, the chairman pointed out that in the week ending about April 1, just before the trams were running, the Central London Railway carried 130,000 passengers to and from Shepherd's Bush. At the present time they were carrying 161,000 passengers a week, so that the development of suburban traffic, first by the railway to Shepherd's Bush and then by the trams, was actually bringing them 5,000 extra passengers per day. The expenses of the line were now 54 per cent. During the first five months they were 58 per cent. About 4 per cent. of these expenses was, however, due to the cost of maintaining the lifts, so that at present the working expenses might be taken at 50 per cent. Another matter of interest was that the Board were about to utilise the upper parts of their stations, and they had decided to let three at once by way of experiment. They were advised by their surveyor that these upper structures would become a very valuable property. The directors had also under consideration the advisability of creating a reserve fund. With regard to the Bill which the Company promoted in this session, it had been divided into two parts: (1) providing for an extension of the line to Liverpool-street, with a loop at that point, and at Shepherd's Bush, and to authorise the raising of £400,000 share capital with the usual borrowing powers; (2) providing for the acquisition of land to enable the Company to construct additional lifts at Shepherd's Bush Station, also to authorise the raising of £150,000 share capital, with borrowing powers. No. 1 Bill had been before the Joint Committee of both Houses of Parliament on Underground Railways, who had recently issued their report to the effect that they approved the loops contemplated, but with regard to the Central London loop they thought that as it traversed such a central point in the City where two or three other tubes were proposed, it should be referred to a select committee in the ordinary way. No. 2 Bill was unopposed. On the question of vibration, the directors had undertaken to make experiments in the matter, and they had experimented with a modified engine, which had so far given them great satisfaction and bids fair to settle the vibration trouble. And in another month they would have completed a series of experiments as to the division of the motive power on the principle of multiple motors—*i.e.*, dividing the weight of the engine over the whole of the train. He could not say that the committee would be satisfied with the improvements in the engine, but the Company's engineer advised that in his opinion the modification they had carried out would so lessen the vibration effects of the running of the trains that they might dismiss further anxiety on the subject. Reverting to the report of the Joint Committee, the chairman said the directors had under consideration certain suggestions which were made therein, which they would bring before the proprietors at the next meeting. The directors, he might say, in conclusion, were quite satisfied with the progress made in the six months' working; there had been no real hindrance to it. He might almost say that the working of the railway deserved, and it had received, the public approval. He then formally moved the adoption of the report and accounts and the payment of an interim dividend of 4 per cent. per annum on the whole of the share capital.

Lord Colville of Culross, Kt., seconded the motion.

Replying to a shareholder, who protested against the overcrowding of carriages,

The Chairman said the Board deprecated it as much as possible, but there were practical difficulties in the way of effectually preventing overcrowding. All they could do, as they were doing, was to instruct the conductors to tell the passengers that the cars were full. It was impossible to use force; the British public would not wait. The directors wanted the people to know that the railway was always clean comfortable, fast, and cheap.

Without further discussion the resolution was then put and carried unanimously.

A vote of thanks to the chairman closed the proceedings.

EDISON AND SWAN ELECTRIC.

The ordinary general meeting of the proprietors of this Company was held on the 2nd inst. at the Cannon-street Hotel, E.C. In the absence of Mr. J. Staats Forbes, Major S. Flood Page occupied the chair.

Before moving the adoption of the report, the **Chairman** expressed regret that Mr. J. S. Forbes, who had been the chairman and presided over every meeting of the Company since its inception, was not present to preside on that occasion. Since the directors arrived in the building they had received a letter from Mr. Forbes, stating that, owing to the fact that he was in another room presiding at another meeting, he was not able to be present. He (Major Page) was presiding that day at the earnest request of his colleagues. They were a headless body, and he could not speak, therefore, with the authority of a chairman, and, moreover, with the end of this meeting he would no longer be a member of the Board. Dealing with the report, the chairman said that in the third

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paragraph the directors stated that competition had been very keen, and that prices had been higher and business smaller, hence the fact that the revenue had diminished. Since the expiry of the Company's patents great competition at constantly reduced prices had been going on. There had been a constant change in the article which they had to manufacture. The engineers forced upon the lamp-makers, without due consideration, the change from low to high voltage, and high-voltage lamps were much more difficult and more expensive to make, and did not last so long. Improvements in holders, fittings, and other things had also made the position of the Company extremely difficult. They had, however, greatly improved the high-voltage lamp. They had two factories working, one at Newcastle and the other at Ponder's End, practically in competition, and the result was that they had a cheaper and a better lamp. In addition to the loss of trade, they had been in a transition state in the fitting department. Turning to the profit and loss account, it would be seen that the sales of lamps and fittings amounted to £235,433. This showed a very serious loss in trade, but those who knew the fluctuations of the business of the Company could hardly be surprised. In the year 1893 the sale of lamps and fittings amounted to £183,641, in 1894 they fell to £131,250, and in 1895 to £114,890, so that in two years there was a loss in trade of £68,751. In 1896 the sales went up to £128,101, and in 1897 they had improved a little more, but even then they were some thousands of pounds below what they had been five years previously. For a long time the Company had been passed over in consequence of price by the Admiralty, but recently the Admiralty sent them an urgent order for 100,000 lamps. This Company was probably the only one in the world which could have delivered immediately 15,000 lamps, and this they did, and got an order for 100,000. Certain changes would have to be made—changes in prices and reductions in the cost of distribution. At the last meeting of the shareholders the chairman announced that a new manager of the fittings department had been appointed. Mr. Joyce, the gentleman in question, did not take possession for some months afterwards. He found the fitting factory not at all in good order, and he devoted a long time in trying to get it in order. After being there for some time he overhauled and examined everything in the factory, and during his investigation, to the great surprise of the directors, he found that in the past work which had been completed at a loss was reported as work in hand and carried forward as a good asset. That work represented £14,772, and ought to have appeared in previous accounts. Referring to Clause 6 of the report, the chairman said they were absolutely obliged to absorb the Manchester Edison-Swan Company and take over their Broadheath factory; otherwise, that business would have cut into the lamp business of this Company. It was a very small business when the Company took it over, and although they tried to develop it, they could not make it profitable. The result was they came to the conclusion that it ought to be closed. The investigation of the new manager of the fitting department led to further changes. Amongst others, the general manager was removed from that office, and the directors set on foot a special enquiry into the value of the whole of the stock belonging to the Company, and they regretted to say that they had found it necessary to write off therefrom the large sum of £31,048. The sums of £31,048 depreciation of stock, £19,875 special outlays written off, £9,069 loss on closing factories, and £4,578 provision for bad and doubtful debts, together with the interim dividend paid on March 1 of 2½ per cent., amounting to £9,586, had absorbed the whole of the reserve, and £784 was carried forward, as against £6,199 last year. No shareholder could have been more astonished than the directors were when they found out these facts. As stated in the report, the directors had placed before the shareholders fully and unreservedly the result of the special examination which had occupied them for several months. In expressing their sincere regret at these unexpected results, they desired to say that they were of opinion that the business, if properly conducted, was good, and that there was reason for believing that with certain changes in organisation and in policy, which had been already under consideration, and which would have to be decided when the Board was reconstituted, the Company could be placed again in a satisfactory commercial position. He declined to acknowledge in any way that the Company was a failure. The directors were responsible for the selection of the men who had to carry out the work of the Company, and he admitted that they had failed in that respect. However, he left the Board feeling that the Company was in a sound state. The directors held between them very nearly £50,000 in the Company, and not one of them had ever sold a share, neither did they intend to part with them now. In conclusion, he moved the adoption of the report and accounts, which appeared in our last issue.

Mr. J. W. Swan, in seconding the motion, said he shared with the other directors full responsibility for the general management; but beyond that he had had additional responsibility thrown on him in the technical part of the Company's business. He had tried—and, he was sure, not quite unsuccessfully—to improve and cheapen the lamp. At this moment there were being carried out several very important improvements which would have the effect of further reducing materially the cost price of the lamp, and at the same time of greatly improving its efficiency. Therefore the power of extending their business, so far as the lamp manufacture went, was on the point of being greatly increased. The lamp manufactory was being enlarged, and every preparation made to enable an increased demand to be promptly met. He expected that they would improve their position through these changes, and more especially in connection with the high-voltage lamp referred to by the chairman. As a result of these improvements and extensions of their works they had the full right to expect a large increase in the most profitable branch of their business.

Mr. Swan was followed by several shareholders, most of whom severely criticised the conduct of the Company's business in the past. It was generally agreed, however, that the business could, with proper management, be put on a firm basis again.

In reply to questions, the **Chairman** explained the position of the Company with reference to the Altrincham Electric Supply Company, and stated that the £64,895 on the credit side of the balance-sheet was a good asset. With reference to the responsibility of the directors, he referred the shareholders to an important judgment delivered in the House of Lords and reported in the *Times* of that day. It said that directors were entitled to rest in the belief that those whom they employed were honest and were doing their work properly.

The report was then adopted. Mr. E. B. Ellice-Clark and Mr. H. Wolfenden were elected to seats on the Board, and Messrs. Welton, Jones, and Co. having been re-elected auditors of the Company, the proceedings closed.

CROMPTON AND CO.

Mr. John Trotter presided at the annual general meeting of this Company, held at Winchester House on the 1st inst., and in moving the adoption of the report and accounts (which appeared in our issue of the 26th ult.), congratulated the shareholders on the fact that the Company had had another successful year. He thought it would be agreed that the right principle to act on was not to take into account the estimated profit on uncompleted contracts, and the Board had adopted that course. As the result of extensions to the Chelmsford works, the item of freehold land and premises stood at the increased sum of £41,768. Plant, tools, etc., also appeared at a higher figure in the balance-sheet. Competition was growing keener in the trade, and the Board realised that if the Company were to hold their own they must secure the best and most modern machinery in order to enable them to turn out work as quickly and as cheaply as their rivals. The Chelmsford Electric Lighting Company investment had risen from £38,600 to £43,406. That company had now been started on a separate basis, and was altogether free from the works of Crompton and Co. Dealing with other items in the balance-sheet, he pointed out that the goodwill now stood at only £10,000, and eventually he hoped to see it wiped out altogether.

Lieutenant-Colonel R. E. B. Crompton seconded the motion. Referring to his visit to the Continent, he said he had taken great pains to ascertain what their rivals were doing and in what way they were superior to British firms in methods of manufacture and in ability to turn out work rapidly and cheaply. He had read, with some misgivings, as a patriotic Englishman, a good deal of what had been written about the decadence of English manufacturing supremacy, and all he could say was that it did not apply to this Company's works. He was one of a few persons who visited some German works the other day, and he felt that he had nothing to learn from what he saw as to the arrangement of Crompton and Co.'s works, the attitude of the workmen, and the whole procedure. He had at one time rather envied the German system of finance, but lately that had shown signs of weakness, and, perhaps, our more conservative system had its merits after all.

The report was unanimously adopted.

PERTH ELECTRIC TRAMWAYS.

At the general meeting of the holders of the debenture stock of this Company, held at the offices, 3, Laurence Pountney-hill, E.C., the following resolution was considered: "That this general meeting of debenture holders of the Perth Electric Tramways, Limited, hereby sanctions the modifications of the rights of the stockholders against the Company, and the mortgaged premises, and assents to the modification and variation of the trust deed of March 8, 1899, and of the terms and conditions on which the stock is held, which are set out in the draft supplemental deed submitted to this meeting, and for the purpose of identification endorsed with the signature of the chairman."

Mr. Allen H. Stoneham, who presided, said this was a purely formal meeting. Referring to the business of the Company, he said it was meeting with far greater success than was expected. The total mileage authorised was 20 miles, and they had had a little over 12 miles running since January last, and the profits on these 12 miles were upwards of £9,500 for the half-year, or £2,000 more than the interest on the debenture stock for the whole year. This half-year included the months of May and June, which were the worst months of the year, and he thought they could safely assume that the profits for the next half-year would be considerably more than this. As a matter of fact, the profits for the month ended July 26 were nearly £2,000. They were therefore perfectly safe in assuming that they were now making over £20,000 per annum, or nearly three times the amount of debenture interest. In other words, they were earning 5 per cent. on their debentures, 6 per cent. on their preference stock, and 3½ per cent. on their ordinary stock. They were now making an attempt to give the stock a market value and obtain a Stock Exchange quotation for it, and for this purpose they were contemplating making a public issue.

Mr. Herbert Moir seconded the resolution, which was carried unanimously.

CHILI TELEPHONE.

At the general meeting of the shareholders held at Winchester House on the 2nd inst., **Mr. George Keith**, who presided, said the business of the Company had been working very favourably and efficiently during the past year, and the accounts showed that the financial condition of the Company had considerably improved. During the year considerable improvements and extensions had been made to the Company's plant in Chili. An additional line had been erected between Santiago and Valparaiso in order to meet the growing traffic between those places. The central exchange at Santiago served a large number of subscribers, and in order to maintain an efficient service there the directors had on order a new up-to-date multiple

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switchboard, which it was expected would be installed and working during the current year. The relations of the Company to the public authorities all over Chili were cordial. The service was well maintained, and the business, as far as it had gone this year, continued to progress favourably.

Mr. Frank W. Jones seconded the motion, and it was ultimately carried unanimously.

ANGLO-AMERICAN TELEGRAPH.

The meeting of the proprietors was held on the 3rd inst. at Winchester House, when **Mr F. A. Bevan**, the chairman, in moving the adoption of the report, said the shareholders ought to be congratulated on the result, for although they had lost outgoing German traffic to the extent of some £27,000, their total receipts were only £4,000 less than in the corresponding half of last year. No doubt this result was in some measure due to the great boom that had taken place in American stocks; but this only affected them for a very short time, so that it was evident their traffic was improving in all directions. There was also an increase in the profits made by their repairing ship "Minia." All their cables were in excellent working order with but one slight exception, but they must bear in mind that their 1873-84 cables were getting old, and the oftener they were lifted the less chance there was of being able to do so again. He hoped, therefore, that the shareholders would support their policy of adding £12,000 to the renewal fund, which would be seriously depleted if they had to delay one of these cables. Their expenses were slightly higher, and as a net result the amount available for dividend was £2,364 less than this time last year, and they carried forward a slightly smaller balance.

Mr. C. Burt seconded the motion, which was carried.

NATIONAL TELEPHONE.

The directors' report for the half-year ended June 30 last shows that the income accrued in respect of the business of the six months in question amounts to £775,482, as compared with £700,603 for the corresponding period of 1900, being an increase of £74,879. The working expenses for the half-year, including the special expenditure of £17,673 incurred in repairing the damage caused by the snowstorms in the early part of the year, amount to £457,363, as compared with £403,528 for the corresponding period of 1900, being an increase of £53,835. The net result for the half-year (after deducting the Post Office royalties, amounting to £73,229) is a profit balance of £244,888, as compared with £228,609 for the corresponding period of 1900, being an increase of £16,279. The rentals carried forward for unexpired terms of running contracts amount to £784,755, as compared with £733,614 at the corresponding period of 1900, or an increase of £51,140. Out of the available balance of £184,954 shown by the net revenue account the Board will recommend the payment for the half-year of a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, and 5 per cent. per annum on the ordinary shares, less income tax in all cases. The Board also propose to transfer £65,000 to the reserve fund and to carry forward the balance of £5,954. The sum of £303,696 has been expended on capital account during the half-year in the erection of 7,393 additional exchange and private lines, and in the construction of underground works.

BRITISH COLUMBIA ELECTRIC RAILWAY.

This Company has had another year's successful trading, and, says the directors' report for the year ended March 31 last, the prospects for the future are satisfactory. In order to keep pace with the continuous increase of the Company's business in all departments, it will be necessary to acquire further rolling-stock, electrical machinery, and motive plant, and to double track portions of the line. For the purpose of raising funds to meet liabilities already incurred, and to provide for further extensions and improvements, the balance of the unissued preference share capital of the Company—viz., 6,400 preference shares of £10 each—was recently offered for subscription. The shares were all applied for, and were allotted on May 3, 1901, since which date they have been fully paid up. The gross receipts for the year were 496,796dol., showing an increase over the preceding year of 46,174dol.; the working expenses were 297,565dol., an increase of 43,445dol., the net earnings being 199,231dol., or 2,729dol. in excess of last year. The directors regard as satisfactory the increase in business, but they regret that, owing to certain exceptional expenses, the full benefit of the increase has not been obtained. When the further boilers in Vancouver, and the new electrical unit in Victoria, now being installed, are in working order it is intended to shut down the old steam plants, and thus reduce the cost of working. The net profit for the year, after deducting London office expenditure, amounts to £37,420, making, with the balance brought forward from last year, a total of £37,553. Deducting debenture interest and interim dividends on preference and ordinary shares, there is available for distribution and reserves £19,103. From this the directors have decided to write off preliminary expenses, £1,218, and, after providing for the balance of the year's dividend on the preference shares, to recommend the payment of a final dividend on the ordinary shares at 2 per cent., making 4 per cent. for the year, transferring to capital amortisation account £5,000, and to reserve for depreciation £5,000, and carrying forward to next account a balance of £64. The department for the supply of electrical power for commercial purposes is being worked well and profitably. The manager in British Columbia reports that the rolling stock has been maintained in excellent condition.

SOUTH SHIELDS ELECTRICITY WORKS.

The accounts of the South Shields electricity works (just issued) show a total expenditure on capital account to March 31, 1901, of £128,488. Abstracts of the revenue account, general balance sheet, and statement of electricity generated, sold, etc., are given herewith.

Revenue Account.

Dr.		£ s. d.	£ s. d.
Generation of Electricity.			
Coal or other fuel	£2,108 7 6		
Oil, waste, water, and stores	258 13 5		
Wages at generating stations	1,005 8 1		
Repairs and maintenance	360 2 11		
			3,732 11 11
Distribution of Electricity.			
Repairs, etc., of mains	83 10 7		
Repairs, etc., of meters, etc.	31 10 1		
Repairs, etc., of apparatus	6 14 7		
			121 15 5
Public Lamps.			
Attending and repairs	512 19 4		
Renewals of lamps	20 1 11		
			533 1 3
Rates and taxes			251 17 6
Management Expenses.			
Salaries—Engineers' department	521 13 4		
Ditto accountant and clerical staff	259 5 0		
Stationery and printing	85 2 5		
General establishment charges	183 1 5		
			1,049 2 2
Law expenses			141 9 8
Insurances, etc.			84 12 3
Total expenditure			5,914 10 2
Amount carried to net revenue account			6,011 2 8
Amount provided for bad debts			15 2 8
			£11,940 15 6

Cr.	£ s. d.
Sale of current per meter	9,754 6 4
Public lighting	1,903 3 2
Rental of meters	280 9 0
Rents receivable	2 17 0
	£11,940 15 6

General Balance-Sheet.

Dr. Liabilities.	£ s. d.
Capital account—amount received	111,720 14 4
Sundry creditors	1,570 3 8
Balance at credit of net revenue account	1,678 11 2
Sinking fund account	4,148 7 3
Borough treasurer	19,014 10 4
	£138,132 6 9

Cr. Assets.	£ s. d.
Capital account—amount expended for works	128,488 10 0
Stores on hand	271 14 2
Sundry debtors for current supplied	4,983 16 9
Other debtors	236 3 7
Securities held (cost price)	4,148 7 3
Cash in hand	3 15 0
	£138,132 6 9

Statement of Electricity Generated, Sold, etc.

Quantity generated in Board of Trade units			944,629
Quantity sold	Public lamps	182,732	755,826
	Private consumers by meter	573,094	
Quantity used on works			22,650
Total quantity accounted for			778,476
Quantity not accounted for			166,153
Number of public lamps			191
Total maximum supply demanded (kilowatts)			705

APPOINTMENTS VACANT.

Electrical Engineer, Bedford Corporation electricity department, £350 per annum, Aug. 20. Full particulars in our advertisement columns.

Mains Superintendent, Hastings Corporation electricity department, £100 per annum, Aug. 13. Full particulars in our advertisement columns.

Resident Electrical Engineer and Manager, Finchley Urban District Council, £300 per annum, Aug. 19. Full particulars in our advertisement columns.

Mains Superintendent, Corporation of Carlisle, £100 per annum Aug. 20. Full particulars in our advertisement columns.

Stoker (first-class), Tunbridge Wells, accustomed to water-tube boilers. Full particulars in our advertisement columns.

Assistant Engineer.—The Worthing Town Council will shortly advertise for an assistant engineer at their generating station, at a salary of £100 per annum.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Walthamstow.—The Urban District Council invite tenders for house wiring. Tenders by Aug. 30. Details in our advertisement columns.

Willesden.—The District Council invite tenders for the equipment of their proposed electricity works. Details in our advertisement columns.

Leigh.—The Electricity and Tramways Committee invite tenders for the supply and erection of one steam dynamo. Tenders by Aug. 24. Details in our advertisement columns.

Amsterdam.—The Corporation invite tenders for tramcars for electric traction with overhead wire (perhaps 140). Tenders by Sept. 2. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for electrical accessories, machine tools, etc., and car-cleaning materials. Tenders by Aug. 17. Details in our advertisement columns.

Bournemouth.—The Town Council invite tenders for boilers, superheaters, economiser, feed pump, pipework, and accessories. Tenders by Aug. 29. Details in our advertisement columns.

Ilford.—The Urban District Council invite tenders for the construction of about 11 miles of tramways. Specification, etc., may be obtained of Mr. John W. Benton, clerk, Council Offices, Ilford. Tenders by Aug. 31.

Doncaster.—The Corporation invite tenders for the supply, delivery, laying, or fixing of unarmoured waterproof cables and wires for tramway feeders, and feeder and section pillars. Tenders by Aug. 17. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the electric lighting installation, etc., of the second portion of the Colinton Mains fever hospital, the number of lighting points being about 800. Tenders by Sept. 9. Details in our advertisement columns.

Farnham.—The Urban District Council are desirous of contracting with a responsible firm for the supply of electricity under the requirements of their Electric Lighting Order, 1900, in their area. Proposals by Aug. 27. Details in our advertisement columns.

Brighton.—The Guardians invite tenders for installing electric light in a portion of the workhouse premises in Elm-grove. Specification, etc., may be obtained at the office of Mr. B. Burfield, clerk, Parochial Offices, Prince's-street, Brighton. Tenders by Aug. 20.

Darlington.—The Corporation invite tenders for the supply and delivery of one Lancashire boiler (first extension), one 350-h.p. engine, coupled to a continuous-current dynamo (first extension), and extension steam, drain, and feed pipes. Tenders by Aug. 22. Details in our advertisement columns.

Paregwyllt (near Bridgend).—Tenders are invited for the lighting by electricity of Paregwyllt Asylum, near Bridgend. The clerk of works will attend at the asylum by appointment to give all necessary information. Tenders to be sent to Mr. Hugh W. Davies, clerk of asylums, Bridgend, by Aug. 24.

Mansfield.—The Electric Lighting Committee invite tenders for refuse destructors (to deal with the whole of the refuse of the borough) by Sept. 5. Specification, etc., may be inspected at the offices of Mr. Robert Hammond, M.I.C.E., the consulting engineer to the Corporation, 64, Victoria-street, Westminster, London, S.W.

Croydon.—The Lunacy Visiting Committee invite tenders for the execution of the wiring for the electric installation, including ring main and feeders, sub-mains, lamp circuits, switchboards, distribution boards, fittings, etc. Specification, etc., can be inspected at the Borough Engineer's Office, Town Hall, Croydon. Tenders by Aug. 26.

Warlingham (Surrey).—The Croydon Town Council invite tenders for wiring, including ring main and feeders, sub-mains, lamp circuits, switchboards, distribution boards, fittings, etc., at the lunatic asylum, Warlingham, Surrey. Specifications, etc., can be obtained at the Borough Engineer's Offices, Town Hall, Croydon. Tenders by Aug. 26.

Middlesbrough.—The Electric Lighting Committee invite tenders for the supply and erection of mechanical coal-handling plant in connection with the municipal electricity works. Specification, etc., may be inspected at the offices of Mr. Robert Hammond, M.I.C.E., consulting engineer to the Council, 64, Victoria-street, Westminster, London, S.W. Tenders by Sept. 3.

Worcester.—The Corporation invite tenders for water-tube boilers, economisers, steam and feed pipes, pumps, steam dynamos, motor-alternator, booster, Korting condensers, electric pumps, cast-iron suction, delivery, and exhaust pipes, tank, switchboard, overhead travelling crane, and accumulators, for the new electricity works. Tenders by Aug. 23. Details in our advertisement columns.

St. Helens.—The Electric Supply and Tramways Committee invite tenders for the purchase of one 120-kw. direct-driven steam alternator and exciter, horizontal engine by Robey and Co., Lincoln, alternator by Johnson and Phillips, 2,000 volts, 60 periodicity, Ferranti switchboard and instruments, arranged for two distributing circuits, two alternator circuits, and synchronising gear, eight 21-kw. transformers, 2,000 to 200 and 100 volts, steam and exhaust pipes, valves. Details in our advertisement columns.

RESULTS OF TENDERS.

Aberdeen.—The Churches Committee have accepted the tender of Messrs. Pratt and Keith, at £134, for the electric lighting of the East parish church.

Barnsley.—The Park and Lighting Committee have accepted the tender of W. Arnold and Co., at £1,865, for the supply of two boilers for the electricity works.

Newcastle.—The Town Council have accepted the tender of Messrs. Walter Scott and Co. for rails in connection with the tramways.

Croydon.—The following tenders have been accepted: Babcock and Wilcox for main, steam pipe, and exhaust piping, at £1,375; H. Windsor and Co. for boiler settings, at £395.

Peterborough.—The Corporation have placed the contract for 200-h.p. lighting and tramway set, with Willans engines and spare armature, with Messrs. D. Bruce Peebles and Co.

Bury (Lancs.).—The tender of C. Dennis, Bury, has been accepted for the work required in the extension of the engine and boiler houses and other contingent works at the electricity works, Rochdale-road.

Wolverhampton.—The Town Council have accepted the tender of the Callender Cable Construction Company, Limited, for supplying, laying, and erecting complete the necessary feeders, conduits, and feeder switch pillars for the electrical equipment of various routes of tramway.

Cardiff.—The Town Council have accepted the tender of Bolckow, Vaughan, and Co. for the supply of about 2,000 tons of rails: 45ft. rails, £6. 10s. per ton; 60ft., £7; fishplates, 45ft., £8 per ton; 60ft., £8. 10s. The quotations for Continental makes were £6. 5s. per ton for rails and £6. 15s. for fishplates.

Blackburn.—The Corporation have received the following tenders for extensions to electricity works, Jubilee-street:

J. Knowles	£16,550	0	0
S. and J. Whitehead	16,300	0	0
Wilson and Son	16,186	0	0
Marshall and Dent	16,155	10	0
Lewis and Son	16,060	0	0
Keeley and Son	16,017	0	0
D. Smith	15,831	6	0
R. Shorrock	15,800	0	0
Fecitt and Sons	15,775	0	0
Highton and Son	15,700	0	0
J. Cronshaw	15,600	0	0
Higson and Sons	15,350	0	0
Whittaker and Sons	15,084	0	0
J. Boland	14,910	0	0
W. J. Woof, Cronshaw (accepted)	14,884	0	0

BUSINESS NOTES.

TRACTION.

Sheffield.—A service of electric cars from Broomhill to Ranmoor has been commenced.

Surrey.—The County Council have lodged a petition to the House of Lords against alteration of the London United Tramways Bill as sent from the Commons.

Liverpool.—The Corporation have decided to license the tramcars under which the number of passengers to be carried on one car at a time will be limited to 74.

South London Electric.—On Monday the South London Electric Railway carried an increase of 15,000 passengers over last year's figures for the corresponding day, the total being 42,000.

Barrow.—We understand that the amended terms offered by the British Electric Traction Company, Limited, as to the supply of electricitv have been agreed to by the County Council.

St. Helens.—The Electric Supply and Tramways Committee recommend a modification of the terms of the lease of the tramway undertaking to the St. Helens and District Tramway Company.

Shropshire.—The County Council have agreed on the question of the speed of motorcars, that there should be no fixed limit, but that the drivers should be compelled to obtain certificates as to their capability.

La Capital Traction and Electric, Buenos Ayres.—Payment of the 5 per cent. cumulative dividend (less income tax) upon the preferred shares from date of issue to Sept. 30, 1900, is recommended by the directors.

Middleton.—At the last meeting of the Town Council, on the question of the tramways, it was stated that the Corporation had not yet completed their arrangement with Manchester as to who should supply the motive power on the road.

Reading.—Sir Frederick Bramwell has concluded the hearing of the references as to the purchase money to be paid by the Reading Corporation for the undertaking of the Reading Tramways Company The arbitrator's award is now awaited.

South Shields.—The Corporation Tramways Committee have resolved to recommend the Council to apply to Parliament during the next session for powers to enable the Corporation to lay down and work the projected tramways themselves.

Cardiff.—It has at last been decided that the Corporation shall purchase the permanent way of the Cardiff Tramways Company for £40,000, including parliamentary expenses, engineering commission, etc. The question of the depôts stands over for the present.

Wandsworth.—The Borough Council have decided to inform the London County Council that whilst they approve the tramway extension from Clapham to Kingston, they see no reason why they should contribute more than one-sixth of the net cost of the street widenings.

Birkenhead.—The Board of Trade inspection was expected one day this week of the three new electric tramway routes that only await its sanction to be opened for traffic—viz., Conway-street, Cleveland-street, and Claughton-road. The Higher Tranmere route is the next to be opened.

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Bradford.—The Queensbury extension of the Corporation tramways has been inspected by a Board of Trade official, and a public service has been put on the line. The Tramways Committee are considering the feasibility of running a tramway up Church Bank, one of the steepest gradients of Bradford.

Metropolitan District Railway Co.—The directors recommend a dividend on the 4 per cent. guaranteed stock at the rate of 3 per cent. per annum for the half-year ended June 30 last. For the corresponding period of 1900 the full dividend was paid, while 3½ per cent. per annum was paid on the preference stock.

Soothill.—The District Council have decided to give notice to the Dewsbury, Batley, and Birstall Tramways Company of their intention to purchase that portion of the line of their tramways which is within Soothill Upper parish, and that it is their intention to lease that portion of the line to the British Electric Traction Company.

Wolverhampton.—The Corporation have decided to extend the tramway on the Waterloo-road from its junction with New Hampton-road to the entrance to Molineux Grounds, and also the tramway in Lichfield-street, by a short length of single line running from its junction with Fryer-street to its junction with Railway-street.

Camberwell.—The following notice of motion has been given by a member of the Council: "That this Council strongly protests against the action of the House of Lords Committee in rejecting the Camberwell-green to Forest Hill tramway scheme, thereby inflicting a serious hardship and inconvenience on the inhabitants of this borough."

Berlin.—It is stated that the completion of the Berlin electric underground railway has been very much delayed of late owing to the immense quantities of underground water which have to be pumped out, and it is believed that the line cannot be opened at the time fixed. Immense suction pumps have, however, been set to work to clear the tunnels.

Bournemouth.—The Corporation intend to apply to the Board of Trade for sanction to borrow another £21,000, being the additional cost of adopting the conduit system. Application will also be made to the Local Government Board for sanction to borrow £37,500 for the purpose of carrying out wood paving works in connection with the proposed tramways.

Pontypridd.—The Bill confirming the provisional order empowering the Pontypridd Urban District Council to construct electric tramways has been considered by the Select Committee of the House of Commons presided over by Mr. Jeffreys. The Taff Vale Railway Company opposed the scheme. Ultimately, however, the committee passed the preamble, subject to the widening of the roads.

Newport (Mon.).—The lease of Messrs. S. Andrews and Sons for seven years of the Newport tramway system has expired, and the undertaking has been taken over by the Corporation. The service will be run by the Corporation until the power station now in course of erection is completed, and until the lines have been equipped for electric traction the cars will be worked by horse traction.

Croydon.—On Friday last the permanent way of the new municipal tramways was inspected by an official of the Board of Trade, and the next morning a service of horse cars was commenced from the Norbury terminus to the High-street. The first week in September is named for the inauguration of the electric service on the main base line from Norbury through Croydon to Purley, a distance of nearly six miles.

Private Bills.—In the House of Lords the West Cumberland Electric Tramways Bill has been read a third time. On the motion of Lord Morley, the promoters of several London Underground Railway Bills have been authorised to "hang up" the Bills until next session. In the Commons the Birmingham (City) Tramways Bill and the Tyneside Tramways and Tramroad Bill have been read a third time.

Leeds.—The Cardigan-road and Burley-road section of the Corporation tramways was inaugurated on Saturday with an electric car service. The new service gives a car every 10 minutes from the Leeds City-square to the junction of Cardigan-road and Kirkstall-lane, Burley, and one by way of Burley-road, Cardigan-road, and Victoria-road, to Hyde Park, and back to the city, completing a circular route.

Wigan.—It was stated at the last Town Council meeting that owing to a falling market in regard to the New Springs tramline, it was not expected to cost as much as the other lines. When all the routes it was intended to construct were complete, the Corporation would have not much less than 25 miles of lines, and would want 120 to 130 cars. It is hoped to secure the Hallgate site for sheds as a central station.

Southport.—The formal opening of the electric lines of the tramways company took place yesterday week. The new electric tramways comprise what is known as the Cambridge-road section of the company's system. Three miles of double track have been laid since March 18, and a few weeks will see the completion of the second or Roe-lane section. Then the whole of the company's lines will have been completed.

Middlesex Light Railways.—The Light Railway Commissioners having for the present rejected the Middlesex County Council's scheme, have sanctioned the application of the London United Tramways Company to extend their electric tramway system from Twickenham to Hanworth, Hanworth to Hounslow, and Hounslow to Cranford. Further proposed extensions to Hampton, Sunbury, and Southall are held over for the present.

Dundee.—The tramways account shows that the actual expenditure has been £27,734. 14s. 7d., while the revenue has been only £26,058. 0s. 1d., thus bringing out a deficiency on the year's transactions of £1,676. 14s. 6d. This deficiency has been carried to the suspense account, which now amounts to £1,698. 0s. 10d. It is, however, hoped that this sum will be wiped off during the current year. The fund for the renewal of rails stands at present at £2,667. 13s. 9d.

Brighton.—The Corporation have approved draft by-laws and regulations for the new electric tramways, with an addition that no smoking shall be allowed inside the cars nor on the three front seats on top. Another rule is that no one with "dirty clothes" shall be allowed inside the cars. The motion to rescind the previous resolution of the Corporation in favour of running the electric cars on Sundays was withdrawn at the last meeting on the plea of the "absence of supporters."

West Hartlepool.—A discussion took place at the last Town Council meeting upon a recommendation of the Works Committee adverse to the proposal of the tramway company to construct a new line to the south of the municipal buildings, the committee favouring a double line of rails upon the existing route at this point, according to plans practically agreed to by the company 18 months ago. They also reported against applications for the extension of the company's tenure for 21 years from 1911. Final consideration of the subject was deferred.

Light Railways in Kent.—At the Board of Trade enquiry concerning the proposed light railway between Canterbury, Herne Bay, and Whitstable, the Commissioners rejected the scheme in its entirety. Railway communication with the rural districts in the Isle of Sheppey was established on the 1st inst. by the opening of the Sheppey Light Railway between Queenborough and Leysdown. The new line, which is about 10 miles in length, joins the South-Eastern and Chatham Railway Company's line at Queenborough, and there are stations at Sheerness, Eastminster, and Eastchurch.

Batley.—The Corporation have approved specifications for the permanent way of the proposed electric tramways. It was explained at the last meeting of the Council that the British Electric Traction Company were prosecuting with all their power their objections to what the Corporation were doing in connection with the proposed tramways. However, if the Board of Trade granted the application of the Corporation for an extension of time (six months) for the commencement of the work of constructing the line, the Corporation, on the other hand, would, at the end of that time, proceed with the work with all possible haste.

Tube Railway Schemes.—In the House of Commons on Monday Sir J. Dickson Poynder asked the President of the Board of Trade whether, in view of recommendation 22 of the report on London underground railways, he proposed sending an engineer from his department to examine into the subway system now in use in certain towns in the United States and on the continent of Europe, and to report as to the advantages afforded by the system over the underground tubes now in use in London. Mr. Gerald Balfour said he would consider with the technical officers of the Department whether such enquiry was desirable.

West Bromwich.—The negotiations between the Corporation and the local tramways companies, which have been going on now for some two years, have at last been brought to a satisfactory conclusion. The Highways Committee in their last report to the Town Council recommend the Council to apply to the Board of Trade for sanction to borrow sums of £5,500 and £32,000 for the purchase of the undertakings of the Birmingham and Midland Tramways Company and of the South Staffordshire Tramways Company. It is further proposed that Mr. R. C. Quin be appointed consulting engineer to the Corporation for the reconstruction and electrical equipment of the tramways.

Middlesbrough.—An inquest has been held on the body of Elizabeth Ash, aged seven, who was run over by a tramcar in Newport-road last week, and died some hours afterwards. The child was knocked down by a car going at a speed, it was stated, of about six miles an hour. The evidence went to show that the guard pushed the child along two or three yards, when she got under the guard, and was dragged about 15 yards. There was not a pair of jacks on the car, and they had to be sent to the tramsheds for. The jury found that death was accidental, and expressed the opinion that there should be a more strict supervision of the cars, agreeing that there should be a pair of jacks on each car.

A "Tube" Claim.—Mr. Wm. Cattlin, the owner of a large house known as No. 1, Highbury-place, has succeeded in recovering damages from the Great Northern and City Railway Company, who are constructing a "tube" railway through North London. In the London Sheriff's Court it was given in evidence that soon after the work of driving the tunnel 52ft. below the ground surface at Highbury-place, cracks began to appear in the ceilings and walls of the plaintiff's house, and there was an undoubted "movement" in the building. Sir Douglas Fox, called for the company, said there would be practically no damage in the future. The jury eventually awarded a sum of £660 as compensation.

Electric Railways in Sweden.—The Vienna correspondent of the *Morning Post* wires as follows: "The *Politische Correspondenz* learns from Stockholm that electricity is likely to replace steam as the motive power on all the Swedish railways within a short time. The Government is already considering several detailed plans proposed for the great enterprise. Sweden possesses such exceptional natural resources in the shape of waterfalls and swift streams that the substitution of electricity for steam is greatly facilitated. Experts estimate the cost of the transformation to be 40 million Scandinavian kronen. If the scheme favoured by the Government receives the necessary sanction, operations will be begun before the end of the year."

Blackburn.—In reply to a series of questions at the last Corporation meeting, the Chairman of the Tramways Committee stated with respect to an alteration in the tramcar motors, that there had, of course, during the past two years been a development in motors, and the firm who were making theirs thought some they had would have a considerable advantage over those for which they contracted. They had suggested making the alteration, and after the committee had seen

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them they were satisfied, and on the advice of the engineer they decided to have them. As for the delivery of cars they would not want them until May, and they had arranged with the contractors not to have them until a later date than had been originally fixed.

Erdington.—A special committee of the District Council recommend the Council to promote a Bill in the next session of Parliament for the construction and working of tramways within the district, comprising the following: (1) a tramway from Aston boundary at the Gravelly Hill terminus to the Sutton boundary at Chester-road; (2) along the Slade-road from the terminus to Stockland Green; (3) from the Six Ways, Gravelly Hill North, down Summer-road and along Gravelly-lane to the Sutton boundary, with the addition of the loop line along Reservoir-road and down South-road; (4) along Kingsbury-road, commencing at the junction at Gravelly Hill with No. 1 and terminating at or near to the intersections of Bromford-lane.

Ramsgate.—At the last meeting of the Corporation reference was made to a police report on the question of the speed of the trams. This showed that the police had measured off 100 yards where they had reason to suppose the tramcars had greatly exceeded the limits laid down by the Board of Trade, and a very long list had been prepared. In every case the speed laid down by the Board of Trade—which in the particular spot referred to was four miles an hour—was greatly exceeded, and the speed went up in the case of one car to 11 miles. In most cases the speed averaged between nine and ten miles an hour. The Council, in view of this state of things, decided to collect the necessary evidence with a view of action being taken in the matter.

Great Northern and City Railway Co.—Presiding over the half-yearly meeting of this Company, Sir Chas. Scotter said the total length of the tunnel completed up to date was 6,659 lineal yards of 16ft. tunnel, and 514 lineal yards of station tunnel. It was intended to work the railway on the multiple-unit system. Experience in all directions had proved that system to be the best for the particular work in connection with the traffic to be carried. They had lately had a very good object lesson in the result of the working of the Central London Railway. The directors intended to take advantage of all the latest improvements, so that the success of the Great Northern and City Railway should be equal to that of the Central London Railway.

Proposed Tramway Letter-Boxes.—Experiments have lately been going on in different provincial towns concerning the proposals of the Post Office for carrying letter-boxes on tramcars. Of the local authorities consulted, only those at Halifax have as yet come to any decision in the matter. The Tramways Committee of the Halifax Corporation recommend the adoption of the second proposal of the Post Office, that in lieu of any payment to the tramway authorities the Post Office officials shall collect the letters from the boxes in the tramcars at certain hours each day. The first proposal was that the conductors of the tramcars should take the boxes containing the letters to the head post office in the town, for which work the Department would pay the tramway authorities a sum not exceeding £25 a year.

A Snowdon Scheme.—In the House of Commons on Tuesday the Port Madoc, Beddgelert, and Snowdon Railway Bill was ordered for third reading. Two objections were raised to the measure: one, as to the possible defacement of beautiful scenery; and the other, as to the use of water power to generate electricity for the working of the railway. It is proposed to build a single-track railway to run through the Pass of Aberglaslyn and the Vale of Gwynant to the top of Lake Gwynant, and to carry goods and minerals as well as passengers. The promoters wish to utilise the waters of Llyn Llydaw and Llyn Teryn, two lakes on the eastern slope of the mountain, which feed the River Glaslyn, as a generating power for electricity. This proposal was opposed by Lord Balcarres, who moved to leave out the clause relating to it. After considerable discussion it was decided by a majority of 110 to retain the clause.

Obstruction Summons.—The following is a *Daily Mail* report of an incident which occurred the other day in the Brentford Police Court: "In answer to a charge of alleged obstruction, a Brentford tradesman said: It's all the electric trams, sir. I have to move my cart six times in ten minutes sometimes to let the trams go by.—Mr. Montagu Sharp: Why should you? You have as much right to carry on your business as they have to carry on theirs.—The Tradesman: If I didn't move the cart it would block the cars.—Mr. Sharpe: Why not block the whole system? You tradesmen ought to combine and fight the case out in a law court. Put a cart on the rails, and let it stay there till all the cars are stopped, and then let both sides instruct counsel and have the matter fought out. You have as much right to the road as they. It may be explained," adds our contemporary, "that through almost the whole length of Brentford the near rail of the tramlines is less than 2ft. from the kerb."

North Metropolitan Tramways.—Speaking at the meeting of the shareholders of the North Metropolitan Tramways Company on Wednesday, the chairman announced that an arrangement had been come to with the London County Council whereby the latter would find the money for turning the system into one of electric traction. He explained that when the Council called upon the company to electrify the line the former would have to find the money, and the company would have to pay the interest on it. As soon as the Council were ready to have the line electrified the directors would be prepared to do it, but until the Council took the initiative the company could do nothing. Two experts had been sent out by the Council to America to see the best installation that could be made and the best way of putting it down, but until those gentlemen returned the County Council would not move in the matter. The fares would be put at such a rate as to command passengers as against the railway companies.

Aston.—It was stated at the last meeting of the District Council that an agreement has been effected between the promoters of the Birmingham (City) Tramways Bill and the Aston and Handsworth District Councils, whereby the running powers clause to which objection was taken had been eliminated. It has also been agreed to give the city a lease for the Birchfield-road line till 1906, and for the Wheeler-street line till 1911. A clause has also been inserted by which Aston and Handsworth can by agreement with the company exercise the powers of the Act for the adaptation for electrical traction and equipment of any tramways of the company in their respective districts. With regard to the generating station, the Tramways Committee of the Aston Council have decided that they will equip the trams they are purchasing from the Birmingham and Aston Tramways Company for electrical traction themselves; thus they will keep control of their own streets. The committee have also made up their minds to supply the whole of the current for tramway traction in the district, and to light the streets by electricity.

The Bristol Strike.—Tramway matters at Bristol have remained practically in the same position all the week. Despite the fact that the company have discharged some 300 of their employés for having joined the union, the car service is reported to have improved, outside labour having been obtained. But the majority of the men continue to maintain their determined attitude, and numerous meetings, demonstrations, and processions have taken place this week. It is said, however, that many of the men who regret the action they have taken—it is alleged under coercion—have approached the company and have been reinstated, the directors being perfectly willing to consider such applications favourably. The latest news to hand is to the effect that the directors have given instructions to their solicitors to prepare writs to be served on some prominent trade union men and others, who at a meeting proposed resolutions and framed petitions appealing to the public to join and aid them in boycotting the company's cars. This is done consequent on the decision of the House of Lords as to trade union funds being liable for damages arising out of boycotting under certain conditions.

Glasgow.—The Corporation tramway accounts show that the capital expenditure up to now amounts to £1,793,934. There has still to be expended on the lines that have to be constructed about half a million of additional capital, so that when the work is completed the capital will be £2,300,000. In the past 12 months the revenue amounted to £489,469, which was £19,503 over last year. The working expenses were £372,080, an increase of £27,359 over last year. It was explained at the last meeting of the Corporation that this increase was accounted for by the rise in the price of provender and in the public taxes. It was further stated that the Springburn route, which had been wholly worked during the past year by electricity, had yielded a splendid return. The revenue per car mile had been 14·62d., and the cost of working had been 6·62d., so that there was a net profit of 8d. per car mile. In other words, the working expenses of electric traction to Springburn had been 45 per cent. of the drawings, while the working expenses of the horse cars had been no less than 82 per cent. of the drawings. That was extremely encouraging to them, in view of the fact that they had now electric traction over the whole system.

St. Paul's Danger.—Mr. Somers Clarke, architect to the Dean and Chapter of St. Paul's Cathedral, writes to the *Times* on the subject of the cracks which have appeared in the cathedral. Having stated that there has been a settlement of the foundations of the eight piers, and detailed certain more important dilapidations to the structure in various parts, Mr. Clarke enumerates the underground borings that have taken place, saying: "The southern slope of the hill on which the cathedral stands is fairly riddled with excavations of one sort and another. There are sewers, the underground railway, and a tube at a lower level." The writer then refers to pending schemes of excavation in connection with the electric railways, and points out that the cathedral is already attacked on the north. "Here is the tube of the Central London Railway, and this is but 460ft. from the centre of the dome. This tunnel, passing as it does close to Bow Church, has already in the few short years since it was pierced caused the steeple to overhang 1ft. 9in. towards itself. Bow Church tower is a mere toy compared with the enormous weight of St. Paul's. The chief danger to the cathedral lies by no means only in piercing the tubes, or in the vibration from passing trains. The tubes may be sunk ever so far down, the vibration may, and no doubt will, be very much reduced, but wherever the tube may be, a tremendous hole must be made for the public to get at it. Then when the bottom is reached there are footways, cross-passages, and all manner of subsidiary excavations."

New Issue.—The Merthyr Electric Traction Company are making an issue of £30,000 4½ per cent. mortgage debenture stock. The company has a share capital of £100,000, divided into 10,000 5 per cent. cumulative preference shares of £5 each and 10,000 ordinary shares of £5 each, of which 6,000 preference shares and 6,000 ordinary shares have been issued and are fully paid up. The prospectus states that the company owns the light railways (about three miles in length) in the town and district of Merthyr Tydfil, extending from Dowlais through Merthyr Tydfil to Cefn Bridge, which have been working since April 6 last. The company is authorised to construct a light railway about half a mile in length through the village of Cefn as soon as the bridge at Cefn has been rebuilt. Based on the actual traffic receipts since the opening of the lines, it is estimated that the net profit from the tramways alone (without electric lighting) will amount to about £7,000 per annum. The amount required for interest on the present issue of stock when fully paid is £1,350 per annum. In addition to the light railways, the company is authorised under the Merthyr Tydfil Electric Lighting Order, 1899, to supply electric energy in the urban district of Merthyr Tydfil, and numerous applications for lighting purposes have been received. The supply of energy has been commenced, and additional revenue from this source is anticipated. The present issue is made in order to provide for the payment of the balance due on account of the purchase price—namely, £15,000—to discharge further liabilities, amounting to about £8,359, and for additional plant and working capital.

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Scarborough.—Mr. Waller, of London, has advised the Corporation that the proposed new tramway system should be limited in distance, as a small scheme would be more likely to be a financial success than a large one. A report of the Tramways Sub-Committee containing the following recommendations has been referred back for further consideration: "That the resolutions of the committee passed in February and June—that the Corporation obtain parliamentary powers to lay down and work tramways—be rescinded; that the Corporation co-operate with a company in the promotion of a Bill in the ensuing session of Parliament for the purpose of conferring upon the company powers to lay down and work trams in the borough, on condition that the company be formed in Scarborough with influential residents upon the directorate, and that as much as possible of the capital be locally subscribed; that details as to routes, gauge, etc., be mutually agreed upon; that the company promote the Bill, the details of which should meet the reasonable requirements of the Corporation, and that the company repay the Corporation their reasonable legal costs and expenses in connection with the Bill; that the electric supply be obtained from the Scarborough Electric Supply Company; that the Corporation have power to acquire the tramways in the year 1915 as a going concern, and that the Corporation pay not less than the amount the company have expended on the undertaking, plus such sum, if any, as may be required to make up the dividends paid upon the share capital to 5 per cent.; or in 1926 upon a valuation as a going concern without any further proviso; or at the end of 35 years from the opening of the tramways upon terms specified in the Tramways Act of 1870. Further, that the company pay rent to the Corporation at the rate of £25 for every mile of street within the borough upon which the tramways are laid, when the dividend is over 4 per cent. and up to 6 per cent., and for every 1 per cent. above 6 per cent. at the rate of £50 for every mile."

Mr. Behr's Proposed Monorail.—The following important clause has been inserted in the Bill promoted by Mr. Behr for a high-speed electric railway from Manchester to Liverpool, as passed by Sir Lewis McIver's Select Committee of the House of Commons: "For further securing to the public, to passengers on the railway, and to servants of the company all reasonable protection against danger arising from the use of the railway under the provisions of this Act, the following provisions shall have effect (that is to say): (1) the company shall submit for the approval of the Board of Trade plans, sections, and other details of their proposal in respect to—(*a*) the construction of materials of the permanent way and proposed mode of maintenance thereof; (*b*) rolling stock; (*c*) mode of working, including system of signalling; (*d*) electric installation; (*e*) system of braking; and (*f*) mode of fencing and prevention of trespass. (2) The Board of Trade may require the company, at any time before and during the construction of the railway, to conduct at their own expense such experiments as that Board may desire to have made, with a view to determining whether the proposals and arrangements of the company, in respect of any matters referred to in this section, are satisfactory, and the railway shall only be constructed in accordance with the plans, sections, and other details as approved by the Board of Trade. (3) The Board of Trade may make regulations for giving effect to all or any of the foregoing provisions of this section, and also for securing to the public, and to passengers, and to servants of the company, all reasonable protection against danger arising from the use, under this Act, of electrical power on the railway, and for regulating the use of electrical power. (4) The company or any other company or person using any electrical power on the railway contrary to the provisions of this Act, or of any regulations made by the Board of Trade under this section, shall for every such offence be liable to a penalty not exceeding £10, and also, in the case of a continuing offence, to a further penalty not exceeding £5 for every day during which such offence is continued after conviction thereof. (5) The provisions of this section shall be in addition to and not in substitution of any provisions for the protection of the public, and of passengers, and of the servants of the company, contained in any general Act relating to railways which are applicable to the railway and the company."

Mr. Yerkes and the Metropolitan Railway.—Mr. C. T. Yerkes has published a letter in answer to the statements made in the report of the Metropolitan Railway and at the recent meeting of that company. After explaining that this report places him in a false position, Mr. Yerkes goes on: "As to the merits of the electrical systems I will not argue, but merely say what I think of adopting a new system on general principles, and if my refusal to adopt such system makes me 'look absurd,' I am perfectly willing to labour under that condition. I told the gentlemen connected with the Metropolitan Railway whom we met in regard to the matter that if the system which they seemed to adhere to had been tried on a railway like the Metropolitan for a period of three years and had worked successfully, I would most willingly adopt it on any work that I had to do with. To the charge that I am concerned in properties where the general system of electric equipment is being used, and that to adopt a better would cause a great loss by virtue of being compelled to abandon those systems and adopt another radically opposed in principle to it, I will say that we have never been afraid of the scrap heap when we found we had made a mistake, but we do not court it. It is full of wrecks of failures, and it is just here that I would remark that we do not wish to add to that heap a plant that would cost in the neighbourhood of half a million pounds sterling, apart from the expenditure on the power-house. I will also say that, as to systems or works or anything applying to electrical traction, I have no financial interest whatever, and my whole object is to see that whatever plan is adopted on any property with which I may be connected is the best. To take a system which has not been thoroughly tested, not for a few, but for many months, and even years, is a species of business recklessness which I do not wish to try. I also desire it understood that I am entirely free from prejudice, and desire only what is the best. To attempt to experiment now, or to be guided by the experience of the little mountain roads in Switzerland, or the road which is being installed in Italy, which is not yet working, would be foolish, and even if it were in operation its success would be no indication of its adaptability to the Metropolitan Railway. If the managers of the Metropolitan Company had commenced this experiment years ago, when the Central London was begun, I am satisfied they would have lost some time, but they might have corrected their plant so as not to have been in the humiliating position we find them to-day. They cannot make the excuse that their credit was poor and they were unable to raise money. They have simply waited until the wolf was at their door, and long afterwards. Another matter I would like to have understood. The system so called which we propose to use is not the 'Yerkes system.' There is no such thing. I never invented anything pertaining to electricity. It is a system universally used the world over by all modern-built railways, and I am only one of the scores of people who are doing this. It is used extensively in England, and only lately Glasgow has adopted it in the important plant which they have recently made, and which is the largest in Great Britain. In regard to the proposition that was really made to the Metropolitan Company, I will now give it and leave it for others to say whether it was fair. At the present time I am chairman of the Metropolitan District Electric Traction Company, and we have a subscribed capital of £1,000,000. The subscribers are all gentlemen of means, and I may say affluence. Our propositions were: (1) That we would electrify the Metropolitan Railway, furnish all the rolling-stock, also a power-house and sub-stations, and do everything and furnish everything necessary to change and operate their road by electricity, charging therefor the sum of ½d. for each passenger they might carry. There were some things, such as keeping their buildings in order, that they were to provide for. But I cannot see any way that they would make such a statement as they made in their report—that we would charge them £291,000 for what cost them £101,000. (2) The second and most important proposal was that we would work or lease the whole of the railways and general undertaking of the Metropolitan Company, subject to the statutory obligations of that company, guaranteeing to the Metropolitan Company a net yearly revenue sufficient to pay the whole of its debenture and other fixed charges and its guaranteed and preference interest. As to a yearly dividend upon the ordinary share capital, we found that the average dividend for a period of seven years terminating on June 30, 1900—that is to say, prior to the competition which the company has had to meet with the Central London Railway—was £3. 6s. 11d. per annum. We offered to pay on the aforesaid capital stock yearly dividends in perpetuity at the rate of 3½ per cent. The dividend this half-year is at the rate of 2¼ per cent. per annum. In regard to the surplus land stock, the dividend upon that would be provided, as heretofore, out of the revenues of land especially set apart for payment of interest on the surplus stock, and our proposition did not affect this stock. For securing the dividend on the ordinary shares the traction company proposed at its own expense and cost of not less that £700,000 to convert the railways mentioned in the scheme from steam to electric traction, build all necessary sub-stations (the Metropolitan Railway Company to supply the land for the same), and supply the rolling-stock. We proposed to increase the capital of the traction company from £1,000,000 to £2,000,000, or more if necessary; also to give to the proprietors of the Metropolitan Railway Company the right to take £500,000 of the increased stock. We also proposed that the whole of the capital, or the property of all kinds whatsoever belonging to the Metropolitan District Electric Traction Company should be placed in the hands of trustees, who should hold the same for the benefit of the contract to be made with the Metropolitan Railway Company. In case we desired to sell or change any securities belonging to the traction company, we should do so only with the consent of the Metropolitan Company. The security of the traction company has been sneered at by the Metropolitan Company, but it seems to me that with £2,000,000 of hard cash well invested, a portion of it in the property of the Metropolitan Company, this security is such as would not be offered by any other company. The terms that we offered—namely, placing all our property in the hands of the Metropolitan Company—were for the purpose of reconciling our differences and endeavouring to join the two companies, the Metropolitan and Metropolitan District, together in such a manner that they could be worked by one official head. It is my belief that if so worked a fair profit could be gained by our company—much greater than can be done if the two companies are separate. The tender having been rejected, I wish to say that it is the desire of the managers of the Metropolitan District Electric Traction Company to proceed to carry into effect at the earliest moment possible the electrification of the District Railway; and as the officers of the Metropolitan Company have also expressed the same desire, there is no reason why the latter should hold to the text of the Bill which has been passed—namely, that one month should elapse before we can go to the Board of Trade. The losses to both companies at the present time are very great, and I believe there is nothing that will stop the continuance of these losses but the running of the roads by electricity. Therefore every day means money, and it is for that reason that I am extremely anxious that not a moment should be lost."

LIGHTING AND GENERAL.

Tonbridge.—The Guardians have now decided to instal the municipal telephone in the clerk's office.

Lowestoft.—A special meeting of the whole Council will be held shortly for discussing the matter of electric lighting in committee.

Grantham.—The Town Council have decided to apply for sanction to borrow £2,000 for the purpose of establishing a municipal telephone exchange.

Morley.—The electrical engineer's last report states that the output from the works during the past four weeks showed an increase of 100 units.

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Liverpool.—Sanction has been received to the £300,000 electricity loan.

Fleetwood.—Mr. C. H. Wordingham, M.I.C.E., has been appointed by the Board of Trade to act as electric inspector under the Fleetwood electric lighting order.

Trowbridge.—An application from Messrs. Crompton and Co. as to sub-letting them the electricity supply provisional order obtained by the Council is being considered.

Leyton.—Colonel C. H. Luard has held an enquiry into the Urban District Council's application for sanction to borrow £15.500 for extra steam plant for the electric supply station.

Carnarvon.—The Town Council, upon the advice of Sir W. H. Preece, are placing themselves in communication with parliamentary agents in order to obtain a provisional order.

Hartlepool.—The Corporation are having specifications prepared and tenders will be invited for the provision of an electric lighting station and plant at an estimated cost of £18,000.

St. Annes-on-Sea.—The electric light is being installed in the parish church. Arrangements are to be entered into with Messrs. Redfern for the erection of two arc lamps on the Crescent.

Islington.—It is proposed to proceed with the laying of distributing mains and feeder cable, etc., as follows: Dalmeny-avenue, £130; Park-street, £625; feeder cable for Upper-street, £800, making a total of £1,555.

Change of Address.—We note that Mr. Ernest Kilburn Scott, A.M.I.C.E., M.I.E.E., has removed to Beesfield House, near Farningham, Kent (nearest railway station, Eynsford, South-Eastern and Chatham Railway).

Hunslet.—The Guardians on Wednesday decided that an electrical turret clock be provided for the new workhouse at Rothwell Haigh at a cost of £63, and that 25 electrical clocks be purchased for use in the house at a cost of £170.

Newcastle.—The Board of Trade have granted the Town Council an extension of time for the exercise of powers under the electric lighting order. The Town Council have decided to light the town hall buildings by electricity.

Lincoln.—The Town Council have agreed to create £6,000 and £1,551 Lincoln Corporation 3 per cent. redeemable stock, the former for electric lighting purposes and the latter for street improvements in Sinoil-street and the Cornhill.

Ealing.—Mr. A. E. Lewis has accepted the post of business manager in the electric light department. He will take up his duties on Sept. 1, and will receive, in addition to a fixed salary, 2½ per cent. commission on all new lights obtained.

Darlington.—Application is to be made to borrow £250 in connection with the extensions of the electric lighting plant. We learn with regard to the extension of the mains to Harewood-hill, and for the outlay of about £500, that there is a prospect of £100 revenue.

India.—Major Stuart, R.E., inspector of submarine defences, will probably be employed at Simla in helping the military works department in the preparation of electrical installation projects, and it is not unlikely that an Engineer officer will also be sent from home, as the work is getting very heavy.—*Indian Engineering.*

Catalogues Received.—Messrs. Thomas Parker, Limited, have sent us the fourth edition of their "pocket list" of continuous-current dynamo, motors, etc. This gives the details as to size, output, and price of these machines, and is very handy for reference. The last few pages deal with electric locomotive, starting resistances, etc.

"Robertson" Electric Lamp Cricket Club.—The annual match between the above club and the General Electric Company, Queen Victoria-street, was played at Shepherd's Bush on Saturday, 3rd inst. After a most exciting game the lampmakers were, as usual, victorious, their score at the finish being 79, whilst their opponents made 75.

Aberdeen.—It has been decided to improve the lighting arrangements at Woodside car-shed by the erection of four enclosed arc lamps, and the provision in the wing of the building for the installation of a motor-driven portable air-compressor, to be used for blowing out the carbon dust from motorcars. The cost of the improvement is estimated at £110.

Bognor.—At the special meeting of the Urban District Council held last week for the purpose of considering a report from the Electric Lighting Committe recommending the scheme of Messrs. J. and J. S. Enright for the installation of the electric light in the town, the question had to be adjourned in consequence of the small attendance.

Sowerby Bridge.—The Halifax Corporation have offered to supply the Urban District Council with electricity in bulk at the following charges: 2¾d. per unit up to 15,000 units per annum; 2½d. per unit between 15,000 units and up to 30,000 units per annum; 2¼d. per unit over 30,000 units taken per annum; the point of delivery to be Tuel Lane Top.

Colchester.—The Council have accepted the Electric Light Committee's offer to supply current for lighting the public lamps on the south side of High-street at £3 per lantern per annum, each lantern to contain two 8-c.p. electric lamps. A yearly rent of £3. 10s. 1d. was formerly paid to the gas company for each of the seven lamps on the south side of High-street.

Kingston.—The Town Council have decided, subject to the price of lamps being satisfactory, to light Fassett-road with incandescent electric lamps. The Council last week sealed an instrument authorising the Ecclesiastical Commissioners to pay to the account of the borough treasurer £6,000, to be borrowed by the Council on mortgage on the security of the borough lighting rate.

St. Helens.—The electrical engineer's last report states that the number of lamps connected to June 30 was 25,984, against 14,713 in the corresponding period in 1900; number of units sold for lighting purposes in June 9,026, against 6,100; number of units sold for tramway purposes 65,570, against 42,910; number of units sold for power purposes 12,182, against 7,100.

Fire.—Between three and four o'clock on Sunday morning a fire occurred in one of the underground boxes of the City of London Electric Lighting Company, Limited, near the entrance to New-court in St. Swithin's-lane. Fire-engines were soon on the spot, and after the current had been turned off, the burning indiarubber covering of the wires was extinguished by the aid of a few pails of water.

Spennymoor.—At the last meeting of the Urban District Council the surveyor produced the statutory notice of the intention of the Northern Counties Electricity Supply Company to lay their mains in the streets shown on the plan, also deposited. A plan was submitted for the electricity works adjoining the North-Eastern Railway at Merrington-lane, but as no elevation was shown it was not passed.

Charing Cross and Strand Electricity Supply Corporation.—The directors, after providing for debenture and other interest and dividend on preference shares, have declared an interim dividend at the rate of 8 per cent. per annum for the half-year ended June 30, and carry forward £11,890. The registers for the preference and ordinary shares will be closed for the payment of dividends until the 17th inst.

Beckenham.—At the last meeting of the Urban District Council the Electric Lighting Committee recommended the extension of cables to Den-road, Shortlands, Park-road, and The Knoll, also the laying of a cable to Kelsey Manor, on the lessee giving security for the consumption of current for 10 years at 5d. per unit, amounting to not less than 20 per cent., the cost of the cable being £200. The report was passed.

Worksop.—The completion of the work of laying down the cable and the fixing of standards for the lighting by electricity of the main streets, and the building of works for the supply of electric energy, was celebrated on Saturday by the holding of a dinner at the Boundary Inn, Worksop, given by Mr. W. Hall, the contractor for the supply works, to the workmen who had been engaged on the various buildings.

Brompton and Kensington Electricity Supply Co.—The directors have declared interim dividends for the half-year to June 30 last as follows: on the 12,000 preference shares numbered 58,001 to 70,000, inclusive, at the rate of 7 per cent. per annum; on the ordinary shares, at the rate of 7 per cent. per annum. The share transfer books are closed until the 10th inst. for preparation of warrants, which will be posted on the 9th inst.

Witham.—The Urban District Council propose to obtain an electric lighting provisional order. They have been considering an estimate from Messrs. Christy Bros., of Chelmsford, of the cost of an electric installation of £1,075, which would provide a plant suitable for 216 lights continuously. The present engine at the pumping works is capable of from 10 h.p. to 12 h.p. normal, but for electric purposes 25 h.p. will be required.

New Books.—We beg to acknowledge receipt of "Original Papers of the late John Hopkinson, D.Sc., F.R.S.," edited, with a memoir, by B. Hopkinson, B.Sc.; C. J. Clay and Sons, Cambridge University Press; two volumes; £1. 1s.—"Theoretical Elements of Electrical Engineering," by Charles Proteus Steinmetz, New York (*Electrical World and Engineer*).—Also of Nos. 1 to 6 of Vol. I. of the Boletin de Obras Publicas of the Argentine Republic.

Woodbridge.—The Suffolk Electricity Supply Company, Limited, having asked the Urban District Council whether they would look with favour upon the company coming into the town, and if they would oppose a provisional order, the Council decided to reply that they are not opposed in principle to the application of a private company to supply electric light within the urban district if the details of the proposed provisional order are approved by them.

West Hartlepool.—The Town Council on Wednesday decided to continue the electric cable along Hart-road to the cemetery gates. The number of arc lamps or their equivalent connected to date was stated to be 16,588. The borough engineer was instructed to visit Tunbridge Wells and Huddersfield to obtain information with regard to the institution of a municipal exchange business. The Council decided to support a statutory imposition upon fire insurance companies, obliging them to contribute towards the expenses of fire brigades.

Witting Bros., Limited.—We are informed by Messrs. Witting Bros., Electrical Engineers and Contractors, Limited, that in consequence of the enormous expansion of their electrical engineering business, and for their convenience, they have decided to make this business a separate one, and to form for its transaction a special company under the above-mentioned style. All orders and contracts unexecuted on July 1 will be transferred to the new company, who will take over all liabilities as from that date. Mr. A. C. Eborall remains chief engineer to the new company.

Eastbourne Telephones.—We learn that a provisional agreement has been arrived at between the Town Council and the National Telephone Company, by which all the inconveniences that would have arisen from the existence of two competing exchanges in the borough will be avoided. The Corporation will take over all the company's wires, some of which are underground, and it will no doubt be possible to effect economies in management inasmuch as the borough electrical engineer (Mr. J. Kempe Brydges) has a thorough knowledge of telephone work, having had valuable experience in America as well as in England. While the exchange area will not include the whole of the Eastbourne parliamentary division, it will embrace Hailsham and East Dean. As soon as circumstances permit the charges will be reduced, and the most effectual means of hastening that result will be for the inhabitants to rally to the support of the Corporation in this new and most promising venture. No additional burden will be cast on the ratepayers, as the Corporation will take over a concern which will pay its way from the outset.

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Rainhill Asylum.—The Committee of Visitors of this asylum have appointed Mr. Edward Fazackerley to the post of electrical engineer. Mr. Fazackerley has for some years past been engaged on behalf of Messrs. Mather and Platt, Limited, in supervising the erection, testing, and running of various town-lighting and tramway contracts carried out by them, including the Doncaster and Great Grimsby electricity works and the Blackpool and Fleetwood tramways.

Omnibus Earnings.—In the report of the directors of the London General Omnibus Company, Limited, for the half-year ended June 30 last, attention is drawn to the fact that the closing or partial closing of important thoroughfares for laying down Government telephone and electric light mains seriously affected the earnings of many of the company's services. However, a dividend of 6 per cent. per annum was paid, which will take £25,107, leaving £3,376 to be carried forward.

Derby.—Arrangements have been made to extend the mains to the Parkfield Estate at a cost of about £450. This amount is included in the sum of £35,000 granted by the Council on Oct. 10, 1900. The Council are increasing the salary of Mr. T. K. Hugessen, superintendent of mains, by £25 per annum, with a further increase of £25 per annum in 12 months' time. Mains have been ordered to be extended to West-avenue and Wilson-street. Twelve new arc lamps have been purchased.

Manchester.—The Electricity Committee of the Corporation have resolved to recommend the City Council to increase the price of electricity ½d. per unit to all consumers after Sept. 29 next. Further negotiations have taken place with the Corporation of Salford with regard to the establishment of municipal telephones, and a conference has been arranged between representatives of the Manchester Corporation and all the outside authorities comprised within the telephone area with that end in view.

Marriage.—The wedding of Mr. J. W. Eastwood, chief assistant of the outdoor staff of the electricity department of the Bradford Corporation, took place on Saturday morning at St. Jude's Church, Manningham, the bride being Miss Lucy Austen, who was also the recipient of many handsome and valuable presents. Mr. E. S. Saunders officiated as best man. The employés of the department presented Mr. Eastwood with a handsome black marble clock and a pair of ornaments. In the unavoidable absence of Mr. R. A. Chattock, the presentation was made by Mr. E. S. Saunders.

Telegraph Engineers' Conference.—The annual conference of the Amalgamated Association of the Engineering Department of the Postal Telegraphs was held at Birmingham on Wednesday. Delegates were present from the chief provincial towns. The principal subject under discussion was a proposal to run a candidate for Parliament in conjunction with other organised branches of the service, to which end the formation of a fund by levy was suggested. Mr. Clery, of London, was mentioned as the most eligible candidate, and a resolution in favour of his adoption was unanimously carried.

Strabane.—At a meeting of the ratepayers last week an offer from the Westinghouse Company and an estimate regarding the cost of lighting the town by electricity was discussed. There were also estimates from firms for lighting by acetylene and oil gas. The Westinghouse Company propose to supply gas for heating, cooking, and motive power, and this same power would drive engines to generate electricity by which to light the town. After discussion it was decided to adjourn the further consideration of the matter until the estimate of the Westinghouse Company was received.

North Berwick.—The Town Council have, pending a poll, entered into a provisional agreement for the supply of electric energy for the burgh with Messrs. Crompton and Co., who are bound, at their own expense, within 18 months of the Council obtaining a provisional order, to erect and completely equip the necessary plant, with all modern appliances for the supply of electricity, and also bound to carry on the works for at least 21 years, unless they are sooner acquired by the Council. Satisfactory terms for the acquisition of the works at varying periods by the Council have been adjusted.

Clapham.—We much regret to hear that Mr. Steward Bernard Lea Isaacson, chief electrical engineer of the Grand Palace of Varieties, died on Saturday night in the Bolingbroke Hospital, Clapham. On Wednesday last week Mr. Isaacson, in stepping backwards to withdraw a tube from the feed-pipe of a boiler he was engaged in cleaning, fell into a "sump" containing boiling water. He was at once got out and taken to the hospital, where Dr. Alexander, on examination, found that he had been terribly scalded all over the body. Mr. Braxton Hicks has been informed, and an inquest will be held.

Eastbourne.—Sanction has been obtained to the proposed new electric light works, and the Corporation intend to borrow for that purpose sums of £43,287 and £7,500. The latter sum is expected to be realised within the next two years by the sale of the present generating station. With respect to the proposal to apply the sum of £2,000 which the Council expect to obtain by the sale of old plant in defraying directly the cost of new works, the Local Government Board advise that the Council should raise the amount by loan for a short period. This the Council will be invited to do by the Electric Lighting Committee.

Stock Exchange.—The Stock Exchange Committee have ordered the County of London and Brush Provincial Electric Lighting Company's further issue of £100,000 4½ per cent. debenture stock to be quoted in the official list. Applications have been made to the Exchange Committee to appoint a special settling day in and to grant a quotation to the Chelsea Electricity Supply Company's further issue of 10,436 ordinary shares of £5 each, and the Electric Lighting and Traction Company of Australia, Limited, £75,000 5 per cent. debenture stock, and a further issue of 10,000 6 per cent. cumulative preference shares of £5 each.

Belfast.—The engineer of the Council of the county borough has submitted a statement giving the output of current for quarter ended June 30, 1901, as 170,815 units, being a total increase of 44 per cent. on the output over the corresponding quarter of 1900. Current used for motor purposes showed an increase of 91 per cent., current for lighting an increase of 29 per cent. Of the current sold for lighting purposes during the quarter only 11 per cent. was charged at 6d. per unit, while 89 per cent. was charged at 2d. per unit. Current sold for motor purposes: 15½ per cent. was charged at 3d. per unit, 84½ per cent. was charged at 1¼d. per unit.

The Loch Leven Water Power Bill.—The gigantic undertaking embodied in the Loch Leven Water and Electric Power Bill has had an easy passage through Parliament. It has fared better than the vaster project promoted two years ago. The new Bill provides for the construction of "waterworks, electrical generating stations, and other works for the supply of water, water power, hydraulic power, and electrical energy," empowering the promoters to sell the water and power so obtained to companies, local authorities, and others. For this purpose the waters of Loch Eilde Mor and Loch Eilde Beag, and of neighbouring streams, are to be gathered together.

Swansea.—At a special meeting of the Corporation on Wednesday, Mr. Carl A. L. Prusmann, borough electrical engineer of Doncaster, was appointed to a similar position at Swansea. There were 66 applicants for the position. During the proceedings previous to the voting Mr. Prusmann was asked if he were a German subject. He said he was born in England of German parents, of which he was proud. It was contended that it was hardly the thing to appoint a German subject to such a position, but Mr. Prusmann was elected by a large majority. In returning thanks, the successful candidate mentioned that on two previous occasions his name had cost him the situation.

Brighton.—The Town Council have approved of the following minute: "The Lighting Committee have considered a letter from Mr. E. F. Hope, clerk to the Clayton Parish Council, enquiring if the Corporation would be willing at a later date to undertake the public lighting of that Council's district by electricity, and, if so, on what terms; and resolved that Mr. Hope be informed that in the event of some of the adjoining parishes being desirous of taking electricity from the Corporation in bulk, and being willing to support any Bill the Corporation promote with a view to obtaining power to lay the necessary mains, the committee would consider the question of applying to Parliament for the necessary powers."

Johannesburg Municipal Electric Extensions.—The rejuvenating of Johannesburg is being signalised, as was to be expected, by at least its corporate operations, and tenders were recently invited for the immediate supply of 1,500ft. of 6in. steel or iron piping, with preferably Kimberley joints and 10 6in. bonds. Also for 1,500 yards of $^{19}/_{16}$ S.W.G. insulated cable, or 500 yards of three-core cable, suitable for a working pressure of 2,000 volts alternating. This material is required as an instalment towards the scheme for increasing the electric lighting service, which from both the town's lighting works and from the Rand Central Electric Supply Company, is already below the wants of the area served, without regard to the inevitable fresh demands foreseen. The aims of the municipality are, indeed, thoroughgoing, and its plans contemplate also the reconstruction of the town's electric lighting works at a cost not to exceed £70,000, the scheme for which is in course of preparation.—*The British and South African Export Gazette.*

Africa.—An electric lighting and power plant is being prepared in England and Switzerland for erection at the Livingstonia Mission, British Central Africa. It will furnish electricity for 600 lamps of 6 c.p., and motor power to drive a brickmaking machine, a flour mill, a pneumatic hammer, an iron-turning lathe, wood-working machines, and a printing press. A scheme for the reconstruction of the Johannesburg electric lighting works, to meet the increasing demands for the supply of electric current, is in course of preparation, the estimated cost being £70,000. Extensive additions are to be made to the Natal Government's electric works at the Point, Durban. The British South African Motorcar Syndicate are seeking powers from the Durban Corporation to run motorcars to the various suburbs. The matter has been referred to the borough engineer. A new electric power station is to be erected at the Cape Town docks. The Maritzburg Town Council have decided to order in connection with their electrical plant six new triple-feed lubricators, a portable hoist, condensing plant, four additional 24-kw. transformers and two switch pillars, additional steam alternator, and additional boilers.—*The British and South African Export Gazette.*

Cardiff.—At the last meeting of the Electrical Committee, Mr. Ellis reported on the work done by the department in July. The works cost for the month was 1·710d. per Board of Trade unit, and the total cost, including management, but excluding interest and repayment charges, 2½d. per unit. Mr. Ellis said they had now turned the corner, and were actually making money after paying working expenses. On their capital of £106,000 they were making nearly 6 per cent., but, of course, they had to pay interest and to provide for redemption of capital. If they were a private company, they would be paying a dividend at the rate of 5¼ per cent. per annum. Mr. A. Ellis submitted a circular setting forth the advantages of the reduced charges for the electricity supply for lighting and power purposes. A flat rate of 4½d. per unit, and a maximum demand system, ranging from 7d. to 2¾d. per unit, were shown to be a more economical rate to subscribers than the old system. The object of the revision of prices was to encourage consumers installing lights in places where they would be required for longer periods than is now generally the case, such as in cellars and workshops. For motor purposes the price per unit varies from 4d. to 1½d.

Electric Cranes.—Roughly speaking, the *Western Mail* says, the value of the work done on the new town hall and law courts in Cathays Park, Cardiff, up to the present is £30,000, out of a contract price of

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something like a quarter of a million. The contractors (Messrs. Turner and Sons) have employed the most modern machinery known to the building trade with the view of saving labour as much as possible, and also carrying out the work expeditiously. There are now in use, or shortly will be, eight electric derrick cranes, each capable of lifting five tons. They are elevated 40ft. above the ground, and, although the jibs or arms are 80ft. in length, they are so arranged that they can all be worked at the same time for conveying material to any part of the buildings where it is required. There are, in addition, two locomotive steam-cranes capable of lifting five tons, and a number of hand cranes, both fixed and movable. A 10-ton steam gantry which is employed has been specially constructed for the work, and travels at the rate of 200ft. a minute. The bulk of the stone is sawn and dressed on the ground, the remainder being dealt with at Messrs. Turner and Sons' works in Eldon-road, where they have more plant than on the Cathays Park. The electric cranes are driven from one central dynamo, the contractors providing their own power for generating the current.

Croydon.—The Council have adopted the following report of the borough electrical engineer on the past year's working (ending March 25, 1901): "During the year the capacity of the station has been increased from 2,520 h.p. to 4,320 h.p., the addition consisting of one 800-h.p. engine and alternator, and (for tramways) two 500-h.p. engines and generators. The number of lamps connected has also increased from 45,122 8-c.p. lamps to 59,241 8-c.p. lamps, being an addition of 14,119 8-c.p. lamps during the year. The average price to those under the maximum demand system of charging is 4·241d. per unit, a figure which compares very favourably with other metropolitan undertakings. The cost of production, which depends so largely on the locality, apart from the cost of coal, is lower than that of last year, and compares favourably with other stations of similar size, as is shown by the following: Blackpool, 1·33d.; Bristol, 1·35d.; Bolton, 1·02d.; Bradford, ·80d.; Glasgow, 1·18d.; Hammersmith, 1·11d.; Huddersfield, 1·07d.; Hull, 1·84d.; Islington, 1·56d.; Southport, 1·16d.; Worcester, 1·02d.; Croydon, ·947d. These figures are for cost of production apart from coal. The following is the summary of progress during the year ending March 25, 1901: number of consumers, 793; 8-c.p. lamps connected—private, 55,998; public, 3,243; horse-power installed, 4,320; cost of production per unit, 1·98d. (due to extra price of coal); average price obtained on the maximum demand system, 4·241d."

Sham Electrician.—A man of about 30 years of age, Richard Yorke, has been remitted at the Edinburgh Police Court on a charge of theft. The *Scotsman* says: "For some time past a young man of smart appearance has been going about Edinburgh victimising a number of household consumers of electric light. He described himself as an electrical engineer in the employment of the electric light department of the city, and after having intimated to whoever opened the door to him that his business was to inspect the meters and the fittings generally, he was usually allowed the free run of the premises. That being so, it was an easy matter for the bogus electrician to pick up any money or valuables which happened to be lying about or were in places to which easy access might be got. Thus chests of drawers and closets were ransacked, and the principal victims were servant girls, whose boxes had received more attention than the electric fittings. Many complaints were made to the police authorities regarding the doings of this young man, but as it was money which he preferred to take, and so cleverly and systematically did he go about his operations, that for a time the police were baffled in their efforts to lay hands on him. So serious, however, did the depredations become that Chief Constable Ross felt himself compelled to issue a circular to all electric light consumers warning them against the impostor. The issue of the circular had the effect of causing the thief to stop his operations, but the police did not cease their investigations, and in the course of these the accused was apprehended at Musselburgh, where he had taken lodgings in Downie-place."

The E.E. (R.E.) in South Africa.—We have received the following interesting cutting, unfortunately without indication of the paper from which it was taken, and therefore apologise for not giving the source: "Kroonstad, July 6, 1901. Sir,—In your issue of June 7, which we have just received, we were all very much surprised at seeing a letter from Sapper Dellagana, which I am sure must give you and your large number of readers a very poor impression of the work of our corps out here. To enlighten you on this point may I mention some of the work already completed or in progress? 'Rearranging the installation at No. 10 general hospital, Norvals Pont,' 'the lighting of Vereeniging Bridge' (across the Vaal River), 'lighting of No. 13 general hospital, Johannesburg,' and 'the lighting of No. 8 general hospital, at Bloemfontein.' (This work has already been completed.) 'The lighting of bridge over the Orange River, at Norvals Pont, and No. 3 general hospital, Kroonstad, are now in progress.' All these jobs include putting down of separate plants, the whole work, including the building of the engine-houses, having been done by our own men. We have also supplied men for the search-lights on armoured trains, and all the search-lights around Johannesburg are manned by us. We are thus quite unable to understand what Sapper Dellagana means when he says he is 'sick of inactivity.' We should also like you to understand that when his letter was written we had not been in the country more than about three weeks. With regard to our return home, no one can say yet when that may take place, as there is a vast amount of work yet to be done by us in this country. I am pleased to tell you that with very few exceptions we are all perfectly fit and eager for the work we have to do. I shall esteem it a great favour if you will give publication to this letter, as there are several Chelmsford men among us whose friends may get a wrong impression from the tone of Sapper Dellagana's letter.—Sergeant, Electrical Engineers, R.E."

St. Marylebone.—An application from the postal authorities to take up roadways and footways for the purpose of laying conduits with multiple ducts or cast-iron pipes, and also for the provision of manholes at intervals of 150 yards or thereabouts, and surface boxes where required to give access to the conduits and pipes, has been agreed to by the Borough Council. The report of the Lighting Committee in relation to the appeal to the Board of Trade by the Metropolitan Electric Supply Company against the Council's disapproval of the laying of mains in Edgware-road to connect with a Paddington station recommends that in the event of the Board of Trade giving a decision adverse to the Council, legal proceedings be taken in support of the Council's contention that the company have no power under their Act and orders to lay mains for the purpose of bringing current from Paddington. A notice from the Metropolitan Electric Supply Company to lay a second 5in. pipe (as there is no further room in the present one for cables) across South-street at the Manchester-square station, along the south side of South-street to the east side of Manchester-street, and along the east side of Manchester-street to the north side of George-street has been refused, the Council being of opinion that there was room in an existing pipe in Manchester-street to draw the proposed additional cables. Notices from the Metropolitan Electric Supply Company as to laying a 5in. cast-iron pipe along the north side of Clifton-hill, from No. 52 to No. 24, and along the north and south sides of Clifton-hill, from Nos. 24 to 11, crossing at the west side of Loudoun-road, has been agreed to. With regard to the request of the London County Council for the Council's views as to seeking legislation to empower local authorities supplying electric light to wire premises and put fittings therein, and to obtain loans from the County Council for the purpose, and communication from the Islington Borough Council supporting the principle, but objecting to the restriction of borrowing from the County Council only, the committee concur in the views of the Islington Borough Council. They also see no objection to the Board of Trade's consent being given to the Metropolitan Electric Supply Company to give an extra high-pressure supply of energy to their distributing stations, stating they propose to amend Condition 3 of the consent so as to provide for the limit of 1,000 kw. being exceeded, and stating the company have applied to use their existing trunk mains for transmission of power up to 1,500 kw.

London County Council.—The following notices under Electric Lighting Acts and Orders have been approved: Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Orders, 1897, of intention to lay low-tension mains along a portion of Royal-hill, and mains of high and low tension along Burnt Ash road and hill, and to construct a transformer box at the corner of Burnt Ash-hill and Bromley-road; Brompton and Kensington Electricity Supply Company, under the House-to-House Order, 1889, to lay low-tension mains along a portion of Pembroke-gardens, and mains of high and low tension along a portion of Neville-street; the County of London and Brush Provincial Electric Lighting Company, under the Southwark Order, 1892, to lay low-tension mains along both sides of Mina-road; the Metropolitan Electric Supply Company, under the West London Order, to lay high-tension mains along a portion of Queen's-road and along portions of Clifton-hill and Loudoun-road; and under the Mid-London Order, 1889, to lay low-tension mains along and across Portugal-street; Notting Hill Electric Lighting Company, under the Notting Hill Orders, 1889 and 1895, to lay mains along Chepstow-place, Addison-road North, and St. James's-square; the St. James's and Pall Mall Electric Light Company, under the St. James's Order, 1890, to lay mains along Duke-street, King-street, York-street, Charles-street, St. James's square and place and John-street, and across Vigo-street and Coventry-street. The Highways Committee have also reported upon a notice, dated July 20, 1901, from the Stepney Borough Council, under the Whitechapel District Order, 1892, of intention to lay mains along Vallance-road, Durward-street, Court-street, and Sandy's-row. The Borough Council is the undertaker under the order, and the Council has no power of approval or disapproval of works. The order contains, however, the usual clauses relative to the Council's subways; and as the Borough Council proposes to lay mains along Sandy's-row, where there is a subway, the committee think that the Council should require that those mains be laid in the subway. The committee recommended that the clerk of the Council serve a notice upon the Council of the metropolitan borough of Stepney containing the following requirements—viz., that the mains for Sandy's-row, referred to in the notice dated July 20, 1901, so far as is within the jurisdiction of the Council, be laid in the subway of that thoroughfare; that the Borough Council give two days' notice to the Council's chief engineer before commencing the works; that the Borough Council pay rent in accordance with the scale laid down by the Council in respect of the user of the subway; that the position to be occupied by the mains in the subway be subject to the approval of the Council's chief engineer; and that the work of placing them be carried out, and any damage that may be done to the subway in the execution of the work be made good to his satisfaction and at the cost of Borough Council. The Council have also received notices served under an order granted to a local authority, and under which the Council has no power of approval or disapproval of works, from the Islington Borough Council, under the Islington Order, 1893, of intention to lay mains along Tollington-park, and across and along Cross-street.

Birmingham.—The last report of the Electric Supply Committee states that owing to the necessity of making provision for the future development of the department, and in view of the probable need for electric energy for tramway purposes, the committee recommend the purchase of the site of the old General Hospital, at £23,000, for a generating station. If the ordinary growth of the output continues within the area at present supplied, the existing stations at Water-street and Dale End will be working at their full capacity by the end of 1903, and any extension of the supply, independently of tramway requirements, must therefore be provided for from the new station. The committee have been informed by the Tramways Committee that it is expected that

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electric energy will be required to work about 13 miles of tramway route by Jan. 1, 1904, and a further 39 miles by Jan. 1, 1907. The committee instructed their engineer to prepare plans and report upon the equipment of a generating station on the old hospital site, Summer-lane, so as to meet the requirements of the tramways department and the probable extension of lighting in the near future. They were informed by him that the erection of a sufficient power station and the instalment of the machinery would take at least two years. There was, therefore, no time for delay in going into the matter. The site upon which it is proposed to erect the necessary buildings has an area of 19,409 square yards, and the ultimate cost of the works when the site is fully utilised is estimated as follows: 12 combined engines and dynamos, £79,500; boilers and economisers, £24,000; condensing apparatus, including pumps and exhaust pipes, and pipe connections between canal and pumps, £8,860; steam-piping, feed connections, and exhaust arrangements in engine-room, £12,000; coal-handling plant, £6,300; water-tanks and water-softening plant, £6,100; switchboards, balancers, transformers, and accumulators, £22,300; crane, £1,400; main buildings, including shedding over canal, cooling tanks, etc., £74,500; architect's commission and clerk of works' salary, £4,200—total, £239,220. The whole of the power with which the station will ultimately be equipped will not be required for some years. For the present it is only proposed to provide for 5,000 h.p., which will supply the necessary energy for the tramway system, and for an extension of electric lighting mains, as may be required, to the extent of about 15 miles. The supply of outlying districts, such as Harborne and Bristol-road, will require to be supplemented by subsidiary stations. The engineer estimates the cost of laying the new mains and of the subsidiary power stations at £75,000. To properly work the generating station it will be necessary to practically complete the scheme of buildings, but the machinery can be put down from time to time as needed, and four sets of engines, one-fourth of the boiler equipment, and a portion of the condensing plant will be sufficient as a first instalment of the work. The cost of this work is estimated at £128,890. In order to admit of the Corporation being in a position to work tramways by the beginning of 1904, the equipment of the station must be commenced at the earliest possible date, and the committee recommend that the Council authorise the carrying out of the first instalment of the work at a cost of £128,890, and the laying of the mains referred to, and the construction of the subsidiary stations, at a cost of £75,000. After considerable discussion, the Council adopted this report last week, and also sanctioned an instruction to the Finance Committee to borrow £65,084, the amount expended in the electric supply undertaking in excess of the authorised capital. This included the £23,000 for the purchase of the old General Hospital above referred to, and £20,000 for plant and machinery in Water-street, and £15,000 for engines, boilers, and dynamos which had been ordered to meet present demands.

Hastings.—The following comparative statement by Mr. Leonard Andrews, the borough electrical engineer, showing the income from current sold during the past six months as compared with the corresponding period of last year, has just appeared in the *Hastings and St. Leonards Observer*. The report is made to the Sub Electric Light (Management) Committee. Mr. Andrews says: "It will be seen that the gross income has increased from £5,450 in 1900 to £7,037 in 1901, an increase of £1,587. On the other hand, the total expenditure, including interest and sinking fund, only appears to have increased from £6,680 to £6,897—namely, £217. The above figures are, of course, more or less approximate, as it is only possible to get at the exact cost by taking stock and making a number of adjustments. They are, however, I think, sufficiently accurate for comparative purposes. The following shows the increase in units sold during the first six months of 1899, 1900, and 1901: 1899, 184,720; 1900, 217,270 (32,500 increase); 1901, 314,931 (97,661 increase). The increase shown above is, of course, chiefly due to new consumers. It is, however, satisfactory to note that old consumers are using considerably more current since the price has been reduced, particularly those who are now being charged upon the 10s. and 1½d. per unit system of charging. I think it would now be advisable to issue a circular letter drawing attention to the long-hour system of charging, as I think it is probable many more would go in for it if they knew about it. The plant we shall have installed at the end of this year would be capable of generating, if running continuously, 7,000,000 units per annum, and this current could be sold at a profit at an average price of 1½d. per unit. Owing to the fact, however, that the majority of our consumers use electric light in positions where it is only required for a short time each day, and use gas where light is required for long hours, it is probable our output for the year will only be a little above half a million units, and the average price obtained will need to be over 5d. per unit to realise a profit. 1900 expenditure, January to June: to works cost, management expenses, interest and sinking fund, etc., as entered in bought day book and borough treasurer's book, £6,680. 15s.—total, £6,680. 15s. 1901 income, January to March—by sale of current: public lighting, including maintenance and repairs, 33,277 units at 6·1d., £848. 10s.; private lighting including meter rents, 107,741 units at 5·3d., £2,397. 5s. 5d. April to June, 1900—by sale of current: public lighting, including maintenance and repairs, 21,887 units at 7·25d., £663; private lighting, including meter rents, 54,365 units at 6·5d., £1,486. 6s. 3d.; by rents receivable, etc., £55—total, £5,450. 1s. 8d.; deficit, £1,230. 13s. 4d.; total units sold, 217,270; average price obtained, 5·9d. 1901 expenditure, January to June: to works costs, management expenses, interest and sinking fund, etc., as entered in bought day book and borough treasurer's book, £6,897. 7s. 2d.—total, £6,897. 7s. 2d.; surplus, £165. 1s. 10d. 1901 income, January to March—by sale of current: public lighting, including maintenance and repairs, 56,832 units at 4·2d., £985. 1s. 8d.; private lighting, including meter rents, 147,706 units at 5·1d., £3,101. 12s. April to June, 1901—by sale of current: public lighting, including maintenance and repairs, 34,097 units at 5·9d., £850. 15s. 4d.; private lighting, including meter rents, 76,296 units at 6·5d., £2,070; by rents receivable, etc., £55—total £7,062. 9s.; total units sold, 314,931; average price obtained, 5·35d." From the above it will be seen that in the six months, January to June, this year, there was an approximate profit of £165. 1s. 10d. An informal meeting of local tradesmen and others interested in the subject of municipal telephones was held on Monday at the premises of Messrs. Atkins Bros. and Cox, 10, Queen's-road, Hastings, for the purpose of hearing the views of Mr. S. T. Nicholson, hon. general secretary of the National Chamber of Trade. The question of a municipal telephone service for the town was discussed. Application is to be made for sanction to the borrowing of £132. 10s. for extending electric light mains.

PROVISIONAL PATENTS, 1901.

JULY 29.

15290. Improvements in the method of electrically igniting the explosive mixture in hydro-carbon engines. Michael Holroyd Smith, 47, Victoria-street, Westminster, London.

15295. Improvements in small electric transformers. George Beckett Batten, 2, Underhill-road, Lordship-lane, London.

15322. Improved liquid starting resistance for electromotors and the like. Victor Isidore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

15335. Trolley catcher or controller for electric cars. Charles Isaac Earll, 321, High Holborn, London. (Complete specification.)

15366. Improvements in safety devices for electrical apparatus. Paul Rudhardt, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 25, 1901, being date of application in Switzerland.)

15368. A safety device for exposed electric leads. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktiengesellschaft, Germany.) (Complete specification.)

15369. Improvements in drivers' brake-valve apparatus for operating air brakes both by means of air pressure and by electricity. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktiengesellschaft, Germany.) (Complete specification.)

15370. Improvements in electric meters for measuring electromotive force or current strength. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktiengesellschaft, Germany.) (Complete specification.)

15371. Improvements in electric switches. Percy Walter Ogilvie Hodges, 18, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 24.

1900.

8067. Harmonic telegraphy. Johnson and Guyott.

13538. Current arresters. Lorrain. (Burns.)

13539. Current arresters and alarms. Lorrain. (Burns.)

14463. Apparatus for electrolysis. Schoop.

14488. Electrical controlling apparatus for electrically-driven elevators. Haddan. (Stigler.)

16293. Electric furnaces. Imray. (Soc. Electro-Metallurgique Francaise.)

16508. Electric motor switch gear. Lenderyou and Smart.

17211. Electric conductor casings or conduits. Marsh.

17507. Electric lanterns to be fixed on the top of posts. Proctor.

17642. Instrument for measuring direct or alternating electric currents and potential differences. Duddell.

17904. Electric meters. Ellis.

18006. Conduits for electric conductors. Tugby.

18557. Lightning arresters and high-voltage guards or heating coils for telephonic purposes. Oppenheimer.

22584. Electric furnace with two bed-plates. Keller. (Date applied for under International Convention, May 21, 1900.)

1901.

1461. Telegraphic relays. Ducretet.

2345. Electric meters. Halsey. (Date applied for under International Convention, July 5, 1900.)

7325. Electric motors. Thompson. (Fuller.)

8985. Thermo-electric battery. Bénier.

11168. Railway and tramway vehicles driven by electricity. Feeny. (Allgemeine Elektricitäts-Gesellschaft.)

12071. Electrical ignition and valve operating mechanism for oil or petrol engines for motor cycles. De Jong. (Date applied for under International Convention, Dec. 22, 1900.)

12329. Electric motors. Fox.

12466. Apparatus for deriving electrical currents of one direction from a source of alternating current. Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

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12568. Apparatus for deriving electrical currents of one direction from a source of alternating current. Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

12569. Apparatus for deriving electrical currents of one direction from a source of alternating current. Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

12691. Electric cloth-cutting machines. Leve.

13577. Electrical fuses for high tension. Loescher.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Aug. 3	986	781	+ 205	—	—
Birmingham Tramways	,, 3	4,913	4,570	+ 342	136,693	— *b*
Blackburn Corporation	,, 2	466	489	- 23	14,792	13,523*b*
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 3	1,310	1,291	+ 19	5,541	5,883
Bolton Corporation	,, 4	1,545	1,364	+ 181	44,262	34,189*b*
Bradford Corporation	,, 3	1,193	456	+ 736	23,664	13,433*b*
Bristol Tramways Company	,, 2	3,798	3,451	+ 347	—	—
Carlisle Tramways Company	—	—	—	—	*b*	—
Central London Railway	—	—	—	—	—	—
City and South London Railway	,, 4	1,718	1,541	+ 177	9,268	7,445
Cork E. T. and L. Company	,, 1	585	525	+ 60	13,965	12,140*b*
Darwen Corporation	,, 2	188	152	+ 35	—	—
Dover Corporation	,, 3	300	275	+ 25	6,232	5,839*b*
Dublin & Lucan Electric Railway	,, 4	143	114	+ 29	721	603
Dublin U. T., electric cars	,, 2	4,117	3,923	+ 194	—	—
Dublin S. District, Electric	,, 2	1,216	1,015	+ 201	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 3	12,344	9,070	+ 3,274	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S	,, 3	1,855	1,312	+ 547	8,835	6,719
Liverpool Corporation	—	—	—	—	—	*b*
Liverpool Overhead Railway	,, 4	1,749	1,635	+ 114	8,655	8,499
Oldham-Ashton-Hyde Tramways	,, 8	513	506	+ 7	15,097	14,692*b*
Portsmouth Corporation	,, 3	1,112	—	—	—	—
Potteries Tramways	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 4	3,909	—	—	—	—
Southampton Corporation	,, 1	952	713	+ 239	—	—
Southport Corporation	—	—	—	—	— *d*	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. *b* From Jan. 1. *d* From April 1 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £637 decrease.
Barcelona Ensanche y Gracia, £55 decrease. Barcelona, £260 decrease.
Brisbane (month of July), £854 increase.
Buenos Ayres and Belgrano Electric, £358 increase (month of July), £2,141 increase.
Calcutta, £155 increase.
Cape Town (month of July), receipts, £13,440; expenditure, £6,832.
Mexico Electric (month of June), receipts, £13,465.
Perth Electric, £1,250 increase.
Port Elizabeth (month of June), receipts, £2,983; expenditure, £1,800.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅞-1
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅞-1
—— Ordinary, 1-125,000	1 ..	⅞-1
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	10-11 xd
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	6-6½
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4½-5
British Electrical Engineering, Ordinary	2 ..	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	103-108
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	107-111
—— Ordinary	5 ..	14-15
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	3 ..	3¼-4
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	0-¼
—— 5 per cent. Debentures	5 ..	1½-2¼
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	85-90
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1½-2
—— 7 per cent. Cumulative Pref.	2 ..	2¼-2½
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	15½-16½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	109-113
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	101-104
Telegraph Construction and Maintenance	12 ..	37-41
—— 5 per cent. Bonds	100 ..	101-104
Telegraph Manufacturing, Ordinary	5 ..	10¼-11½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	95-100
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	11-10
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	7⅞-8¼
—— 7 per cent. Preference	5 ..	8¼-8⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7½-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅝
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105
Chelsea Electricity Supply	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	107-110
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	12-13 xd
—— 5 per cent. Debenture Stock	100 ..	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	99-101
County of London and Brush Provincial, Ordinary	10 ..	8¼-9⅛
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	103-106
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5⅞-6¼
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	103-106
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5⅝
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7⅛-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12 xd
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104 xd
Kensington and Knightsbridge and Notting Hill	100 ..	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅞-10¼
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13-14
—— ,, 85,001-98,769	5 ..	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	108-111
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	94-97
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7¼-7⅜
—— £4½ Shares, New	4½ ..	6¼-6⅜
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5¼-6⅛
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	65-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90 xd
South London, Ordinary	5 ..	2¼-3⅛
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15¼ xd
—— 7 per cent. Pref.	5 ..	8¼-9½ xd
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11½-12
Electric Railways.—		
Central London, Ordinary	100 ..	99-102
—— 4 per cent. Pref.	100 ..	102-105
—— ,, deferred	100 ..	98-101
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	52-54 xd
—— Ordinary	10 ..	5¼-5⅝
—— 4 per cent. Debenture Stock	100 ..	112-117
—— 5 per cent. Pref. Stock '91	100 ..	129-134 xd
—— ,, ,, '96	100 ..	123-127 xd
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	90-93
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-129
Blackpool and Fleetwood Tramroad	10 ..	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-4⅜
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	101-103
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¼-7
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¾-14¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅜-1⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	102-105
—— Prov. Cert., all paid	100 ..	96-99
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅝-1¾
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5¼-5⅜
—— 4 per cent. 1st Mortgage Debentures	100 ..	103-106
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11½-12¼ xd
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	98-102
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	105-107
New General Traction, Ordinary	5 ..	3-3¼
—— 6 per cent. Cum. Pref.	10 ..	4½-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	12-13
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	105-108
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	6s. ..	5/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	30 p.c. ..	30 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	3½-3¾
—— 6 per cent. Cum. First Pref.	10 ..	11-13
—— 6 per cent. Cum. Second Pref.	10 ..	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅛-4⅜
—— 4 per cent. Deb. Stock, Red.	100 ..	89-92
—— 3½ per cent. Deb. Stock, Red.	100 ..	94-97
Oriental Telephone and Electric Company	1 ..	⅜-1

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NOTES.

Electrical Draughtsmen. We note that electrical draughtsmen are being engaged by the United States Government for the naval offices. On the 7th inst. applicants for this position were put under examination both at the Brooklyn and Boston navy yards. The pay is between 16dol. and 17dol. a day.

Boston Elevated Railway.—From our American contemporaries we learn that the working of the Boston Elevated Railway on the Sprague multiple-unit system has turned out a success, notwithstanding that the conditions existing there are regarded as most exacting and extremely severe upon the electrical equipment. For more than a month now the motors have been in operation with gratifying results, and the service itself has proved so popular that the company intends very shortly to put another 50 cars on the road.

Restricted Use of Platinum.—A curious Bill, which aims at a restriction on the use of platinum, is exciting considerable interest among electricians and photographers in Germany. Platinum is an essential in much electrical work, and is also at present largely used by photographers. As is well known, the supply of this metal is extremely limited, and the proposed law provides that, since platinum is essential to electrical work, its use in photography, where it is not essential, should be forbidden, so as not to diminish what is at best the scanty supply available for the work that cannot be done without it.

New Canadian Telegraph.—We note that a telegraph line is being built by the Canadian Government, and is now nearing completion, from Portland Canal, which separates British Columbia from Alaska, to Hazelton, 180 miles distant, where it joins the line from Dawson to Ashcroft. With the completion of a small gap in the latter line, a system of 1,843 miles will be in operation. The revenue from that part of the system completed up to Dec. 31, 1900, amounted to about £21,542, and the total number of messages which had been sent was 41,816. The cost of the entire line will be close upon £92,000.

Free Rides for Sick Children.—The consideration shown by some of the American street railway companies for the poorer members of the community is instanced by a concession which has just been made by the St. Louis Transit Company. The company have given notice that during the period of excessive heat children 10 years of age or under, and one member of the family whose parents are unable to pay for transportation, will be permitted to ride free on the cars to the principal parks and recreation grounds in the vicinity on presentation to the conductor of a doctor's certificate certifying that in his judgment these would be benefited by an outing. The announcement, we note, has had a favourable reception.

Franklin Institute.—The *Journal* of the Franklin Institute for August contains several papers of interest in the physical, mechanical and engineering, and chemical sections. Among these are: "A System of Corrections for the Heat Losses in Calorimetric Experiments," by Prof. Jos. W. Richards; "Some Abridgments in Chemical Calculations," by Prof. Jos. W. Richards; "Estimation of Hydrate in the Presence of Alkali Carbonate," by Mr. W. E. Ridensur; and "Moissan's Researches in Fluorine and the Fluorine Compounds," by Dr. H. F. Keller. Several notes and comments appear at the end of the number, including "A New Phonograph," "The Andrew Carnegie Research Scholarship," and "Metallurgy of Aluminium."

Proposed Technolexicon.—We are asked to state that the Verein Deutscher Ingenieure has definitely decided upon the publication of a trilingual technical dictionary, and that the co-operation is invited of technical societies, authorities, establishments, etc., who would be asked to recommend the services of experts and others as collaborators. It is thought that the urgent want of such a dictionary will encourage societies and other bodies to give this assistance gratuitously. The technolexicon will include three languages—German, English, and French—and it is to be noted that the contributions of collaborators will be accepted even if translations are not given. Dr. Hubert Jansen has been appointed editor of the technolexicon, which will appear in three volumes, each volume containing the three languages mentioned.

London's New Telephones.—An important question was put in the House of Commons a few days back by Mr. Henniker Heaton as to whether an arrangement had been come to with regard to free intercommunication between the subscribers to the National Telephone Company's system in London and the subscribers to the State telephones when in operation. In reply, Mr. Austen Chamberlain stated that negotiations are in progress between the Post Office and the National Telephone Company with a view to secure the greatest possible facilities for telephone users in the London district, and in particular free intercommunication between all subscribers on either system within that area. These negotiations are not yet completed, therefore it was not possible to make any further statement upon them at present.

French Purchase of Cables.—At question time in the House of Commons on Tuesday, Sir Chas. Dilke asked the Colonial Secretary whether, in consequence of the recent purchase by the French Government of telegraph cables on the West Coast of Africa, the property of the West Africa Telegraph Company, the lines previously worked by that company would be so deviated as to avoid Bathurst and Accra, with which British possessions these lines were at present in connection. Mr. Chamberlain stated, in reply, that the purchase by the French Government of the cables referred to had not yet been completed; but it had been arranged that the cables which were to be transferred to the French Government would be deviated so as not to touch at Bathurst and Accra. These places would continue to be telegraphically connected with this country by other lines which were in British hands.

Eastern and South African Telegraphs.—Sir Edward Sassoon in the House of Commons last Friday asked Sir Michael Hicks-Beach whether he would give the reasons which necessitated the conclusion of a fresh agreement with the Eastern and South African Telegraph Company for a prolonged period, based upon certain stipulations and subsidies, without waiting for the report of the Cable Committee appointed for the special purpose of examining and reporting upon these very terms and conditions; also, whether the omission of an expropriation clause on fair terms was intentional. Mr. Austen Chamberlain, who replied for the Chancellor of the Exchequer, said the completion of this arrangement had been delayed by protracted negotiations on points of detail, but its principle was accepted by his Majesty's Government and the Cape Government nearly a year before the Cable Committee was appointed.

A New French Power Station.—The development of water power in France was marked recently by the completion of a new central power station at Sant du Martier for the distribution of electrical energy. The River Ain, which at its source partakes of the nature of a torrent,

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supplies the motive force for the generation of electricity. With a minimum supply of 141 cubic feet the available force would not exceed 600 h.p., and in order to secure a reliable supply of 3,000 h.p. a canal has been constructed which reinforces the river in time of drought from the waters of the Chalain Lake, situated about 30 miles distant from the power-house. At present the power station contains four units, each direct-driven by a Piccard and Pictet turbine of 700 h.p. Three-phase 7,500-volt Oerlikon alternators are used. This station supplies light and motive power to the towns within a radius of 13 miles, and it is intended to instal another unit very soon.

New Wireless Telegraphic System.—A wireless telegraphic system which is said to overcome many difficulties in the Marconi method is the invention of three Chicago students of electricity—viz., Prof. Clarence E. Freeman, Dr. L. de Forrest, and Mr. E. H. Smith. According to our American contemporary, *Electricity*, the inventors declare that their system gains over the Marconi method at both sending and receiving stations. The sender, which is worked out from a theory evolved by Prof. Freeman, makes no use of the induction coil. In its place is a condenser, which, beside being less bulky than the sending cabinet with induction coil, liberates energy with greater speed. The receiver, which is the joint invention of Dr. de Forrest and Mr. Smith, aims at receiving signals from the sending station as fast as the operator can work the key. Heretofore 15 or 20 words a minute has been the best speed attainable by wireless telegraphy. Some facts as to what has actually been done would be of interest.

Red Lead as an Insulator.—We understand that the director of the Government telegraphs at Hanover has been recently carrying out some experiments on the use of red lead as an insulating medium. He has employed a vegetable fibre as the means of binding the red lead round the copper conductor, and mixes up the red lead with about one part of linseed oil to four or five parts of the compound. The insulating qualities of the mixture are then said to have about 100,000 megohms per cubic centimetre after drying in air. From what appears in the article before us, we gather that one advantage of a wire so insulated is its immunity from attack when in an atmosphere of chlorine. We can hardly think, however, that the insulation obtained would be of much service except where the wires are not exposed to vibration, as although the vegetable fibre may prevent the red lead from falling off the wire, it would be almost sure to crack if the wire were in a state of vibration, or subject to any mechanical shocks.

The Telegraph in the Philippines.—The development of the Philippine Islands by the United States Government is proceeding apace. The construction of telegraph lines in these possessions has become a very important feature, and at the present time there are hundreds of miles of wires in every part of the islands which have been occupied by American troops. There are nearly 1,000 telegraph offices in the archipelago, and every week new ones are being added. The Filipinos, who were at first hostile to the telegraph lines, have now become reconciled to the innovation, and the authorities are having less trouble on account of their depredations. While the lines have been constructed for the use of the military service, at the same time the native business establishments are beginning to use them, the Government making a fair charge for such use. Recently some of the mining concerns and plantation proprietors have combined to construct a line for their own private use. Prior to the fall of Manila, the Spaniards only used the telegraph in the immediate vicinity of the city.

Ventilation at the Glasgow Exhibition.—We have received from the James Keith and Blackman Company, Limited, some information to show that they are not to blame for the unsatisfactory condition of the atmosphere in the machinery hall at the Glasgow International Exhibition. From the information before us, it appears that even before the opening of the exhibition the firm offered to supply to the authorities free of charge any fans they might require for the ventilation of the machinery hall, but that the offer was refused on the ground that the machinery hall would not require to be ventilated. The reverse has proved to be the case, and in spite of a renewed offer of fans and motors free of cost, there has been a great delay in erecting the same. In fact, at the end of last month practically nothing had been done in the matter except the interchange of letters. It is only right in this instance to explain that the delay has not been due to the above-mentioned firm, who much prefer to exhibit their fans in actual work than to have them merely standing idle.

The Lighting of the Pan-American Exhibition. It would appear from an editorial in the *Electrical World* that the conditions of electric lighting at the Pan-American Exhibition are all that can be desired. At no preceding exhibition have steam-engines, steam-boilers, and smoke-stacks occupied so insignificant a position in comparison with the lighting effect as at Buffalo. The fact that power from the Falls of Niagara, transmitted electrically, is used for nearly all the electric lighting and most of the power distribution in the exhibition gives a special interest to the arrangements, and the consolidation of the lighting supply to three 11,000-volt mains, fed through a large triple-bladed switch, readily lends itself to the gradual increase in brightness at turning on the lamps that constitutes so attractive a feature. An interesting point is that the Nernst lamp is exhibited in the States for the first time as a working apparatus in useful service, being employed in lighting the interior of the electrical building. In short, the Niagara-Buffalo electric power transmission forms in itself at the exhibition a notable display of modern power capabilities in this direction.

The Pacific Cables.—The promise that the new Pacific cables will be laid by the end of next year seems likely to be fulfilled. We note that the "Anglia," the largest cable-laying steamer in the world, belonging to the Telegraph Construction and Maintenance Company, has left for Mauritius for the purpose of commencing the laying of the Eastern Telegraph Company's new cable from Mauritius to Rodriquez and Cocos. From this point the line will be taken to Fremantle, Western Australia, by the "Scotia," which sails to-morrow for Cocos. Another line, which will traverse the Pacific from Vancouver, in British Columbia, to Southport, near Brisbane, in Queensland, will also probably be in operation at the end of 1902. This line will couple up England and British North America with Australia, New Zealand, and the Fiji Islands, and when completed will contain the longest cable span in the world—viz., the distance of 3,600 miles, from Vancouver to Fanning Island. The greatest sounding between these two places is within 300 fathoms of the deepest cable yet laid, being as much as 3,207 fathoms.

Mechanical Draught.—Mr. Henry C. Meyer, jun., in a recent contribution to an American contemporary, states that draught produced by fans possesses many advantages over chimneys as ordinarily proportioned Flexibility is perhaps the greatest of these, it being possible to regulate the speed of the fan so that the proper rate of combustion for the amount of steam required is maintained entirely independent of the weather conditions. Another important advantage is the ability of the fans to create a

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much greater draught than is possible with a chimney. Steam-engines for driving fans are frequently fitted with valves arranged to govern the speed of the engine, according as the boiler pressure varies, increasing it as the pressure falls and reducing it as it rises above the normal. Mechanical draught enables economisers to be placed in the flue to heat the feed water, thus reducing the temperature of the escaping gases far below the temperature that is necessary in a chimney to create a draught. The reduction in draught due to the use of economisers is a much greater percentage of the available draught with a chimney than it is of the draught where fans are employed. Again, the greater draught of fans enables cheap low-grade fuels to be burned that could not easily be used with chimney draught, and the saving that these fuels bring about in some localities is a very considerable sum of money. Still another point in favour of mechanical draught lies in the portability of the fans in case of change of location.

Polyphase Arc Lamp.—There are many difficulties in the way of utilising polyphase currents for a universal distributing system for electric lighting; but, perhaps, the greatest of these lies in the fact that arc lamps do not operate satisfactorily at low frequencies, while, on the other hand, it is difficult to build rotary converters satisfactorily for the frequencies suitable for arc lighting. The *American Electrician* records a device which has been patented by Mr. E. W. Rice, jun., with a view to providing an arc lamp which will operate successfully at low frequencies, and thus eliminate the difficulty referred to above. The lamp in question is provided with a single upper carbon and two lower carbons, two arcs being formed between the upper and lower carbons. When supplied from a two-phase system, the upper carbon must be larger than the lower ones, because the current which it carries is equal to the vector sum of the two currents passing through the lower carbons. With such an arrangement there is no momentary interval of entire extinction, for the reason that when one current is passing through zero there is still the arc due to the other current. As the sum of the current through the upper carbon and the two currents through the lower carbons is a constant value, the total luminosity of the two arcs will be fairly constant, even at low frequencies. It is necessary, of course, that the distance between the two lower carbons be appreciably greater than the length of the arc in order to avoid the formation of a third arc horizontally between these two carbons.

A "Mechanical Accident."—A good deal has been said of late in our New York contemporaries concerning the danger to Brooklyn Bridge from overloading, and the fears which had been entertained for the structure were confirmed only recently by the breaking of a number of the suspension rods. The belief was firmly held in some quarters at first that this was due to electrolysis from the tramway current, but we are pleased to see that such is far from being the case. Mr. John Bernard Walker, a bridge expert, is reported to have stated that the "breaks were due to the rusting of the pins of the suspenders in the bearings which fastened them to the bottom chord of the truss. The consequence of this rusting was an enormous frictional resistance to the turning of the pins in the journals in harmony with the oscillations of the suspenders. The direct effect of this friction was to produce a heavy cross binding strain upon the suspenders, which was much aggravated by the fact that these strains were continually reversed, as the truss structure moved forward and backward in sympathy with temperamental changes and the movement of the live load. It was only a matter of time when crystallisation of the metal set in and the suspenders gave way." It is rightly judged that electrolysis played no part in the breaking of the rods in question, from the fact that their position precluded the possibility of there being present any moisture or salts. That this is the case is borne out by Mr. Edward R. Knowles, a well-known electrical expert, who gives it as his opinion that the accident was of a "purely mechanical nature."

Wireless Telegraphy at Sea.—Experiments continue to be made with wireless telegraphy on the Transatlantic liners. The "Lucania," which is fitted with Marconi's apparatus, on arrival at Liverpool from her latest trip across the Atlantic, reported some very successful trials which were made on her outward voyage with the system. Communication was maintained with the Holyhead station at a distance of 45 miles, and afterwards Rosslare station was picked up and messages exchanged. After leaving Queenstown, the "Lucania's" passengers were able to dispatch numerous telegrams through the Crookhaven station to their friends at home. On the return voyage, a saloon passenger was very anxious to know the contents of a cable from New York which he expected had been addressed to him at Liverpool. He wired to the Cunard Company, *vid* Crookhaven, to open the message and repeat it to him. This was done, and he received his answer through Rosslare. The Marconi system has just been installed on the Nantucket Lightship, so that the "Lucania" will be able to make use on her next voyage to New York of the first Marconi station on the United States coast.

Wanted: A Speed Indicator.—The Grosse Berliner Strassenbahn, the principal electric tramway company in Berlin, has announced its intention of awarding two prizes of £150 and £75 each for the best and second best speed indicator for electric cars. The conditions which the successful devices will have to fulfil are numerous. In the first place, the maximum speeds are to be indicated to the motorman as well as to any passenger by means of visible or audible signs. The maximum speeds which have to be indicated are 16 km., 20 km., and 25 km. per hour. Apparatus capable of indicating only two speeds—16 km. and 20 km. per hour—may, however, enter the competition but will be considered after those capable of indicating all three speeds. It is desirable, but not necessary, that the device should be applicable to ordinary two-axle motorcars, as well as four-axle motorcars. Further, the device must be so simple and durable that the jarring of the cars will have no detrimental effect on its operation. Other requirements are simple transmission of motion from the axle of the car to the shaft of the meter, low maintenance, and easy adjustment in case the wheel diameter is changed. The latter may be as large as 60mm. In case electric current is necessary for the operation of the device, the standard 500-volt circuit must be employed. As the speed indicators will be installed on about 1,500 cars, the cost of the device must be low. All competitive devices and necessary accessories must be submitted to the board of directors not later than Sept. 1 next, and must be sent to the Grosse Berliner Strassenbahn, Berlin, S.W., Friedrichstrasse, 218.

Electrolytic Injection.—Dr. F. W. Smith contributes to the current number of the *Lancet* an interesting article on the electrolytic transmission of sulphur from the Harrogate sulphur waters through the pores of the skin. He refers in this article to a previous communication in February last, in which he proved that nascent sulphur could be deposited on the skin of a patient in a bath of Harrogate sulphur water if a constant current of electricity were passed through it. He then dwelt on the good which could be done in cases of eczema, gout, rheumatism, etc., by this means, which effect a great improvement on the

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ordinary bathing. Since February he has made experiments to show that the nascent sulphur was actually taken through the patient's skin and into circulation. In order to prove that this was so, experiments were made with a piece of pig's skin tied round the mouth of an open-mouthed vessel, the bottom of which had been previously knocked out. A piece of blotting-paper was placed outside the skin external to the vessel, and the positive end of an anode was placed on the blotting-paper. The vessel was then filled from the bottom with Harrogate sulphur water and the negative anode was put into it. Three milliamperes from a 13-cell battery (constant current) were turned on for half an hour. The result was that nascent sulphur was deposited on the pig's skin, driven right through it, and on to the blotting-paper at the positive pole. Illustrations are given in the article to show the sulphur deposit. The doctor also refers to a large number of cases in which good has been derived from the treatment. We believe that this is not the first case in which endeavour has been made to inject medicines into the system by means of electrolytic action, but this is the most conclusive experiment of the success of such attempts we have seen

Electrolytic Determination of Mineral Water Variations.—The *Scientific American* describes a simple and rapid method method of determining the variations in composition of mineral waters by the variations in electric conductivity. Chemical analysis, it is pointed out, is long and costly, and therefore the method of electric conductivity is far more suitable for finding out the variations in composition of mineral waters in consequence of its simplicity and the ease with which such variations can be determined. The experiment is made promptly by the method of alternating currents and telephone (a greater or less sound indicating greater or less conductivity), but care should be taken to operate always at the same temperature, say 25deg. C. The conductivity of a water defines this liquid in the same way as a fusing point defines a chemical substance; it depends upon the nature and quantity of the substances dissolved, which in a potable water are almost exclusively composed of electrolytes. It is natural that two different waters which have the same conductibility may not have the same composition, any more than two bodies with an identical fusing point would be alike, but to follow the variations of a determined source the value method cannot be questioned. The inventor, Mr. M. P. Muller, after two experiments requiring half an hour, predicted the identity of two neighbouring springs, and a subsequent chemical analysis showed an almost complete identity, the only divergence being that for the silica and oxide of iron (present only in minute quantity), and it is known that these substances exist in the waters almost entirely in the colloidal state and non-conduction. In another case he showed considerable variations in the composition of a mineral spring of which an analysis was about to be commenced, and made it evident that such an analysis would have no value.

The All-British Cable.—Despite the fact that the Pacific Cable Bill met with considerable opposition in the House of Commons on Monday night, the motion for second reading was eventually carried by a large majority. This will be understood when it is stated that practically the whole of the opposition came from the Irish Nationalists, whose only plea against the scheme was that it committed this country to considerable financial responsibilities without a reasonable prospect of return. On the other hand, Mr. Henniker Heaton, who has done so much for securing cheap postal and telegraphic communication throughout the British Empire, supported the Bill. He asserted that the present telegraphic rates to Australia were enormous, and he did not know any monopoly which was doing more harm to British trade than the Eastern Telegraph Company and its satellites. It was sound commercial and political policy that the cables of the British Empire should be in the hands of the Government. He knew that the British and Canadian Governments contemplated having a cable of their own between this country and Canada, and he looked forward to the time when they would have 1d. telegrams to America, 6d. telegrams to Australia, and 1s. telegrams to India by means of the all-British route. Mr. Austen Chamberlain practically repeated a speech he made on the introduction of the measure, pointing out that the demand for an all-British cable came from the Colonies themselves who complained of the high rates they had to pay. Further, the project had already had a wholesome effect on the Eastern Telegraph Company, who had now made concessions which they had hitherto professed inability to make. And last, but not least, Mr. Chamberlain added, "I hope it will also be a lasting monument of friendliness and co-operation between the Mother Country and her Colonies." The debate which ensued was suddenly stopped by the application of the "closure," when the second reading of the Bill was agreed to by 183 to 59.

An Arc Lamp Nuisance.—Mr. Temple Cooke, through the correspondence columns of the *Times*, asks for aid in an endeavour to induce the authorities to mitigate what he describes as an avoidable nuisance—viz., the strong and unnecessary light which is thrown by the electric arc lamps upon the upper parts of many residential houses. While not denying that the arc lamps are a great improvement upon anything hitherto used for the purpose of street-lighting, he states that from the height at which they have to be fixed in order to diffuse the light upon the street, they in many instances come unpleasantly near to the upper windows and make bedrooms (unless closed by shutters and dark blinds, which do away with the benefit of having the windows open) as light as day. Many people, he asserts, cannot sleep in a light room, and where the light is placed as it is on the pavement immediately in front of and only a few feet from the houses, sleep becomes almost impossible in the upper rooms. Mr. Cooke proposes a simple remedy for this, one which he thinks would cost very little, and that is to paint so much of the upper part of the lamp, or to put a small disc, so as to screen the upper part of the houses where desired. This would not in any way reduce the light in the street below, but, if anything, increase it, while leaving the upper parts of the houses in the same condition of shade as those not exactly in front of the lamps. Mr. Cooke has appealed to the city of Westminster authorities to adopt this plan, and, though admitting that they "can quite understand the annoyance caused at times by these lamps on first erection," they do not suggest any necessity or any use in it, and the only answer they give is that they are "unable to accede to the request, being of opinion that it would be undesirable to create a precedent of this description." This he regards as a "feeble excuse," and concludes: "If the thing is a nuisance (and this it is, as the authorities themselves admit, but is easily avoidable), so far from being undesirable, the sooner a precedent for its remedy is created the better."

Motor Trial Awards.—The official list of the judges' awards in the third trials of motor vehicles for heavy traffic, which took place in the Liverpool district in June last, has now been issued. They are as follows: Gold medals.—Class A (conditions: load, 1½ tons; maximum tare, two tons; minimum level platform area, 45 square feet; minimum width of driving tyres, 3in.; speed, eight

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miles per hour) to Messrs. Geo. F. Milnes and Co., Limited, Motor Department, London—official numbers, A 1, A 2. Class B (conditions: load, five tons; maximum tare, three tons; minimum level platform area, 75 square feet; minimum width of driving tyres, 5in.; speed, five miles per hour) to the Lancashire Steam Motor Company, Leyland, near Preston—official number, B 1. Class C (conditions: minimum load, five tons; no tare limit; minimum level platform area, 95 square feet; minimum width of driving tyres, 6in.; speed, five miles per hour) to the Thornycroft Steam Wagon Company, Limited, Chiswick and Basingstoke—official number, C 1. Class D (conditions: minimum load, four tons; no tare limit; level platform area not specified; minimum width of driving tyres, 4in.; speed, five miles per hour) to the Thornycroft Steam Wagon Company, Limited, and Messrs. T. Coulthard and Co., Limited, Preston—official numbers, D 1 and D 2 Silver medal to the Mann Patent Steam Cart and Wagon Company, Limited, Leeds—official numbers, D 3 and D 4 In making these awards the judges remark: "We have confidence in recommending the vehicles to which gold medals have been awarded for adoption where haulage of goods by mechanical means is contemplated. We also draw attention to vehicle No. B 1, the performance of which, in respect of load and consumption, was highly creditable, whilst the tare was below the present legal limit of three tons. In Class D the vehicles Nos. D 1 and D 2 had several points in which they were practically equal and some in which each excelled the other. We therefore had no alternative, where each had high merits, but to award two gold medals in this class."

The Proposed Electric Railway to Snowdon.—A correspondent of the *Times* discusses the proposal to carry an electric railway from Portmadoc to the foot of Snowdon on its south side, mainly from the point of view of the effect which such a line would have upon the surrounding country. The railway would run through the Pass of Aberglaslyn and the Vale of Gwynant to the top of Lake Gwynant. Passengers, as well as goods and minerals, would be carried, and the line would be worked by electrical power. Originally, says the writer, the promoters proposed to disfigure the Pass of Aberglaslyn with cuttings, viaducts, and spoil banks; but they have now undertaken to tunnel through the pass. A railway along the course of a mountain stream does not add to the charm of the scene, but the concessions made have disarmed opposition on this ground. "The serious feature of the project," the letter continues, "is that for the purpose of generating electrical power it is proposed to impound the waters of Llyn Llydaw and Llyn Teyrn, two mountain tarns high on the eastern slope of Snowdon. These lakes are the principal head waters of the River Glaslyn, into which they discharge down the ravine known as Cwm Dyli. At present they tumble down the rocky descent in falls and rapids. The railway company, if allowed by Parliament, will put them into pipes, through which they will flow in a decent orderly way to the generating station of the company; but mountain lakes and mountain streams are capricious, while a railway must work in dry weather as in wet. To maintain a constant and even supply of power it will probably be necessary to raise the level of Llyn Llydaw. The natural margin of the lake will disappear in favour of an artificial dam; the lake will become a reservoir." The correspondent then goes on to enlarge on the point that Parliament is asked to authorise by a definite enactment the abolition of a mountain stream and the disfigurement of mountain lakes on the side of the most famous mountain of England and Wales. "If such things are to be encouraged on Snowdon, he asks, "what, then, is to be the fate of the less famous hills and rivers of England?" We do not know, but it is certain that the progress of electric traction in this country is not going to be stopped on any such sentimental grounds. Besides, we cannot think that the grandeur of the mountain district would in any large degree be affected by the development of the waters in question for the generation of electricity.

American Review of Telephony Abroad.—The *Electrical World* for the 3rd inst. gives a most interesting review of the present state of the telephone in the different European countries of consequence. It is, in fact, an abstract of statements made by Mr. M. N. Bethell, general manager of the New York Telephone Company, who was requested by the United States Industrial Commission recently to furnish data as to the differences between the telephonic conditions in the United States and in Europe. In the course of his evidence Mr. Bethell dealt with the question in regard to Great Britain, France, Belgium, Switzerland, Austro-Hungary, Germany, Bavaria, Holland, Denmark, Sweden, Norway, and Stockholm. One conclusion to which he has come from his survey is that the poorest conditions obtain under Government and municipal ownership, that better conditions obtain under private ownership with Government control, and that the best conditions obtain under private ownership where there is the least Government and municipal interference. In not one of the cases where there is Government or municipal ownership has he found in combination adequate facilities, efficient service, reasonable rates, and a self-sustaining system. Of cities having a population of 200,000 or more, in America there are 20, in Europe 44. In the American group there were at the first of this year 21 telephones per 1,000 of population, in the European group 13—almost two to one in favour of the American group. Among cities of 1,000,000 or more, New York stands at the top with twice as many telephones *per capita* as any city in its class except Berlin, and it is far ahead of Berlin. Among cities from 500,000 to 1,000,000, Boston stands at the top with more than twice as many as any European city except Hamburg, and almost twice as many as Hamburg. At Berlin and Hamburg, Mr. Bethell pointed out, the growth has been accelerated by means that have stifled growth in other parts of Germany, or that have been a charge upon other than telephone revenues. Among cities from 200,000 to 500,000 Stockholm stands first, but in fair comparison San Francisco is unquestionably entitled to the honour. In the smaller European cities and towns the development becomes insignificant when compared to that in American cities and towns of equal rank. On the question of State ownership, Mr. Bethell quoted President Hadley, who has said: "There is one respect in which England and America are like one another, but sharply different from France, Germany, or other European countries. It is in the way in which people in general are disposed to regard governmental interference. The English and American maxim is that whatever can be done without Government should be thus done. The Continental principle is that whatever can be done by Government should be." In closing, Mr. Bethell stated his opinion that England seems to have forgotten the maxim temporarily, but that loss of trade and lack of progress will cause her to recall it in due time. Already there is a strong movement in that direction. Recognising this difference in the popular idea of liberty, and observing that the telephone development in the United States under private enterprise is far ahead of that in Europe under Government and municipal ownership, it is to be concluded that the best possible results will be obtained in this country by leaving the industry to private enterprise.

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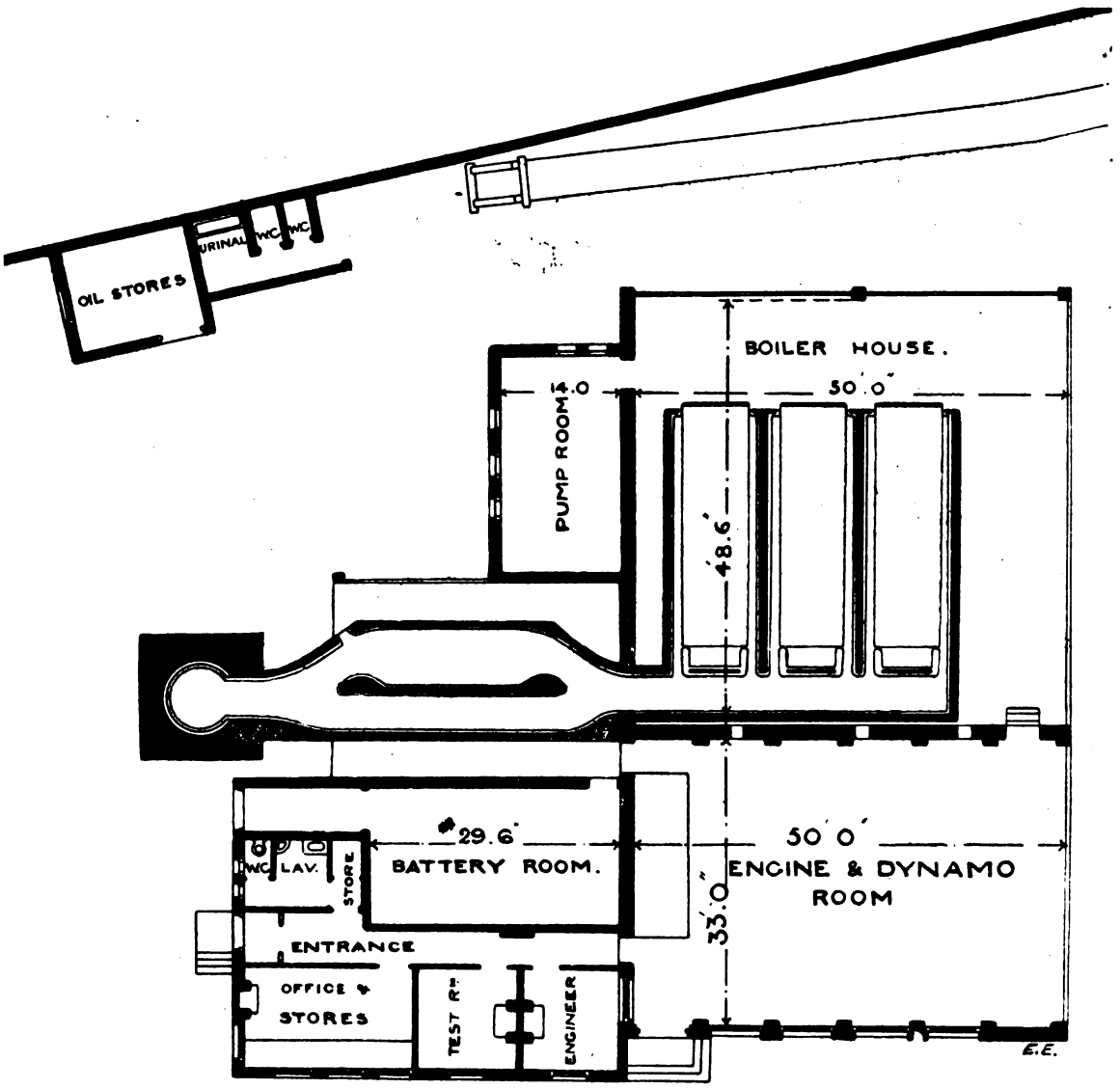
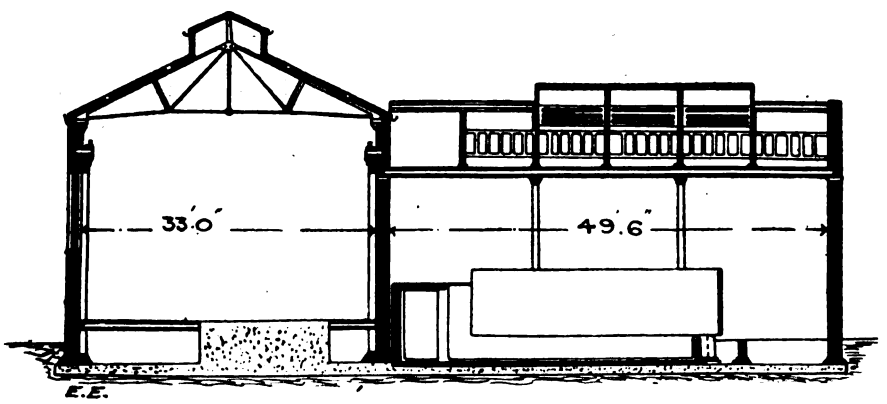
HOYLAKE AND WEST KIRBY ELECTRICITY WORKS.

In our last volume was announced the opening of these important works, and now, through the kindness of the consulting engineer, Mr. T. L. Miller, we are enabled to get details of the plant and equipment. The urban district of Hoylake and West Kirby is situated in Cheshire, close to the estuary of the River Dee. The district is a large one, being some 2,029 acres in extent, and the population, which is growing fast, has now passed 11,000. The ratable value of the property in the area is £70,000. It is wholly a residential district, and is much favoured by Liverpool merchants. As regards electric lighting, the first step in this direction was taken in 1897, when a provisional order was obtained. In January, 1899, Mr. Thos. L. Miller, M.I.C.E., was appointed consulting electrical engineer to the Urban District Council. In the following April Mr. Miller presented his report to the Urban District Council on the establishment of electricity supply works in the district. In July, after the report had been fully discussed, Mr. Miller was instructed to prepare full plans and specifications for the necessary plant and mains. Tenders were invited on these in October, and in November, 1899, the following contracts were placed with the respective firms mentioned:



PLAN.

FIG. 1.—Block Plan of Site and Buildings.



LONGITUDINAL SECTION.

FIG. 2.—Section of Buildings.

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for boilers, superheaters, and economiser, Messrs. Tetlow Bros., of Hollinwood, £2,510; for engine-house plant and piping, Messrs. Crompton and Co., London, £6,273; for switchboards and connections, Messrs. Cowans, Limited, Salford, £720; for accumulators, the Chloride Company, Limited, Clifton Junction, £680; for transformers, Messrs. Cowans, Limited, Salford, £908. 10s.; for the underground cables, Messrs. Callenders, of London, £9,568. 15s.—total, £20,660. 5s. It is of interest to compare this total with that in Mr. Miller's original report, which gives £21,489 as the sum to be expended. After an enquiry the Council obtained the sanction of the Local Government Board to borrow up to £27,000, leaving, as was thought at the time, ample margin for contingencies and extension. It has proved, however, that this sum was not enough, owing to the great demand for electric light, and now a further application for £12,000 has been granted, making a total of £39,000 for electric lighting.

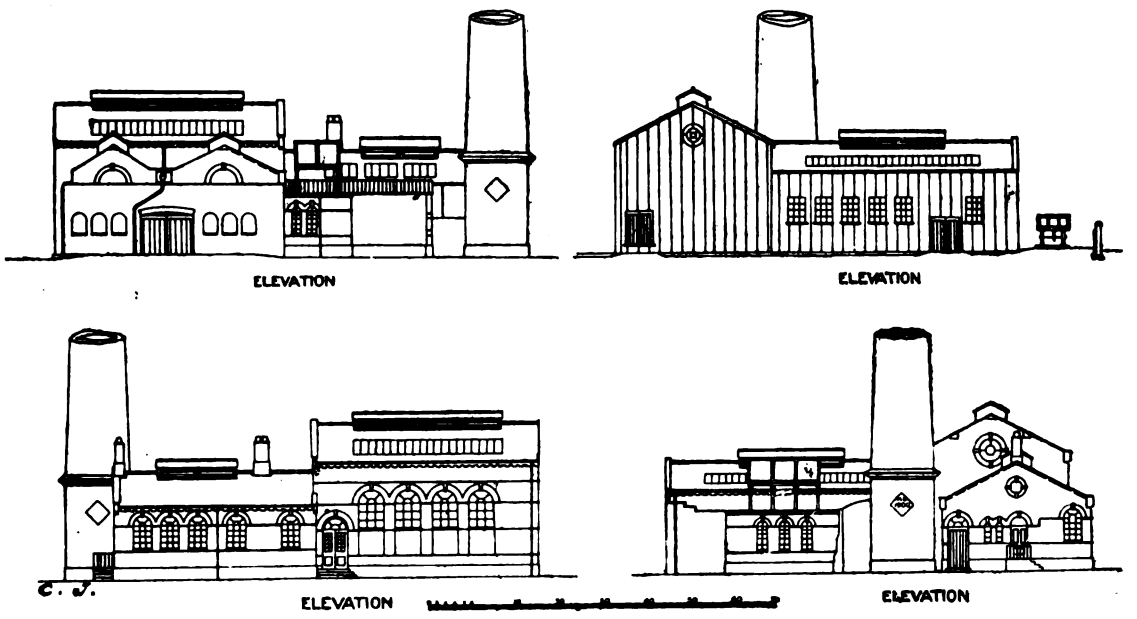

FIG. 3.—Elevations of Buildings.

The arrangement of the buildings, which are situated in Hoylake, are shown in the block plan (Fig. 1), while further details of the same are given in Figs. 2 and 3. These buildings were designed by Mr. Thomas Foster, the engineer and surveyor to the Urban District Council. The engine-house is 50ft. by 33ft., the boiler-house 50ft. by

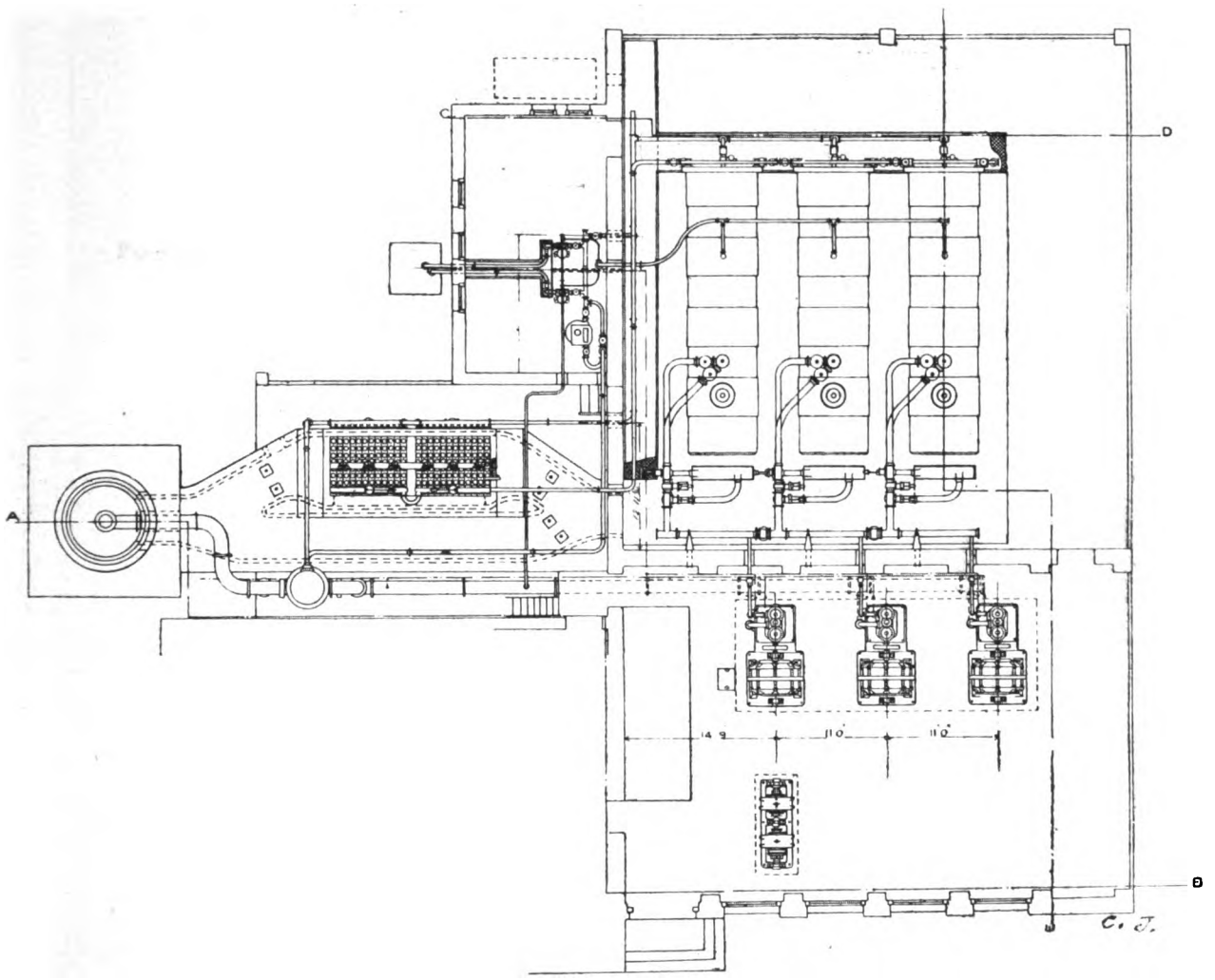

FIG. 5.—Plan of the Works.

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48ft., the battery-room 29ft. 6in. by 16ft., and the pump-room 25ft. by 14ft. The chimney (Fig. 4) has an internal diameter of 7ft., and a height of 125ft. The contractor for the buildings was Mr. Jas. Merritt, of Birkenhead.

FIG. 4.—View of the Hoylake and West Kirby Electricity Works.

The boiler-house plant consists of three Lancashire boilers, made by Messrs. Tetlow Bros. Each of them is 7ft. 6in. in diameter by 28ft. long, with two flues, each 3ft.

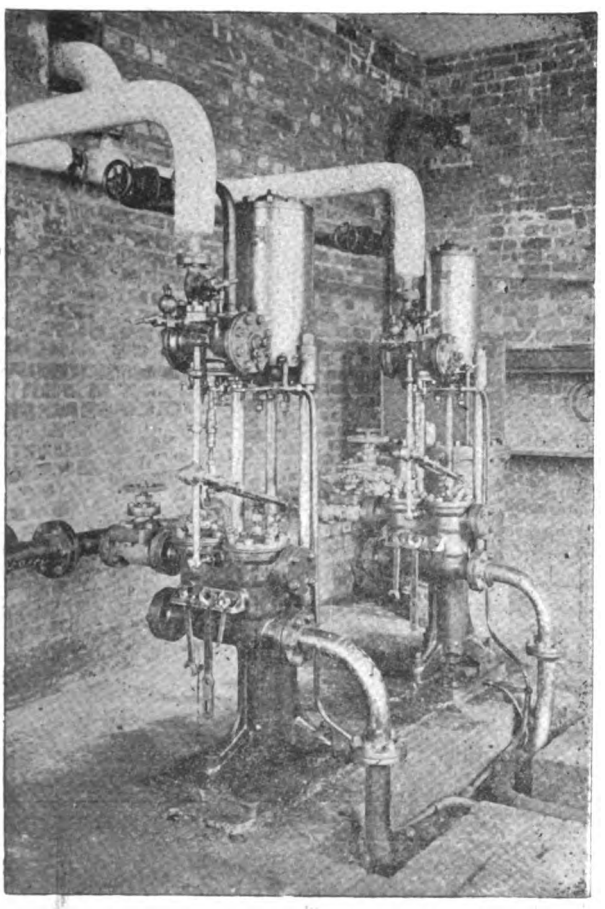

FIG. 6.—View of the Pump Room.

diameter at furnace end, tapering to 2ft. 6in. diameter at back end. The shell plates are $\frac{13}{16}$in. thick, end plates $\frac{15}{16}$in. thick. In the flues the first ring is of plates $\frac{5}{8}$in. thick, while the remainder are $\frac{1}{2}$in. thick. Hopkinson's mountings are used throughout. The working pressure of these boilers is 160lb. per square inch. The economisers are of Green's own make, consisting of 192 tubes, each 9ft. long and about 4in. diameter inside. The economiser gear is driven by an electric motor. The above boilers are also equipped with three Musgrave superheaters, each consisting of 33 U tubes. These are placed at the back of each boiler and arranged so that the amount of steam passed through them may be varied at will, so as to obtain any desired amount of superheat in the main steam pipe or at the engines. Details of by-pass arrangements are shown on the plans (Fig. 5). The pump-house adjoins the boiler-house, and contains two sets of Weir pumps (Figs. 6 and 7) equipped with a duplicate set of delivery pipes. The arrangement of the steam and exhaust pipes can also be seen on the ground plan mentioned above.

In the engine-room (Fig. 8) are placed three steam alternators of Belliss-Crompton make. The engines are

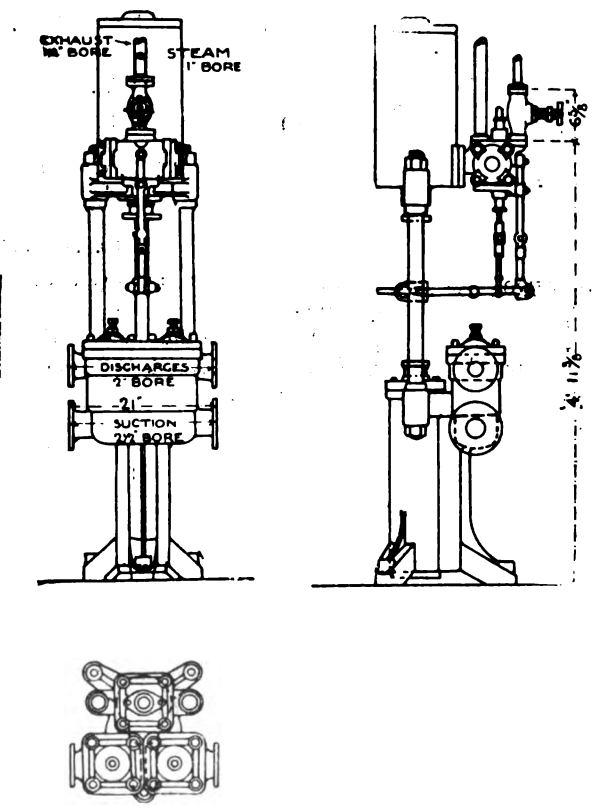

FIG. 7.—Elevations and Plan of the Weir Feed Pumps.

Belliss E.C. 5 size, and are capable of indicating 125 h.p. continuously when running at a speed of 500 revolutions per minute, with a steam pressure of 150lb. per square inch at the engine stop-valve. Each engine is coupled direct to a Crompton-Brunton alternator, capable of an output of 75 kw.—viz., 33 amperes at an E.M.F. of 2,300 volts, with a periodicity of 50 complete alternations per second. The exciting current for the magnets is taken from the batteries hereinafter mentioned.

The steam consumption tests of these steam alternators (Fig. 9) were carried out at the enginemakers' works, and the following are the figures obtained for one set running non-condensing: full load, 32lb. per kilowatt-hour; three-quarter load, 34·2lb.; half load, 39lb.; quarter load, 52·4lb.

The motor-alternator, also supplied by Messrs. Crompton and Co., consists of a direct-current motor directly connected to and standing on the same bed-plate as an alternator, and is of such size that the driven side can always give an output of 25 kw. Thus, if the alternator is driven, it must be capable of delivering from 11·5 amperes at 2,200 volts to 10·5 amperes at 2,400 volts, while if the direct-current side be driven the dynamo must be capable of giving from 110 amperes at 150 volts to 156 amperes at 156 volts. When the main alternators are running, the alternating-current side of the motor-alternator will be run as a motor, driving the direct-current side, which, acting as a generator, will deliver current for charging the batteries

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and for exciting the fields of the main alternators. In like manner, when the steam plant is shut down, the direct-current side will be run from the batteries as a motor, and the alternating-current side will be driven as a generator supplying current to the mains.

directly opposite to the panel of the alternator whose fields they control. The outer omnibus bar is carried at the station. The regulating switches for the batteries are placed in the battery-room, a spindle or spindles being brought through the wall and provided with handwheels

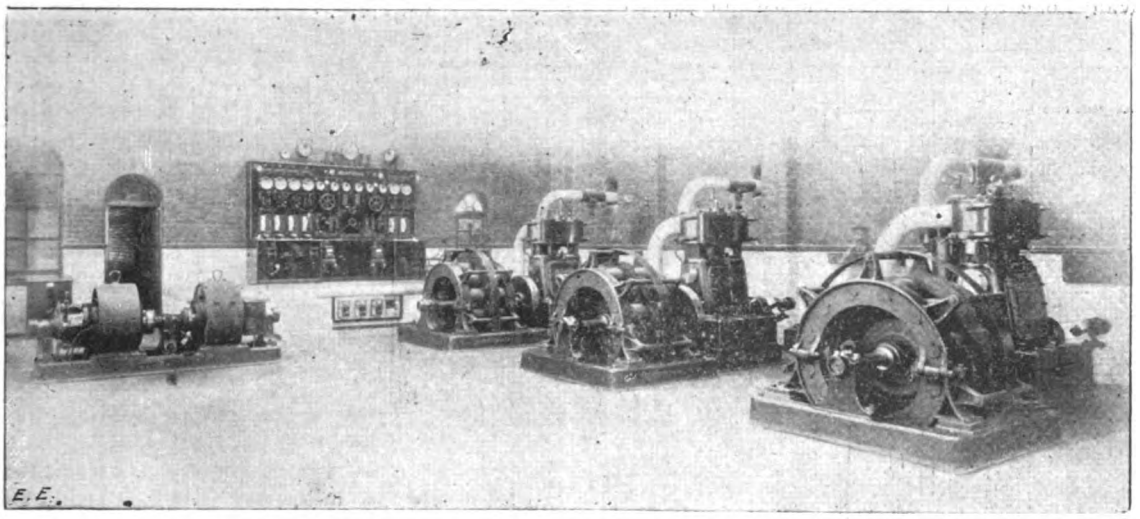

FIG. 8.—The Hoylake Engine Room, showing Generating Plant and Switchboard.

The switchboard consists of three distinct portions—viz., the alternator panels, the battery and low-tension side of the motor-alternator panels, and the feeder panels. The board (Figs. 10 and 11) is of Messrs. Cowan's design and make, and is arranged to as to make accidental contact with the high-tension gear almost impossible. For over-

on the switchboard, thus greatly simplifying and cheapening the cable connections.

The accumulators, as mentioned above, are of the Chloride Electrical Storage Company's make. Two batteries have been supplied, each containing 60 cells of a normal capacity of 500 ampere-hours, and capable

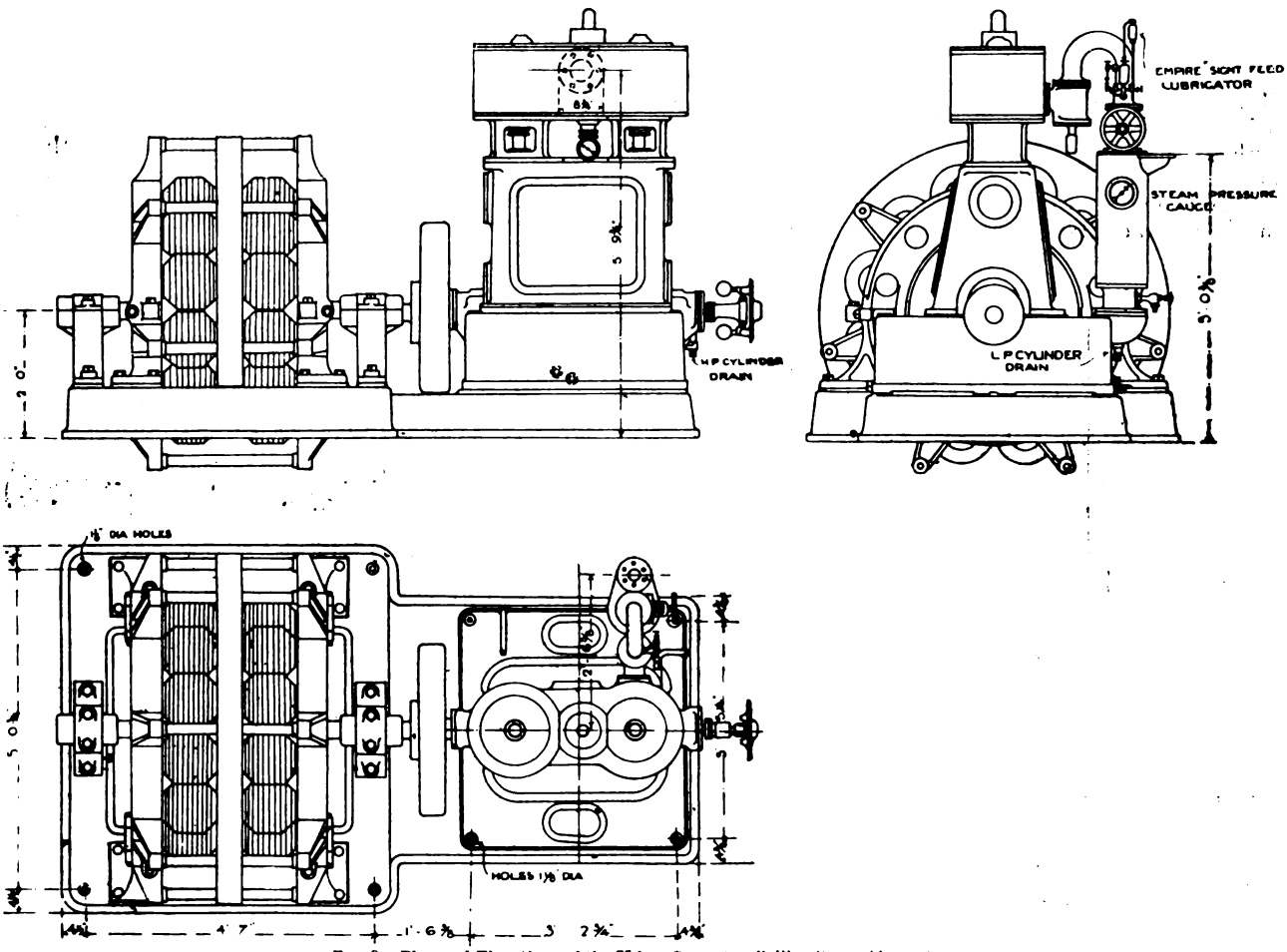

FIG. 9.—Plan and Elevations of the 75-kw. Crompton-Belliss Steam Alternators.

hauling connections at the back of the board the panel is swung forward on a hinge at the bottom of the board, thus breaking connection with the live terminals at the back, after which the panel can be lifted out and the required repairs carried out. The sketches of connections (Figs. 12 and 13) show the arrangement of the instruments. The field-regulating switches are placed in front of the switchboard

of giving 100 amperes for five hours, or 300 amperes for one hour. The E.M.F. at end of discharge, and taken when battery is discharging at normal rate, is guaranteed to be not less than 1·86 volts per cell, with a temperature of electrolyte of 55deg. F. The battery connections to the regulating switches are made of bare copper.

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The transformers used on the high-tension network are of Messrs. Cowan's make, of the following sizes: three 20 kw. capacity, three 15 kw. capacity, four 10 kw. capacity, four 5 kw. capacity; also one of 3 kw. capacity for station lighting. Two transformer sub-stations (Fig. 14) are provided, one at Hoylake, at the back of the District

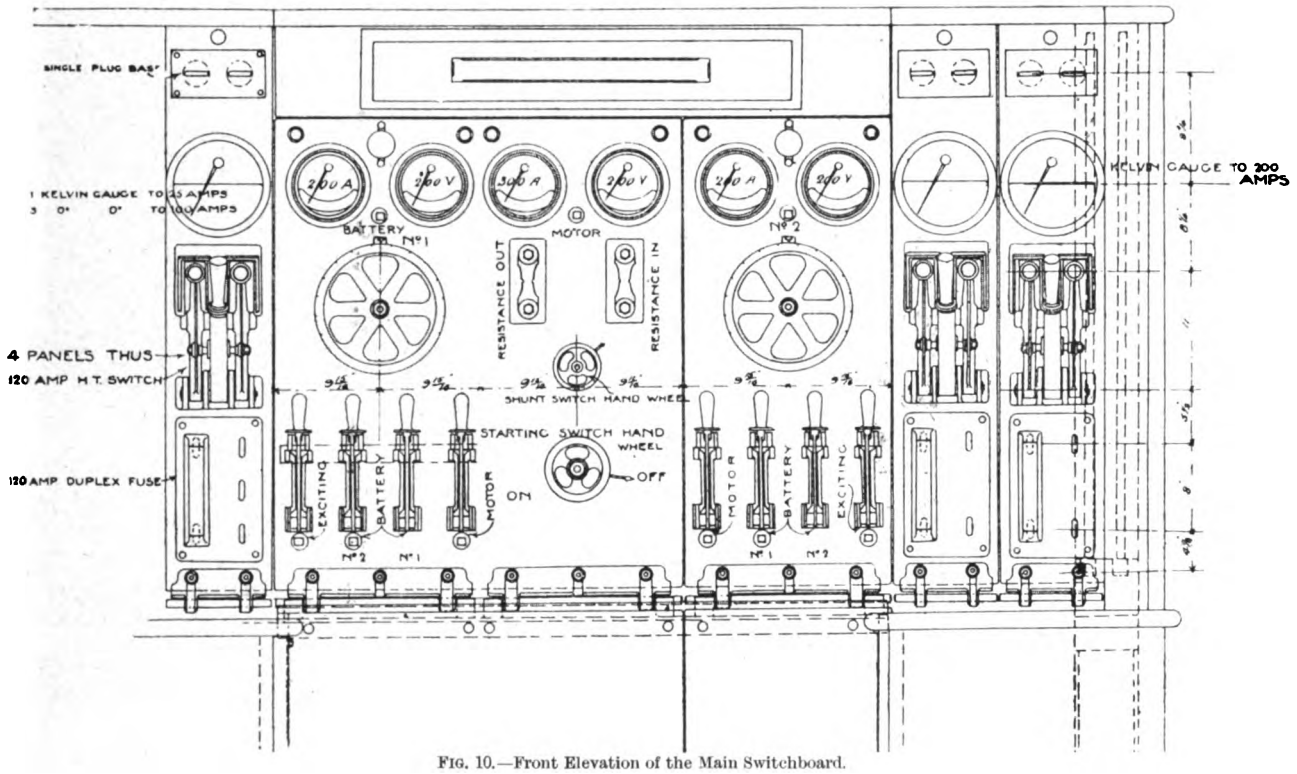

FIG. 10.—Front Elevation of the Main Switchboard.

Council offices, and the other at West Kirby, in Meols-drive. In all other cases, transformer pits under the foot-path are provided. Figs. 15 and 16 show the switch gear in these sub-stations.

The mains are lead-covered concentric of Callender's make, laid in earthenware troughs (supplied by the Stonite

between inner and outer, and ·11in. between outer and the lead sheathing; while for the low-tension conductors the radial thickness of insulation is ·085in. between inner and outer, and ·080in. between outer and the lead sheathing. The outer conductor of the high-tension cables, as has already been pointed out, is earthed at the station. All cables were subjected to the following pressure tests at the works: high-tension cables, 7,000 volts between inner and outer, and 2,500 volts between outer and earth; and the low-tension cables, 2,500 volts between inner and outer, and 1,500 volts between outer and earth. Two feeders are run from the electricity supply works, one, ·10 square inch

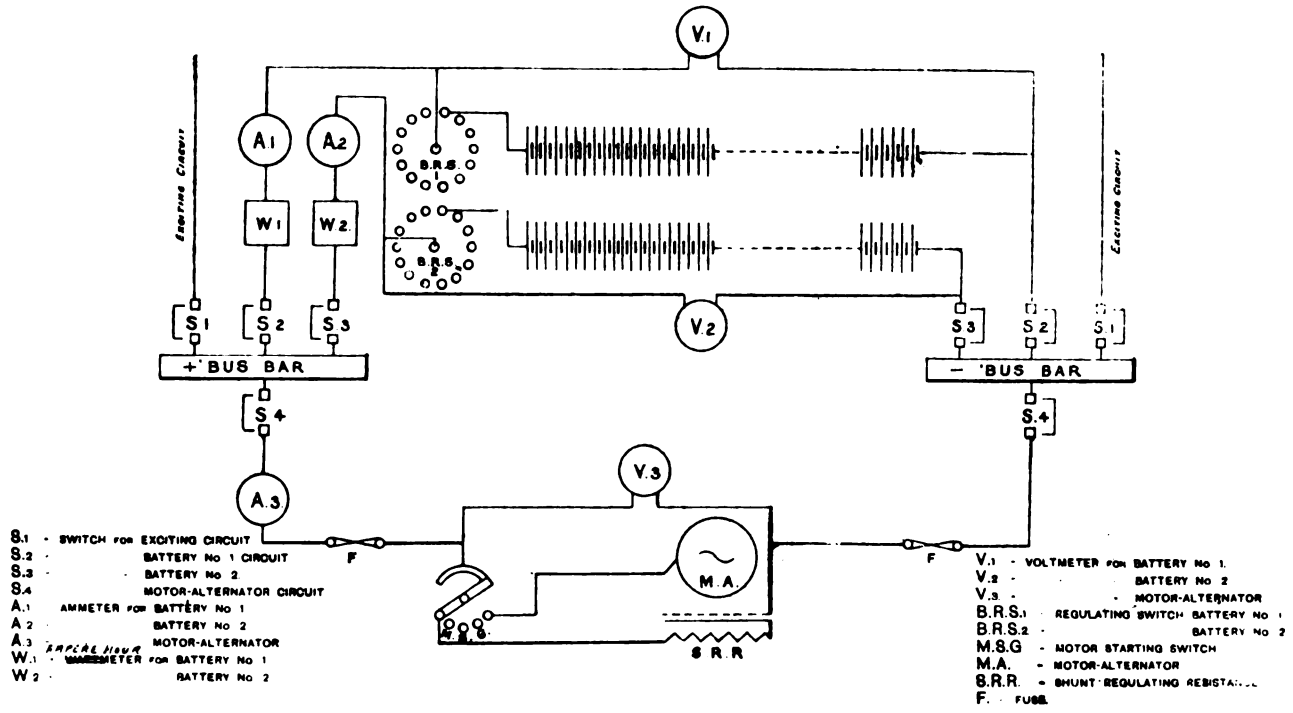

FIG. 12.—Diagram of Connections on Low-Tension Switchboard.

Company, having square flanges and interlocking joints), and run in solid with pure refined Trinidad bitumen. The insulation of the conductors consists of fine spun jute fibre put on in several layers, each layer being served in the inverse direction to the preceding one, and the whole thoroughly impregnated with fine bitumen. The radial thickness of insulation is: for the high-tension cables, ·20in.

section, to the transformer sub-station at the back of the District Council offices, Hoylake, and the other, ·15 square inch section, to the transformer sub-station in Meols-drive, and from these sub-stations a high-tension network is run throughout the district, as shown on the sketch plan (Fig. 14) of high-tension mains, which also shows the positions of transformers. The low-tension distributing

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mains are ·15, ·15 square inch and ·10, ·10 square inch section respectively, and up to the present a total of over 15 miles of high-tension and low-tension mains have been laid, while further extensions, as shown by the map of the district (Fig. 17), are being proceeded with.

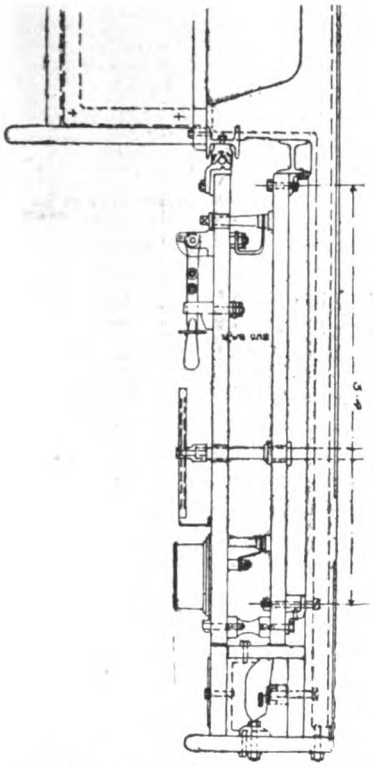

FIG. 11.—Section of the Main Switchboard.

ing through transformers in pits under the footpath into a low-tension network from which services are taken to condensers. The pressure in the high-tension mains is 2,300 volts at 50 ~. The consumers are supplied at 230 volts.

At the date of opening the applications for supply numbered 80, the total lamps demanded agregating 6,000 of 8 c.p. or their equivalent. Since then a further number of 1,550 lamps has been applied for, making 7,550 in all. To meet the next winter's demand the Council have placed an order with Messrs. Crompton and Co., Limited, for an additional 150-kw. steam alternator. The Urban District Council have decided to light the public lamps along the roads in which mains have been laid by electricity, and for that purpose they propose using prism globe fittings.

The resident engineer to the Urban District Council is Mr. Ernest Marples, who acted as clerk of works during construction, and Messrs. Rhodes and Blackburn act as his assistants. The Council, under the advice of Mr. T. L. Miller, their consulting engineer, are charging for electric energy on the Wright system, the price being 7d. per unit for the first hour's average use per day and 3d. for all over that quantity.

THE SUPERSESSION OF THE STEAM LOCOMOTIVE.

BY W. E. WARRILOW.

Since it has been the lot of man to invent machinery for the economy of his physical strength, he has been con-

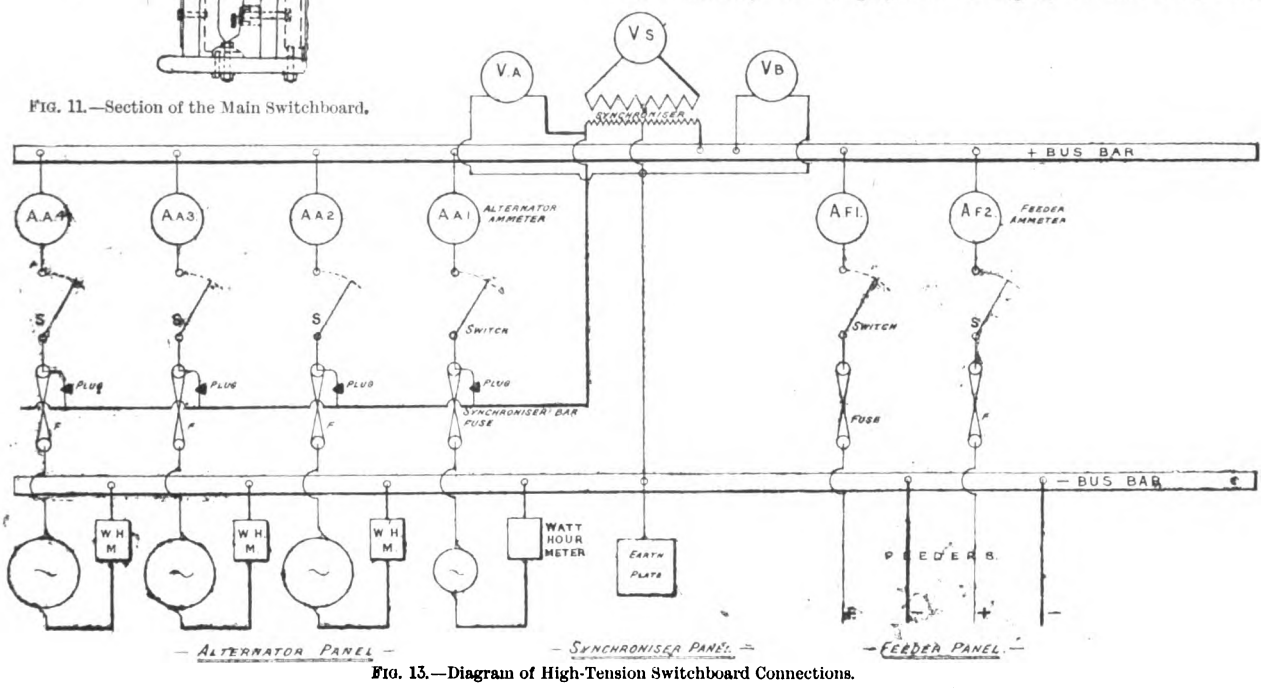

FIG. 13.—Diagram of High-Tension Switchboard Connections.

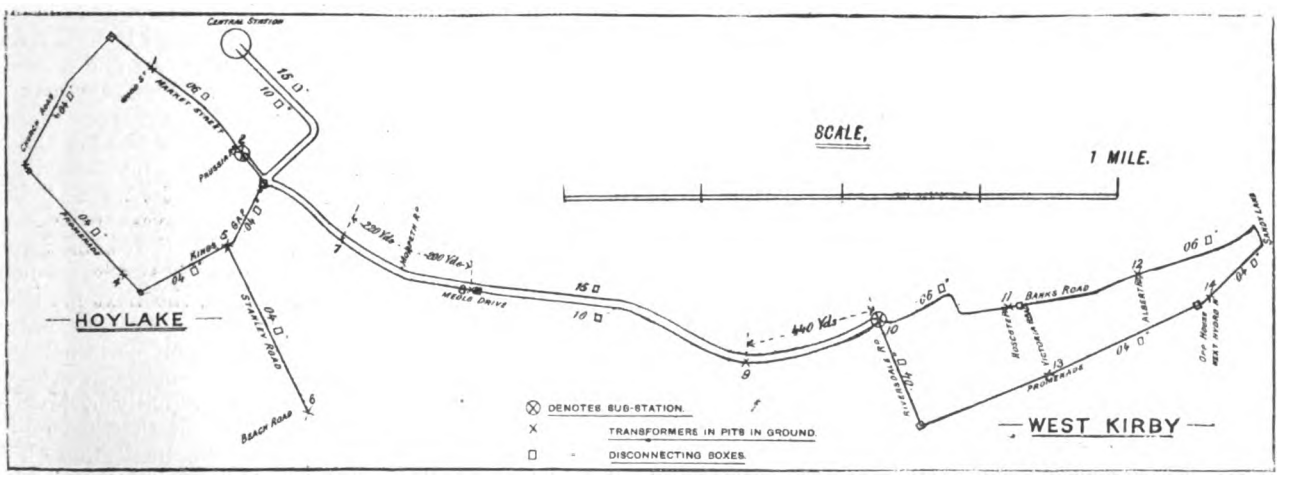

FIG. 14.—Map of the High-Tension Mains, showing Transformers and Sub-Stations.

As will be gathered from the above, the system of supply is high-tension alternating with high-tension network feed-

tinually striving after perfection in the design of such apparatus. The natural evolution of things points out that

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this struggle after the highest is the only true method which makes for perfection, and without which no real progress is made. The present attainments in engineering

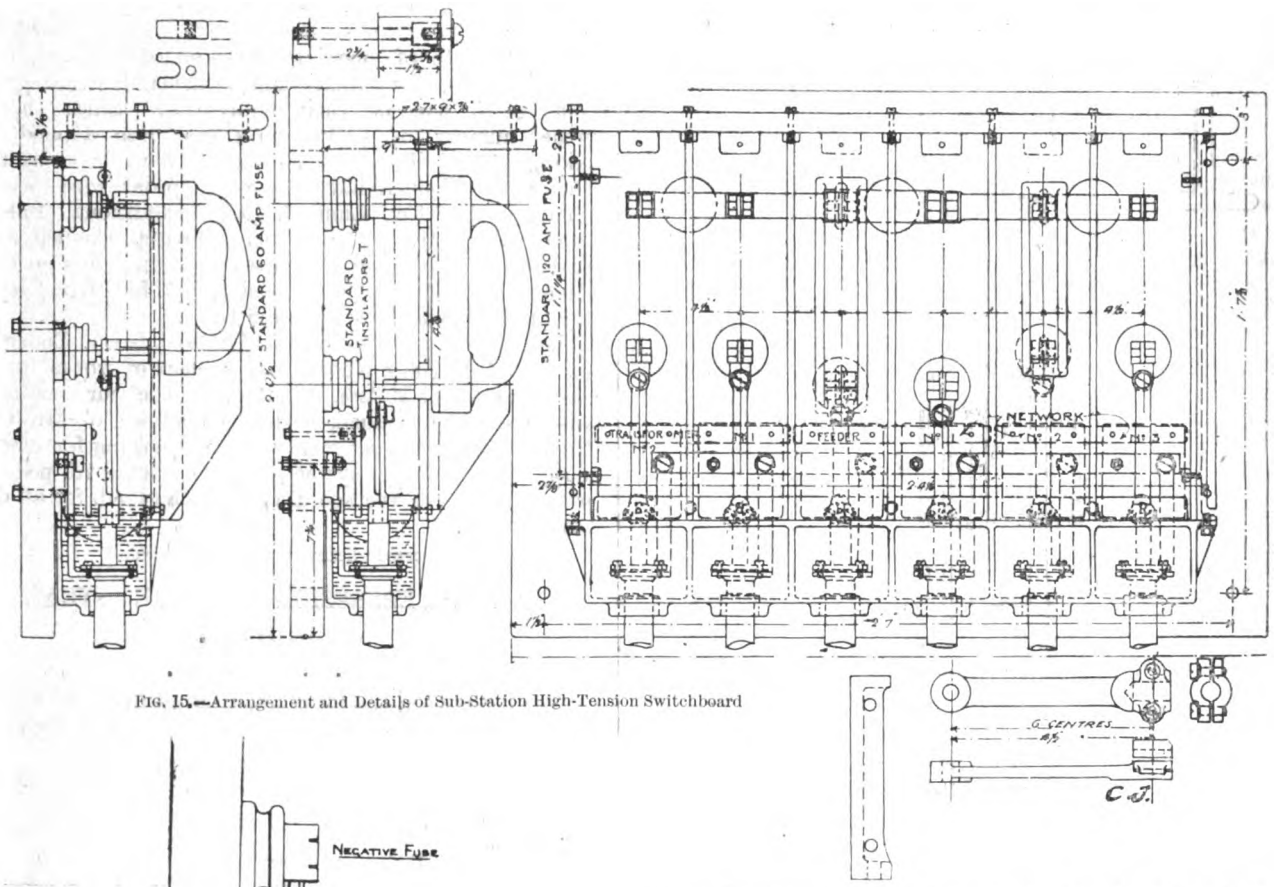

FIG. 15.—Arrangement and Details of Sub-Station High-Tension Switchboard

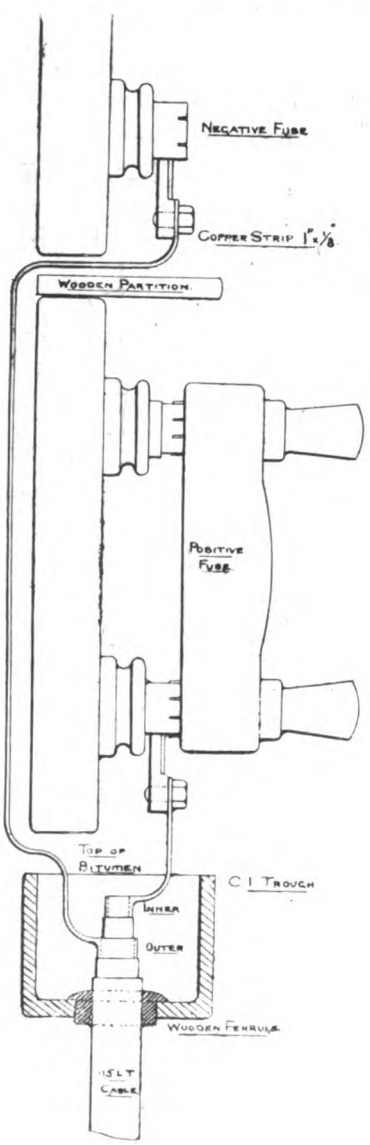

FIG. 16.—Details of the Low-Tension Fuseboard.

are the result of years of hard toil and drudgery, of designing and redesigning, of making and unmaking. At the same time, although success cannot be gained but by continuous improvements being effected, there is a limit beyond which a particular design of principle cannot be carried. A glance at the history of invention shows that a certain machine invented for a particular object has had to be frequently improved to meet the increased demands upon it, the improvements in question being sufficiently good to answer immediate requirements. However, a stage in the development has been reached when the original design must be discarded, to give place to a new principle, which, phœnix-like, rises out of the ashes of its predecessor. On inspecting the development of any invention, it will be found that the result will bear out the above statement.

In the case of small pieces of machinery, improvements involving the redesigning of the apparatus can be effected without serious disturbance, but in many instances it is evident that certain inventions have developed into enormous industries which may form the support of large numbers of people, and prove of importance in the prosperity of a nation. In considering the principle underlying these industries it becomes a serious matter when improvements can no longer be effected—when supersession by more advanced competition is inevitable. The capital at stake also is an item which calls for very great consideration. It is, of course, true that in no case does supersession occur at once, for were this so, disaster would be the fate of many an otherwise flourishing business. However, an all-wise Providence seems to ordain that when one door closes another shall open, though even in this case many are affected by the march of circumstances.

As far as supersession goes, in the new century the force to take the place of all other forces is undoubtedly electricity, and already the benefits due to its magic influence are becoming more widely felt. So vast have already become the fields of its application that the common wonder is what will be the next step forward. If the predictions of some engineers are to be accepted, the next industry to come under the sway of electricity is that of our railways, and at no distant date the steam locomotive will have given place to the electrically-driven train.

The matter has been well treated recently by Mr. Langdon in his paper, "The Supersession of the Steam by the Electric Locomotive," read before the Institution of Electrical Engineers. The paper dealt with the subject in a most comprehensive manner, no stone being left unturned to enter into all the possibilities of the case. The system

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proposed was outlined, estimates were given, and the results expected compared with those appertaining to steam railways, considerable economies being foretold. The paper met with much criticism, chiefly on technical or commercial lines, the general principle of the suggestion being taken for granted as feasible with certain modifications. To the uninitiated reader the figures quoted by the author would seem to offer every prospect of success, more especially as certain economies in working are pointed out. However, even assuming the accuracy of the statements in the paper, there is one question which must in duty bound be asked—*i.e.*, is the supersession of the steam by the electric locomotive feasible on the grounds proposed by Mr. Langdon (as representing the electrical industry)?

The answer to this question is to be found in an analysis of the proposed scheme and a comparison of it with the steam system. It is suggested that power-houses should be erected at stated intervals along the line, that currents at high pressures be generated at these power stations, supplying rotary converters in sub-stations from which currents at a lower voltage are distributed to the trains. Traffic on the sections of line would then be dependent on four sources of electric supply, or rather, one common source and three tributaries: the power-house, the feeder system, high and low pressure, the transformer system, and the collecting system. Mishap to any one of these would bring about the stoppage or delay of the train service. Now, the generation of electricity for large power purposes is not sufficiently well established to warrant absolute reliance being placed on any of the apparatus, especially when steam generators are used. In this country the abundance of coal and the absence of water power make it essential to employ steam, which can be relied upon in great measure, but not to the same extent as the hydro-electric plant. Consequently, when considering the reliability of an electric train service dependent upon steam, less confidence is to be placed in the system than if more simple power sources were to hand. Further, when it is seen that want of confidence is felt, not only at the power station, but in the high-pressure feeders and rotary converters, the reliability of the system in maintaining a constant train service could not be guaranteed. The principal feature to be noticed, of course, in the proposed scheme is the subdivision of the power source, rendered necessary by reason of the present impossibilities of generating large quantities of electricity in a small space. Were the currents for the propulsion of the trains able to be generated on the locomotive, a more self-contained, and therefore more reliable, service would be possible, but as it is, the power must be produced *outside* the trains, and conveyed by suitable means to them. The most casual observer will see at once that such a course, though rendered necessary by present circumstances, is fatal to reliability, in that it increases the complications of working, a state of things which should be reversed.

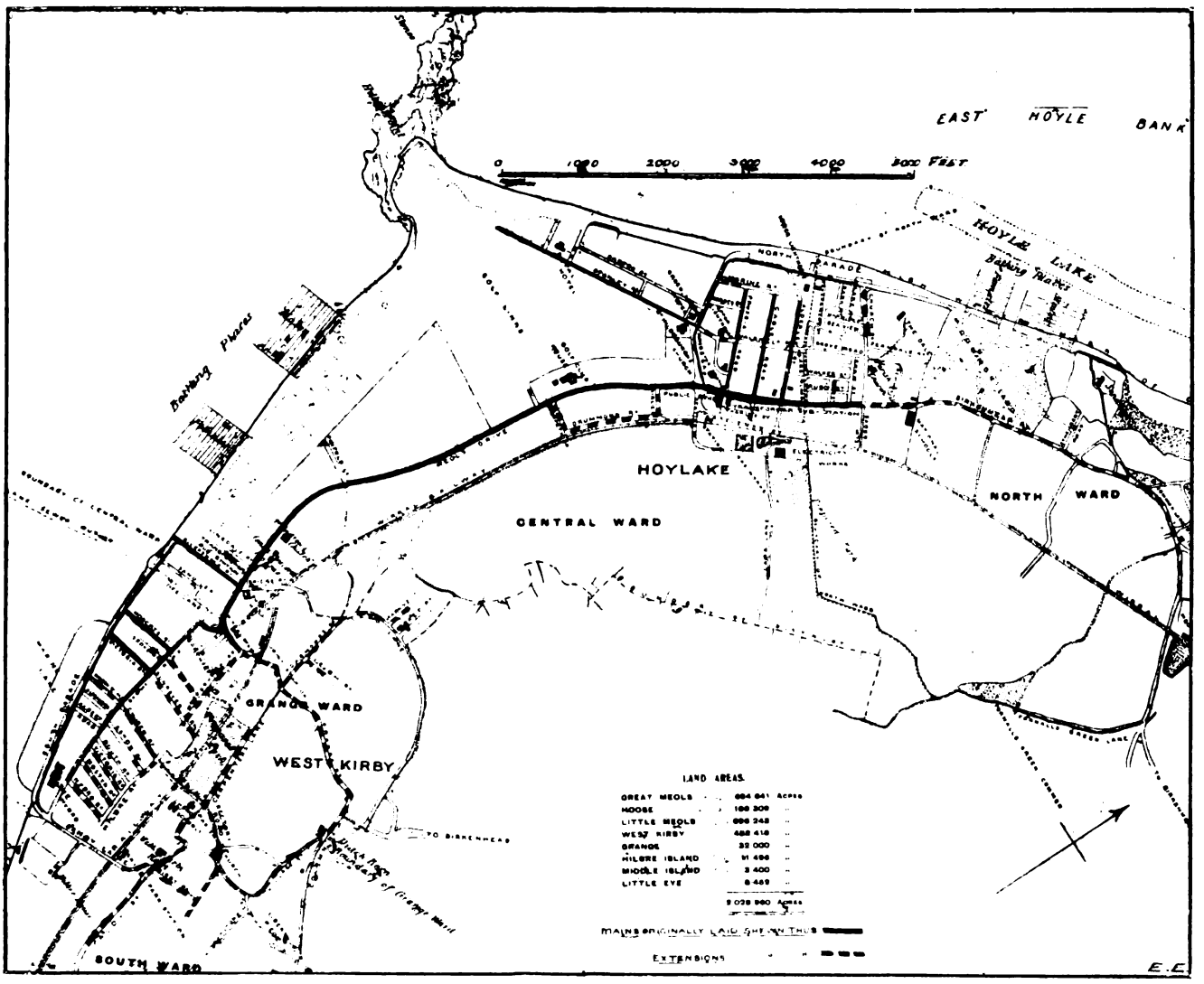

FIG. 17.—Map of the District Supplied, showing Low-Tension Mains.

In comparison with the electric railway, on grounds of simplicity in operation, the steam system appears in a much more favourable light. However, the statements possible in connection with the steam railway are based on many years' experience. Apart from coal and water stations, the steam locomotive is self-contained as far as power generation is concerned. The working parts are confined to an engine, and should breakdown occur to this engine, a similar power unit can be attached at short notice and with small delay, repairs to the damaged engine being effected while traffic still continues. Coal and water are taken up as required without difficulty, these commodities being readily stored along the line. This reduction of the working parts of the system must bring with it decrease in the working staff, the simplicity of operation being correspondingly

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increased. These economies of operation relate to the power generation of the system only, it being assumed that the staff on the permanent way, at stations, goods yards, etc., be the same practically for either the steam or electric railway. The general simplicity of the steam railway accounts in a large measure for its enormous success in application to passenger and goods traffic. After many years of hard work, the system has been developed to a degree that punctuality is assured (on main lines, at any rate), and a public confidence gained, which alone reflects well on the efforts of railway engineers. Further, the knowledge that the public appreciated their efforts urged these engineers on to further achievements, which have proved not only a credit to the skill and perseverance expended, but illustrate in a lasting manner the power of mind over refractory material in spite of all obstacles.

There are, however, other grounds on which the steam railway will hardly bear comparison with the electric, the most important being those of cleanliness. The steam locomotive brings dirt with its simplicity, as those who live close to the railway, and those who frequently pass through tunnels, know well. Closely allied to the dirt is the noise, an attribute of the railway with which the same section of the public above mentioned are acquainted. These undesirable features, combined with certain limits in the direction of economy and speed, detract much from the ultimate value of the steam locomotive. The cleanliness of the electric train is above question, and there can be no doubt that the economies possible are very considerable, but, unfortunately, they are only gained at the expense of reliability. The subdivision of the power sources into a number of complicated parts cannot but militate against simplicity of operation. The necessary increase to the staff, independent of those engaged on trains and permanent way, is no small matter. Experience has taught that elimination of the human element from all spheres of labour is conducive to economy, and that the reduction of working parts is in accordance with experience goes without saying.

Therefore, considered as a whole, the merits of the electric train scheme are not balanced by that simplicity which experience demands, so that it may not be looked to as suitable for displacing the steam train—*i.e.*, for permanently superseding it. At the same time, the steam railway is approaching that stage which is necessary in the development of all inventions; it must either take a radical turn for the better, or make up its mind to be replaced by a more worthy successor. That the latter is the only course may be reasonably assumed, but if the electric train may not fill the vacant place, what may be expected to? There is only one answer—the flying machine. That, and that alone, can truly succeed the steam locomotive. Some will say at once that they are quite aware of the fact, while others will ridicule the idea, and treat it with scorn. Those who can see sufficiently ahead to discern the inevitable must realise the fallacy of expending time and money on the conversion of the steam to the electric railway, and those who cannot see further than to ridicule the attempt at the solution of a great problem may ultimately perceive the inaccuracy of their point of view. At first sight no doubt the statement may seem far-fetched, but a little examination will show that there is real truth in it. Who will deny that as a method of transit the flying machine embodies all that could be desired? It represents the very acme of perfection in its simplicity of principle, its independence of power-houses, of rails, of tunnels, of bridges—in fact, of all earthly bonds. Its course is undefined, yet definite; its flight speedy, yet imperceptible, its field of operations unlimited. Its possibilities can be but faintly outlined, so vast can be the sphere of its operations. But away with sentiment; the aeronef has still to be produced, and ours is the task to produce it. The chief point to be here impressed is, that even should electrical engineers undertake the work of converting the steam to the electric railroad, they will not on its completion have established the ideal method of transit. Many will say that the flying machine is such a long time in putting in a practical appearance, little thinking that on account of ridicule one section of workers has had small encouragement, while the other body of enthusiasts has been hampered by lack of funds. It cannot be said with truth that the experiments have been unproductive of good results, as a glance at the history of aeronautics will show that all efforts have in a measure been aids to the final solution of the problem. Moreover, the task is no ordinary one, in that great risk is run in conducting experiments, but such a circumstance has been no obstacle in the eyes of those men who have laid down their lives for a good cause, and it need present less difficulties now than heretofore by reason of the additional experience gained.

But to return to the chief point of interest—the conversion of the steam railway to the electric. In the face of a possible solution of the problem of aerostation, it seems waste of money to convert the present railway at all. The expenditure contemplated would do much towards the bringing of the flying machine into our midst, especially when it is considered that the sum of money laid out on aeronautical experiments is but a fraction of that devoted to the preliminary trials of the steam locomotive. Such a circumstance would lead us to believe that were more time and money devoted to the problem, the solution would be effected at no distant date. The limit to speeds obtainable over rails and points by either steam or electric train can be said to be well in sight, so that the only practicable method of land transit with which we are acquainted (traffic over metals) must sooner or later be doomed. A recognition of this fact should arouse British engineers to a sense of their responsibilities, and make them look farther ahead than the next year or two. They have yet to realise that they are labouring as much for the future as the present generation, but the sooner they wake up to this fact the better for all concerned. In wishing to replace the steam by the electric locomotive they are no doubt working in accordance with progress, but it is a progress which cannot extend beyond a few years. Many will say that the pioneers of steam could not foresee the possibilities of electricity, and apply their statement to electric railway engineers of the present day. But the case is different. At the time of the production of the steam-engine the inventive faculty of man was not developed to the same extent as it is nowadays, so that it was hardly likely that any man should foresee the supersession of the locomotive. At the beginning of the twentieth century we are in a position to look back on the labours in the field of machinery, and judging by the progress made within even recent years we may safely foretell the possibilities of future development In the case before us, moreover, we are able much more clearly to see the track ahead. We are considering the supplanting of the steam locomotive, not by a new principle of transit, but by an electric locomotive which must be hampered in development by similar bonds to those which bind the steam system—namely, the rails and constructions inseparable from the permanent way, such as tunnels, bridges, viaducts, and the like. The same engineering difficulties will be presented in the extension of the electric railway as now obtain with the steam; the same expenditure in the maintenance of all these attributes of the system, combined with the maintenance of power-houses, transformers, cables, and the indispensable accessories to electric power distribution.

Considered from all points, we may reasonably assume that the wholesale expenditure of money on converting the present steam system to one operated by electricity is not in accordance with true progress; that the complications of the electric railway quite outbalance its advantages in the shape of economy and cleanliness. Further, that the science of aerostation deserves to be more widely recognised as the embodiment of the true principles of locomotion, and that when British engineers recognise to the full the attention it claims at their hands, they will open out a field of enterprise unparalleled in the history of invention.

Electric Heating for Acid Concentration.—We understand from a French contemporary that in the concentration of sulphuric acid a source of heat consisting of a platinum wire electrically heated has been used with good results. The wire was 0·2in. in diameter and 30in. long, and was brought to a temperature of 480deg. Fifty-five pounds of acid were concentrated in a day. To make 62lb. of 66deg. acid it requires just over 44 horse-power hours.

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THE VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO BERLIN.

[BY OUR OWN CORRESPONDENT.]

(Continued from page 17.)

Another station visited, but not specially referred to in the description of the Berlin Electricity Supply Company's principal plants, which appeared in a previous article under the above heading, was that situated in the outlying suburb of Berlin known as Moabit. This station merits at least a brief reference on account of its being the most modern of the company's stations. In it, as in the Oberspree works previously described, high-tension three-phase current is generated for transmission by means of triple-cored, lead-covered, armoured cables laid directly in the ground to various sub-stations in the city. The station is designed for an ultimate output of some 36,000 kw., the steam-driven sets at present installed having each a capacity of 3,000 kw. Both the three-phase inductor alternators and their driving engines are of uniform design, the former being of the revolving field type and the latter of the horizontal triple-expansion slow-speed type, having four cylinders placed two in tandem, and driving two cranks with the generator placed between. Except in certain minor details of construction, these sets are similar in design to those of like capacity installed at Oberspree, and run at the same speed—namely, 83 revolutions per minute—at which speed each engine is capable of developing 4,000 b.h.p. The steady running of these engines on load coupled with the remarkable absence of vibration was much commented upon, as was also the total absence from view of steam-piping and the very generous proportions of the station, space sufficient to accommodate many sets of lancers, if necessary, being left round about the generating set. The ground space occupied per kilowatt of plant installed would in any case be relatively large, owing to the type of engine employed, but in Germany it would seem that the necessity of economising space does not exist, since allowance is made over and above what is absolutely required to efficiently accommodate cumbrous sets. However, on the score of steady and reliable running, inductor alternators driven by slow-speed horizontal engines have undeniable advantages, and, judging from the strong tendency in their favour evidenced by modern practice in Germany, it may be assumed that in the mind of the German engineer these advantages far outweigh any other consideration, so far, at any rate, as very large sets are concerned. Returning to the question of station buildings, it is open to serious doubt whether the German engineer is not altogether too lavish in his expenditure, since whatever the artistic effect obtained may be, it is surely not practical to allot more space to any one department of a central station than would fully suffice for its efficient working. In practice it is, of course, better to have too much space than too little, but the line should always be drawn at undue extravagance in this direction, and when such is in evidence it must not be mistaken in the impression of the moment for good engineering. One of the chief factors governing the amount of spare room required is the size of the unit to be installed, since the amount varies directly as the size of the parts, which may have to be removed and temporarily deposited near by without causing obstruction. But even allowing for the relatively huge size of the plant installed, it seemed to me from casual observation in some of the stations visited that the German engineer errs rather on the side of extravagance than economy in designing his buildings, though exception may possibly be taken to this ruling on sentimental grounds. Certainly the most recent English stations bear but very poor comparison with those seen in Berlin so far as general nobleness of proportion is concerned, but for practical merit on general lines home designs are to be preferred. Some principles common to German practice, such as the disposal of all steam-piping in galleries below the engine-room floor level, might with advantage be adopted in this country. When so placed, the pipes are quite as accessible as when placed above the floor level, while shorter branches to the engines are required when horizontal engines are used, and surface condensation thereby reduced. Moreover, in the event of a leaky joint, it is always better out of harm's way than in the engine-room. In some cases the German plan of accommodating the steam-piping has been adopted in this country, notably in the Tyneside power station, but the practice is by no means so general as I think it might be. Another notable feature in connection with the Moabit station is undoubtedly the very elaborate provision made for elevating and conveying coal from barges on the adjoining canal across the road to the boiler-house.

A somewhat superficial inspection of the installation having been made, the visitors then proceeded in the brakes provided to a sub-station in the Königin Augustastrasse, where the three-phase current from Moabit, at a pressure of 6,000 volts, is received and transformed by means of rotary converters for subsequent distribution to the three-wire networks of lighting and power mains. The voltage between the outers of the house service mains is 440, while current at a pressure of 550 volts is distributed to the tramways. Each of the rotary converters is provided with an alternating-current booster on the three-phase side, so that the pressure on the direct-current side can be varied as necessary and the buffer batteries charged. Also in other essential respects the equipment of this sub-station is very similar to that of the Mariannenstrasse sub-station, already described in the columns of the *Electrical Engineer* for July 5. It should be mentioned that these sub-stations are interconnected, so that either can be supplied with high-tension current from the two distinct high-voltage generating stations, situated respectively in Moabit and Oberspree; in other words, these generating stations are connected in parallel with the sub-stations, thus greatly minimising the chances of breakdown.

In the evening of this, the first day's proceedings, in Berlin, the Institution members were received by the Allgemeine Elektricitäts-Gesellschaft and Messrs. Siemens and Halske at the International Fire Brigade and Appliances Exhibition, where a banquet, with musical accompaniment, had been arranged. Herr Geheimrath Rathenau, in welcoming the English guests on behalf of the two companies, spoke in appreciative terms of the splendid work done by British engineers in the past, and expressed a hope that in the future British and German engineers would work hand in hand for the common good. This welcoming speech, which was rendered in excellent English, called forth loud applause and was suitably responded to by Mr. Alexander Siemens. But quite the event of the evening was the dispatch by the Institution of a telegram to the Kaiser couched in appreciative terms of that monarch's well-known interest in scientific matters. His Majesty's acknowledgement of this spontaneous mark of esteem was duly announced on a subsequent occasion.

It is not, however, my intention to dwell much upon the social side of the visit; suffice it to say that everything was done in magnificent style by our hosts. Both the dinners and entertainment provided were excellent, and the welcome extended, moreover, felt to be genuinely sincere. In fact, the splendid receptions held on the first and succeeding evenings of the visit cannot but be long cherished as pleasant recollections by all who were fortunate enough to partake of the lavish hospitality extended by the two world-renowned firms — Messrs. Siemens and Halske and the Allgemeine Elektricitäts-Gesellschaft.

(To be continued.)

BRISTOL ELECTRICITY WORKS.

The following is the report of the Electrical Committee to the City Council on the working of the electrical department for the year ended March 25, 1901, and shows an expenditure to date on capital account of £299,259. The report of the engineer, together with abstracts of the revenue account, general balance-sheet, and statement of electricity, generated, sold, etc., are appended.

The number of consumers on March 25, 1901, was 1,507, being an increase of 292 during the year. The total connections to the mains

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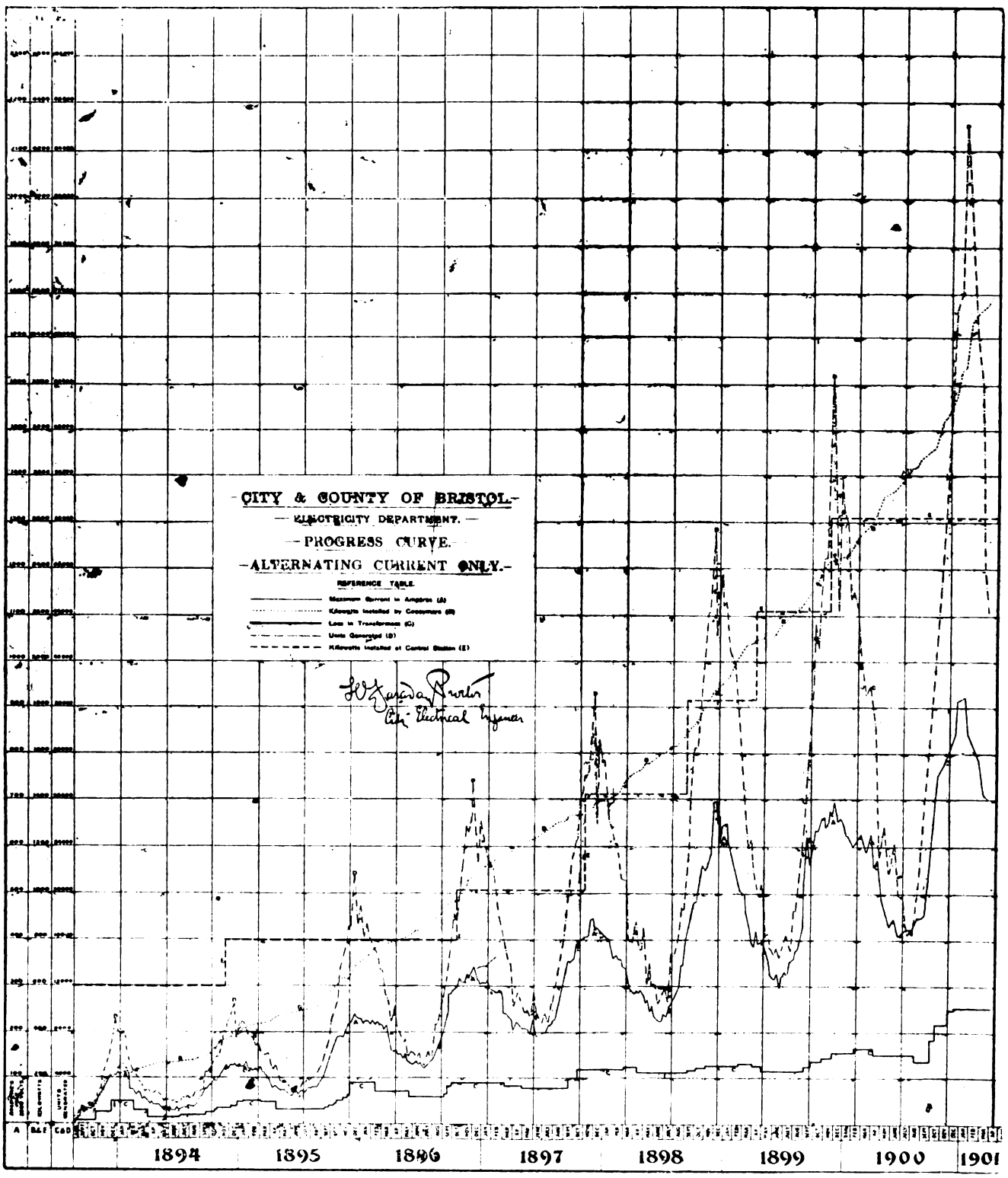
are equivalent to 119,615 30-watt lamps (as compared with 91,117 at the corresponding period of last year), made up as follows—viz.: 9,389 taking energy at the power rate, 104,985 taking energy at the lighting rate, and 5,241 representing the public street-lighting, this being an aggregate increase equivalent to 28,498 lamps, as follows: power connections, 6,619; private lighting, 21,799; public lighting, 80; the increase in private lighting alone exceeding the total additions of any previous year. The number of units sold was 2,191,559, being an increase of 379,048. The use of electric motive power has continued to increase, and your committee are pleased to find that the sale of current for that purpose has more than doubled during the year. The gross receipts amounted to £37,398. 8s., and the gross expenditure to £25,725. 19s. 8d., leaving a gross profit of £11,672. 8s. 4d.; available towards payment of dividends on stock, interest on loans, and bankers' overdraft, £7,327. 5s. 8d.; repayment of money borrowed, £6,811. 11s. 7d.; Avonbank preliminary expenses, £90. 11s. 3d. The credit balance at the commencement of the year was £3,062. 3s. 9d., which has met the deficiency on this year's working of £2,557. 0s. 2d., and left a balance to carry forward to next year's accounts of £505. 3s. 7d. The deficiency on the year's accounts, which would have been heavier but for the reduction of the contribution to the sinking fund by the recent issue of stock, is attributable to the largely-increased price of coal during the year (this item alone has increased the cost of generation by over £4,000), to the interest and contribution to redemption fund for the unremunerative capital at Avonbank, amounting to upwards of £900, and to the management expenses being high, although less in proportion than last year, on account of the salaries of members of the staff engaged almost exclusively on new works being charged to revenue, as mentioned in the engineer's report attached to the report of your committee of July 20, 1900. Your committee think it right to state that they do not anticipate a material improvement in the net financial result of their trading during the current year, as although the price of coal has been considerably reduced, the unremunerative outlay is being increased, and the advantage of this outlay will not be felt until the new Avonbank works are completed and in operation. The following statement exhibits the financial position of the undertaking on March 25, 1901: total capital expenditure, £299.259. 11s. 6d.; mortgage debt, £246,092. 18s. 10d.; balance at credit of reserve fund, £5,000; and balance at credit of depreciation account, £1,390. 3s. 1d.



Engineer's Report.

The increase in the number of consumers connected to the system during this period has exceeded that of any previous year, and points to the ever-increasing popularity of electric lighting for business and domestic purposes. Most of the additional connections have been made on mains which have been laid for some considerable time—indeed, the amount of extra distributing main laid during the past year is only about one-half of that which was added during the previous

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year. A considerable amount of cable has been laid for the distribution of continuous current where such is likely to be more suitable than alternating current for motive power purposes. About 100 motors have already been connected to the mains, and there seems great prospect of a largely increased demand in the near future.

Temple-back Generating Station.—Several improvements have been effected in the plant at Temple-back, the most notable of which are the following: One of the 52-kw. arc light dynamos has been converted into an exciter. This machine now being used entirely for the internal working of the station, the total kilowatt (output) capacity of the station, as shown on Table A, is reduced. A battery booster of 20 kw. and a 1,500 ampere-hour battery are being put in at the present time. A new exciting switchboard of the latest design has taken the place of the old board, which had become too small to efficiently control the whole of the plant. These improvements add greatly to the reliability of the exciting portion of the electrical plant, which is of the greatest importance, as upon it depends every branch of the system. A new "charge engineers'" office has been built in a convenient position, commanding a view of the switchboard and the whole of the boiler-house. This office is approached by a gallery which has been placed across the engine-room from the switchboard. The switchboard gallery is being extended throughout the entire length of the engine-room to make provision for the new switchboard (now on order) for the control of the continuous-current power supply and for extensions of the high-tension feeder board. The windows facing Temple-back will be built up to allow of the fixing of these switchboards.

Avonbank Electricity Works.—The foundations for the first portion of these are nearly completed, and the contracts for all the machinery are very well advanced. It is hoped that these works may be sufficiently far advanced to allow of their supplying electric energy in time for the coming winter load.

External System.—New sub-stations for the transformation of the high-tension alternating current, and the distribution of current generally, have been constructed at Portland-square and at Maudlin-street, bring up the total number of sub-stations to 53. The total mileage of cables laid to March 25 is 148, having 350 miles of conductors. Two additional arc lamps have been erected on Bristol Bridge, and the position of two others altered, effecting a great improvement in the lighting. An important alteration in the charge for electricity for motive power and heating purposes was brought into operation on Oct. 1, 1900. The minimum charge then in vogue (25s. per quarter per kilowatt installed) was done away with in all cases except where a consumer retained stand-by machinery. This is calculated to greatly increase the popularity of this supply without materially reducing the profit per unit sold. The costs of working during the past year and during the previous year are given below:

	1899-1900.	1900-1.
Number of consumers connected to March 25...	1,215	1,507
Increase during year	248	292
Equivalent in 8-c.p. lamps connected to date...	91,117	119,615
Added during year	17,420	28,498
Number of units sold	1,812,511	2,191,559

Cost per Unit Sold.

	1899-1900.	1900-1.
Coal and other fuel.....	·83d.	1·25d.
Oil, waste, and water.....	·07d.	·08d.
Wages of workmen.....	·36d.	·38d.
Repairs and maintenance	·24d.	·28d.
Works cost	1·50d.	1·99d.
Rents, rates, and taxes	·23d.	·24d.
Management salaries, office expenses, etc.	·45d.	·39d.
Total cost.....	2·18d.	2·62d.

Price per Unit.

	1899-1900. Max.	1899-1900. Min.	1900-1901. Max.	1900-1901. Min.
Charges for private lighting.....	5d.	2·5d.	5d.	2·33d.
Charges for private power	1·5d.	1·25d.	1·5d.	1·2d.
Obtained for private lighting	4·18d.		4·186d.	
Obtained for private power	—		1·632d.	

It will be noticed that the coal bill per unit shows a considerable increase over that of recent years. This is entirely due to the heavy price that has had to be paid for coal, the average price per ton having increased from 12s. 5d. in 1900 to 18s. 7d. in 1901. The price in 1896 was only 8s. 6½d. per ton.

H. Faraday Proctor, City Electrical Engineer.

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	283,014	10	5
Sundry creditors	3,848	10	6
Deposits by customers as security.....	275	10	0
Balance at credit of net revenue account.....	505	3	7
Balance at credit of stock and loan account	2,832	2	10
Balance at credit of reserve fund account	5,000	0	0
Balance at credit of depreciation account	1,390	3	1
Balance at credit of suspense account	200	0	0
Amount overdrawn at bank less cash in hand	25,860	6	9
	£322,926	7	2

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	307,324	1	11
Stores on hand.....	1,232	3	0
Sundry debtors for current and other debtors	11,537	19	5
Stock investment and bank interest.....	2,832	2	10
	£322,926	7	2

Revenue Account.

Dr. Generation of Electricity.				£	s.	d.
Coal or other fuel.....	£11,437	8	5			
Oil, waste, water, and stores	725	14	9			
Wages at generating station	2,793	1	6			
Repairs, etc., of buildings and plant...	1,930	14	8			
				16,886	19	4
Distribution of Electricity.						
Wages and other remuneration	663	18	3			
Repairs, maintenance, etc., of mains...	276	6	2			
Repairs, etc., of transformers, etc.....	32	6	10			
Repairs, etc., of apparatus	275	3	10			
Sundries.....	41	18	10			
				1,289	13	11
Public Lamps.						
Attending and repairs	1,107	10	11			
Carbons and renewals of lamps	605	9	2			
Sundries.....	39	3	5			
				1,752	3	6
Rents payable	482	5	3			
Rates and taxes.....	1,726	4	3			
				2,208	9	6
Management Expenses.						
Salaries—engineer's department.....	1,519	1	1			
Salaries—secretary and clerical staff...	953	8	0			
Stationery and printing	242	2	9			
General establishment charges	421	1	0			
Auditors' fees	35	0	0			
Stock management expenses	111	1	9			
				3,281	14	7
Law and parliamentary charges.....				26	8	9
Special Charges.						
Fire and boiler insurance, etc.	141	1	3			
Canvassing for new customers	6	5	11			
Interest on deposits as security	9	13	0			
Testing machinery, mains, etc.	19	7	11			
Gratuities	34	2	0			
Salary of electric inspector.....	70	0	0			
				280	10	1
Total expenditure				25,725	19	8
Amount carried to net revenue account				11,672	8	4
				£37,398	8	0

Cr.	£	s.	d.
Sale of current, less discounts	28,566	16	8
Rental of meters.....	1,382	12	4
Rental of motors, less depreciation	29	7	6
	29,978	16	6
Less bad debts	45	4	2
	29,933	12	4
Electricity supplied to public lamps.....	5,391	11	10
Attendance, repairs, and carbons for same	1,752	3	6
	7,143	15	4
Incidents	5	8	0
Improvers' premiums	101	10	0
Charge for preparing contract	5	5	0
Fees for insulation tests.....	5	15	6
Surplus lands—rents receivable.....	18	17	0
Charging batteries	9	0	6
Work on consumers' premises	6	16	1
Profit on sundry sales of material.....	10	18	3
Refund of income tax	156	0	0
Fees for testing meters	1	10	0
	£37,398	8	0

Statement of Electricity Generated, Sold, etc.

Quantity generated in Board of Trade units			2,913,680
Quantity sold { Public lamps	475,347		
Quantity sold { Private consumers by meter.....	1,716,212		2,191,559
Quantity used on works			722,121
Total quantity accounted for			2,913,680
Number of public lamps			319
Total maximum supply demanded (kilowatts).....			2,099

NEW COMPANIES.

The following new companies have been registered since our last issue:

Witting Bros., Electrical Engineers, Limited. — Capital, £40,000. Object: to adopt an agreement with Witting Bros., Limited, to carry on the business of electrical and general engineers, contractors, and manufacturers of and dealers in electrical and other machinery and articles to or in connection with which electrical power or electrical process of any kind may be applied or used.

Scarborough and District Motor Vehicle Syndicate, Limited. Capital, £3,000. Object: to carry on the business of motor, cycle vehicle, ship, boat, launch and carriage builders and owners, electricians, engineers, etc.

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All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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TELEGRAPH ENGINEERS.

The telegraph engineer, even in civilised countries, has to be a man of resource and prompt action, owing to the great importance of telegraphic communication to the commercial world. Thus, after a heavy fall of snow in a half-thawed state, it is no uncommon thing for English telegraph engineers and linesmen to spend many consecutive days and nights in making repairs to broken lines. These repairs are, however, facilitated by the ease with which stores can be obtained, and also by the good transport arrangements available. When, however, the telegraph engineer is at work in a comparatively undeveloped country, the difficulties increase enormously. This is shown by a perusal of the report of the British South Africa Company just issued. This company has recognised the vast importance of the telegraph as a civilising agent in a new and unsettled country. Their confidence has been backed by a liberal expenditure of money on what is bound to be somewhat unremunerative undertakings for several years. Long trunk lines have been constructed and the company has taken the lead in the organisation of the Cape-to-Cairo line, which will form when completed a most useful link between the British dependencies in Africa. The reports of the various telegraph engineers and superintendents which are included in the volume mentioned above are most interesting reading, and show the enormous difficulties which these gentlemen have successfully overcome. That some of the work done is only temporary in character is no disgrace to these pioneers, who by their exertions have given prompt telegraphic communication between isolated stations, and thus have enabled a few Englishmen to control vast areas even in time of war. How large a part the telegraphic department of the company played in this war is exemplified by the following extracts from the Postmaster-General's (Mr. G. H. Eyre's) report: "The period under review has been one of great commercial depression throughout Rhodesia, owing to the stoppage by the Boers on Oct. 12 of railway and telegraph communication a few miles south of Mafeking. At 4.25 p.m. on that date the Bulawayo-Kimberley telegraph line suddenly failed, and a few minutes later the telegraphist at Mafeking informed us that all his lines to the south had been cut. Communication by wire with Mafeking was maintained until 5.30 a.m. on the 13th, when the wires north of that place were also cut by the enemy. The area of the operations of the Boers gradually extended north until at one time they were in possession of the railway station at Mochudi. Meanwhile several engines and trucks were armoured at Bulawayo, and telegraph communication between the base and Bulawayo was established in a steel-plated carriage attached to the advance train. The position of this train varied according to the exigencies of the situation, the first base being at Crocodile Pools, 83 miles north of Mafeking. Subsequently the base train moved back successively to Gaberones, Metsimaclaba, Mochudi, and Magalapye, the latter place being 217 miles north of Mafeking. At the date of this report (March 31) the base is at Ootsi, 61 miles from Mafeking. Communication between the base train and Mafeking has been maintained by means of native runners at fairly regular intervals since Oct. 22, 1899. Telegrams in large numbers have been carried by these runners, and that the facilities thus afforded have been appreciated by the beleaguered garrison and townspeople is shown by the fact that in the month of February telegrams and cables to the value of over £150 were dispatched from that place. Shortly before the declaration of hostilities a request was received by this department from the military authorities for certain telephone circuits at

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Mafeking. This request was referred to the telegraph department of the Cape Colony as being within its jurisdiction, but the matter was left in the hands of this department. Our chief constructor (Mr. J. J. Kiddy) was sent from Bulawayo with one lineman to carry out the work. An underground telephone exchange was established, and connections made to the various forts forming the defences of the town. Electric mines were also laid. I very much regret to record the fact that Mr. Kiddy died of fever in the Mafeking Hospital on Feb. 2 last. His zeal and devotion to duty were most marked, and the department has by his death lost a very valuable servant." This plain and unvarnished record of services rendered to the State is one of which electrical engineers may well be proud. In the case of the transcontinental lines, of which a large part has been constructed, the fight has been against natural obstructions, and communication has only been maintained by the strenuous labours of the linesmen. Thus in the section between Chiromo and Chikwawa, the line crosses a tract of land known as the Elephant Marsh. The Lower Shire River runs through the middle of the marsh, and during the rainy season overflows its banks and swamps the whole area, and consequently there is a considerable depth of water in some of the low-lying parts over which the line passes. The vegetation on this marsh grows to a great height during the wet season, and overtops the line to some extent, making a leakage of as much as fifty degrees during last season. It is impossible to get natives to cut down the grass and trees, as the place swarms with crocodiles, and is absolutely unsafe. In other sections of the line a depth of six to eight feet of water is commonly found over the country during the rainy season, and renders the upkeep and supervision of the lines far from a sinecure. In the hilly country the rains render the ravines practically impassable. The report of these and many other difficulties is concluded by the note that "great credit is due to Mr. Fox, chief constructor. The construction of the line since he has been in charge has been very much better carried out than formerly." The new work on the transcontinental line is being much hampered by the scarcity of labour, but this is likely to improve after the war. The telegraph engineers carrying on this pioneering work have faced their difficulties manfully, and the settlement of the areas served will be greatly hastened by the success of their labours.

ELECTRIC RAILWAYS IN OHIO.

Mr. George S. Davis has a long article in the *Street Railway Journal* on the interurban railways of Ohio. The spirit of electric railway building, he says at the commencement of the article, is pervading the entire country, hardly any section having a considerable population being without some projects of this kind. At the present time there are in operation in the cities and towns of Ohio, 898 miles of electric railways; Cleveland and Cincinnati each having over 200 miles of track, and Toledo and Columbus about 100 miles each. Of the interurban roads running from one town to another, there are in operation some 868 miles, while there are in actual progress of construction no less than 1,435 miles of road. As showing the progressive spirit of the capitalists in connection with electric traction in this State, we may mention that in less than three years as many as 144 companies, with over £10,319,000 capital stock, have been organised in Ohio to build electric railways, not to mention several which have been incorporated in other States for the same purpose, while various companies interested in the business have during that period increased their capital stock by over three millions sterling. After careful researches, the writer estimates that franchises and rights of way have been secured or are being secured for no less than 4,800 miles of road, on which no work other than surveying has yet been done. There is, however, a strong rivalry between the various syndicates for territory, but the author regards this as a good thing, as tending to improve the character and construction of new lines. As regards speed, for the present the more conservative and successful lines are satisfied with from 30 to 35 miles per hour, with little or no attempt to compete with the steam roads for time. A glance at the map given in our contemporary shows that when the lines under construction and those projected are in operation, there will be a complete network of electric railways in this State. Thus the cities of Toledo, Dayton, Columbus, Zanesville, Canton, and Cleveland, which form a complete circle, will sooner or later all be connected by electric roads, while the branch lines will serve to open up territory which has never been traversed by steam railways, and a large number of them will prove of great value in providing short cuts from one town to another. The longest line now under construction is that from Toledo in the north to Cincinnati at the extreme south of the State. Roughly, this road will be about 210 miles long, and joining with the existing line at Toledo will provide a through run to Detroit, about 70 miles further north. It is to be noted that while there are a very large number of syndicates in the field, the majority of the lines are owned by some 20 or more well-known corporations, one of these controlling fully 1,500 miles of electric railways, either building or in operation.

THE BATTERY.

BY S. LEES.

No doubt the above title will suggest to many readers that there is another of 'em trying his hand at the poor old battery. Be that as it may, the writer of this short article hopes that the following notes and hints may be of use to those in particular who have charge of private installations. Generally speaking, these class of jobs are often in the hands of men who never saw an accumulator before in their lives, and as the care of the battery devolves upon the man in charge, it very often receives scant respect, and, consequently, in 12 or 18 months' time the cells begin to look rather the worse for wear. This in due course is brought before the notice of the owner, who naturally wants to know what is the matter. The engineer then proceeds to pour out his tale of woe, to something like this effect: poor make of cell; worst I have come across in all my experience; not used in one installation out of a hundred; firm went smash long ago! and so on. The battery has most likely been ruined by overworking it, heavy discharges at high rates, and charging up at double or treble rates, and the engineer has not had time or patience to exercise a little commonsense in making daily inspections of the cells, with consequent disastrous results to same.

With persons of this description it becomes necessary on their taking charge of an installation to acquire some knowledge of batteries, and naturally they resort to the numerous works on the subject. Now, as these books differ very much in their information, particularly in their advice as to the treatment of backward cells, the engineer gets a confusion of ideas, and, instead of using a little commonsense, he prefers to cudgel his brains, diving into the theory of and trying to understand the chemical changes which take place during the charge and discharge of a cell.

We will skip the usual directions as to the setting-up of cells, length of time of initial charge, etc., as the firm who supply the battery generally see that all is right up to the end of the first charge and discharge. The battery people will very likely have given the engineer a sheet of instructions, giving correct charge and discharge rates, and hints as to care of cells, etc. Now, in many cases this is where the trouble lies. The engineer being ignorant in the matter, and not caring to show it, generally lets the erectors depart without gaining some useful information from them, or in the case where the engineer is engaged after the plant has

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been working for some time, he is afraid of writing to the makers for advice on points relating to the battery.

A new battery always requires a deal of attention during the first few weeks of working, and if this is omitted, trouble is sure to arise. The engineer finds here and there that the specific gravity of the liquid at end of charge is very low, and in spite of directions, "Add water only," proceeds to fill up with strong acid. Also, there is cell No. So-and-so not gassing along with the others, and according to information derived from his favourite book, he proceeds to poke viciously between the plates with a stick, and maybe he stops against something, and with a "Ah, I've got it!" after a lot of pushing down it goes, and probably a good sized piece of plate with it.

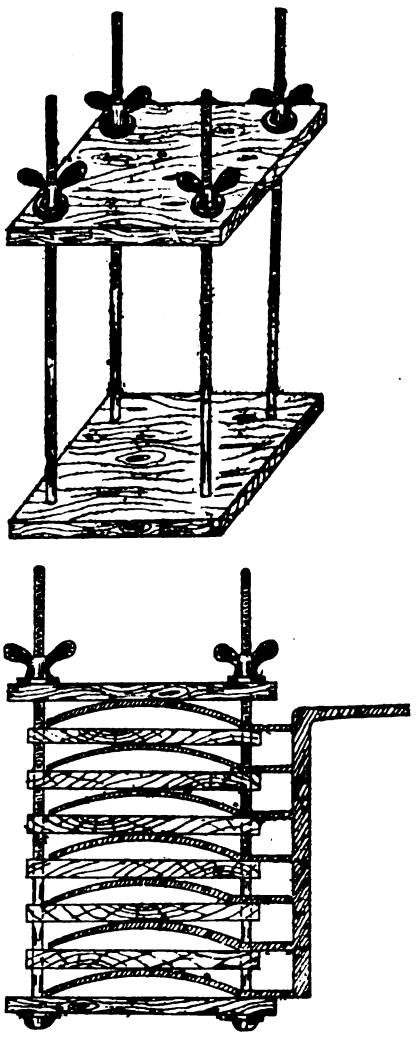
Removing short-circuits with a stick is all right in some cases, depending on the nature of short, and if done with care. The engineer may find that one or more cells have become reversed, usually a short time after the commencement of a discharge. This is due to the plates being covered in places, or, perhaps, almost over the whole surface, with a whitish substance, and its presence means a loss of as much active material as is covered with it. This is caused, in the first place, by over-discharging, and if it is not removed at once the plates deteriorate rapidly, and in a short time collapse altogether. As this substance prevents the plates from receiving their proper charge, the consequence is that when the discharge is started the volts of cell drop more or less rapidly (depending on condition of plates) down to zero, and if the discharge is still prolonged the cell reverses its polarity—that is to say, the discharging current from the rest of the battery is charging it in an opposite direction, and changing the positive plates to negatives and *vice versâ*. When a cell behaves like this it is advisable, immediately the volts drop to zero, to bridge over from the two cells on each side of it with a piece of cable or bare copper strip of a sufficient size to meet the requirements of the occasion. The cell should now be disconnected and thoroughly examined, and if found to be very dirty, with a large accumulation of mud at the bottom, the plates should be taken out, and the liquid carefully strained off to get rid of the dirt, and the cell well washed with clean water. A very good way to remove the whitish substance before mentioned is to brush the bad plates carefully with a piece of card clothing (commonly called file card, and sometimes used for cleaning files), and afterwards rinse them with a little of the liquid taken from the same cell.

Perhaps the battery has been neglected so much that many cells are found in which the plates are buckled badly. The engineer comes to the conclusion that the easiest way to straighten them will be to force a board down between each plate, and very likely he does so. With few exceptions, small and medium sized cells are connected up by having their lugs bolted together, large cells, as a rule, being burned together. A good method of straightening buckled plates is to cut the cell out completely (in the manner explained before) from the rest of the battery; take the plates out, and whilst wet apply pressure gradually until they have recovered something like their proper shape.

A very simple and efficient press can be made for this purpose by almost anyone. Get two pieces of pine 1in. thick and about 3in. larger all round than the size of the plates, and bore four ½in. holes in each piece, about 1½in. from the corners. Procure four ½in. bolts, say about 3in. longer than the length of the negative section measured across the top from end plate to end plate. The bolts should be screwed for about halfway down, and each provided with a good substantial thumb-nut and two washers. Now get a number of boards, say as many as there are negative plates, about 1in. larger all round than the size of plate, and make them a nice easy fit to insert between each plate. All the boards should be well planed up, and chamfered slightly on their edges so as not to present a cutting edge to the plates. The sketches will illustrate the manner in which the press is put together, and how used.

Strict attention should be paid to the proper charge and discharge rates, and these should not at any time be exceeded by a great amount, except in the case of an emergency discharge, and then only for a short time if at more than double the ordinary working rate. From 5 to 8 per cent. ampere-hour overcharge on each discharge is ample, with a milking charge, say, once every 10 working days. Readings should be taken of the volts of each cell every alternate day, once during the last half-hour of the charge, then a short time after the discharge is started, and again during the last hour of the discharge. This may appear to be very tedious and unnecessary work to the engineer, but the three readings altogether will not take up more than an hour, and if this is attended to it will probably save an endless amount of trouble later on.

Readings of the specific gravity of the liquid in each cell should be taken twice a week, once during the last hour of a good discharge (preferably preceding the milking charge) and again during the last hour of the milking charge. At no time should any cell be allowed to fall below 1·72 volts, with liquid of 1·155 specific gravity, and if at any time the



specific gravity is below this mark, and repeated overcharging fails to bring it up to at least 1·185, then, and then only, should acid be added. It is always better in the case of a private installation to purchase acid direct from the battery makers, as local dealers will not usually guarantee it as to purity when ordered in small quantities. The liquid should be kept about ¾in. higher than the tops of the plates, and it should never be allowed to get so low as to expose the plates to the air. Wherever possible, it is much better to fill up with distilled water and to use an earthenware jug when filling up, and not, as is usually done, with the hose-pipe or bucket because it is quicker. The proper time for filling up is when the cells are gassing freely.

Where lead or lead-lined boxes are used, an inspection lamp is very useful for locating short-circuits, and noting the general conditions of the plates, but if not used with care, it very soon becomes useless. There are some works on accumulators, the authors of which advocate the use of caustic soda, oxalic acid, etc., for mixing with the liquid of backward cells, for the purpose of getting them back in a healthy condition, but

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the writer is of the opinion that these substances are best left alone so far as battery work is concerned. It is safe to say that in many cases the battery receives the least attention of any part of the plant, oftener than not being treated more in the light of a primary source of energy.

The writer has in mind an instance of a battery which cost nearly £900, and which was transferred to the scrap heap after a few years' working, notwithstanding the fact that during this time it was overhauled twice and renewed with new positive plates. This was almost wholly due to the battery (with the exception of filling up, usually when the cells were about half empty), being left to take care of itself, with the results mentioned above.

In conclusion, the writer may say that the above has been taken from many years' practical experience in the care of accumulators, and while much more might be written on this subject hopes that the foregoing remarks may be of assistance to those who would endeavour to prolong the existence of the much ill-used battery.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS

403. When in a continuous-current drum-wound motor one armature connection is disconnected from its commutator bar, why is it that not only that bar is marked by sparking, but also a bar opposite to it? Would the same thing occur were the sparking caused by one coil being short-circuited?—S. G. P.

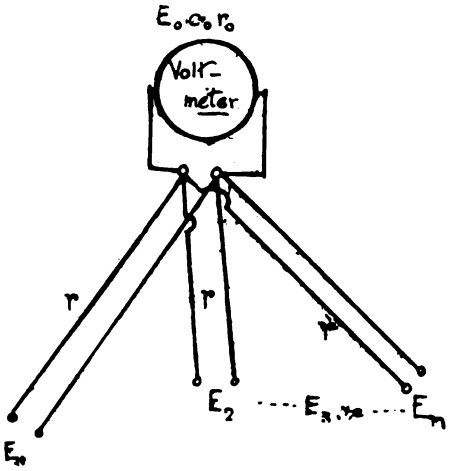
404. What is the most likely cause of a growing temperature rise in the disc armature of a 125-kw. Ferranti alternator, and how can the balance of the two halves of the armature be best tested with the ordinary station instruments?—M.

ANSWERS.

Question No. 397.—Explain a method of connecting a voltmeter at a central station so that it will indicate the average voltage at a distant group of feeding points on a direct-current system.

Best Answer to No. 397 (*awarded* 10s.).—It is most important in a system with any considerable lighting load to ensure that the voltage at the terminals of the lamps is as constant as it can be made under practical conditions. The feeders are so designed that their resistance, along with the arrangement of the interconnecting network, ensures the potential at the feeding points being fairly constant all over the system, in which case it is likely that the voltage at the lamp terminals will also be fairly constant. As there is a volt loss in the feeders, the potential difference generated at the station must be higher than that required at the feeding points by an amount depending on the load. It is in networks of small area often sufficient to raise the station voltage, as measured on the 'bus bars, by an amount proportional to the consumption at the moment. In other cases a "compound-wound" voltmeter may be used, having two actuating coils—one a shunt across the dynamo terminals, the other carrying the main current and opposing the "volt coil," the whole being so designed that the effect of the main current is to sink the reading by just the requisite amount to give the proper volts at the feed points when the pointer is brought back to its proper position. This is equivalent, of course, to raising the station voltage proportional to the load, but it is easier to regulate, as the instrument is designed to have a constant reading. Reference may also be made to the method of voltmeter compensation, described in the *Electrical Engineer* some weeks ago, which employs various resistances in circuit with various parts of the installation.

The usual way, however, is to employ a voltmeter at the station, and to bring to its terminals a pair of pilot wires from each feeding point. These wires may be separately laid along with the feeders, or a special wire may be embedded in the insulation of the feeder during construction and used for this purpose. When one voltmeter is used like this, the dynamo voltage is not read, but only the average potential at the feeding points, which will be, in a well-designed case, nearly the same as the voltages at the individual feeding points. Consider the case of n feed points. The sketch shows the pilot wires coming back



from these to the voltmeter. Each pilot wire has its resistance adjusted by means of resistances in series to the same amount, say r. The voltages at the various points are $E_1, E_2, \ldots E_n$; the mean voltage at the feed points is E_m, which is equal to $(E_1 + E_2 + \ldots + E_n)/n$; the resistance of the voltmeter is r_0, the current through it is C_0, and the actual difference of potential between the voltmeter terminals is E_0. The current, C_0, is the sum of the currents in the various pilot circuits, and it may be taken that this is sent by the voltage, E_m, through a resistance, r_0, in series with all the pilot wires in parallel—*i.e.*, altogether, $r_0 + r/n$.

Hence
$$\frac{E_m}{C_0} = r_0 + \frac{r}{n} = \frac{E_0}{I_0} \cdot \frac{r}{n}$$
$$= \frac{E_0\, n + r\, I_0}{C_0\, n}.$$

Hence
$$E_m = E_0 + \frac{r}{n} \cdot C_0$$
$$= E_0 \left(1 + \frac{r}{n} \cdot \frac{I_0}{E_0}\right)$$
$$= E_0 \left(1 + \frac{r}{n\, r_0}\right).$$

If n and r_0 are large, then E_m will be practically equal to E_0, which is the reading of the voltmeter as ordinarily calibrated; but if n is too small, the correction factor gets bigger than is permissible, and the voltmeter must be specially calibrated. The one calibration and setting will be sufficient if a voltmeter is to be used always on the same number of feeders; but if the number of feeders (n) varies, as will generally happen, then the voltmeter must be specially calibrated to suit *one* feeder, and it can then be made to suit a larger number by the insertion of series resistances. As the number of pilot wires goes up their total resistance in parallel diminishes, and therefore the voltmeter would read too high.

The amount of resistance required is easily found, for if N feeders be put on instead of only 1, the resistance is diminished by the amount

$$r - \frac{r}{n}, \text{ or } r\left(\frac{n-1}{n}\right),$$

and consequently this amount must be put in between the common point of all the pilot wires and the voltmeter terminal.

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The calibration for one feeder is done by putting an external resistance, r, in series with the voltmeter while preparing the scale, and calibrating it so that its reading gives the voltage not direct on the terminals, but at the end of the total resistance, $r+r_o$. This will, of course, be higher than the amount at the terminals of the instrument, in the proportion of $(r+r_o)/r_o$. The voltmeter will then read correctly the average voltage at the feed points, provided the total voltmeter circuit resistance is made up to $(r+r_o)$, which is accomplished, as shown, by putting in series with the voltmeter a resistance $r\left(\frac{n-1}{n}\right)$, where n is the number of feeders whose average voltage is to be obtained. These resistances can be arranged in connection with a voltmeter switch, and switched in as desired as the number of feeders increases.—T. C.

Answer to No. 397 (*awarded* 5*s.*).—The first answer which naturally suggests itself is to run pilot wires from the various feeding points to the voltmeter, and connect all positives to the positive terminal of voltmeter, and all negatives to the negative terminal. The average voltage would then be registered. For a three-wire system two voltmeters would be required, one between the positives and the neutral and the other between the negatives and the neutral. Suitable resistances would require to be arranged in series with the pilot wires to prevent any interchange of current between the various feeding points. Pilot wires are a very considerable expense, and methods have been devised to save this expense. To get the average voltage of a number of feeding points using electromagnetic voltmeters, it would be necessary to compound the shunt windings with a wire for each feeder (after the method of Dr. Hopkinson), which would compensate for the drop along those feeders, and the voltmeter would indicate the average voltage at the far ends. Weston voltmeters constructed on the D'Arsonval principle are in great favour, and to this type of voltmeter Mr. M. B. Field has given special study, the results of which were given to the Glasgow Section of the Institution of Electrical Engineers in a paper read by him in February of this year, and from which the following extracts are practically copied.

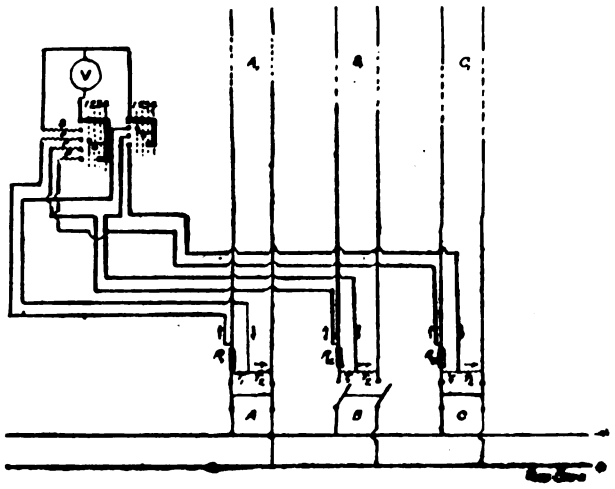

Fig. 1.

Fig. 1 shows the arrangement for a two-wire system of supply. The contact switch of the voltmeter would be on the principle of a miniature tramcar controller. R_1, R_2, R_3 are series resistances inserted in each feeder circuit, and shunt resistances divided into two portions (r_1 and r_2) are connected across each pair of feeders; ρ are resistances to prevent interchange of current between the feeders; V M is the voltmeter, and S a shunt to keep the calibration of voltmeter correct when the voltmeter switch is in the fourth position. In positions 1, 2, 3, the individual voltages at A_1, B_1, and C_1 would be given, and in position 4 the average voltages of A_1, B_1, and C_1. Explanation—r_1 is $(1/n)$-th part of r_1+r_2; therefore, drop of pressure down r_1 will be $(1/n)$-th part of the 'bus-bar voltage.

R_1 is $\left(\frac{1}{n-1}\right)$-th part of the whole (go and return) resistance, and the drop along R_1 will be $(1/n)$-th of the total drop. The voltmeter therefore measures $(1/n)$-th of the 'bus-bar voltage - $(1/n)$-th of the drop—that is $(1/n)$-th of the voltage existing at the far end. If the feeder switches are always in, the arrangement can be simplified by putting the resistances r_1 and r_2 across the 'bus bars and thereby reducing the number of shunts to unity.

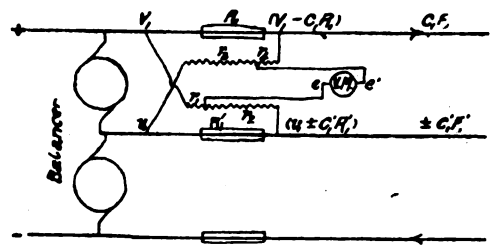

Fig. 2

Fig. 2 shows Mr. Field's arrangement for a three-wire system, and is applied in this instance to one set of feeders. Two voltmeters would be required (as previously) in a three-wire system, one to get the average voltage between the positive outer and the neutral, and the other to get the average voltage between the negative outer and neutral. Fig. 3 is an explanation of

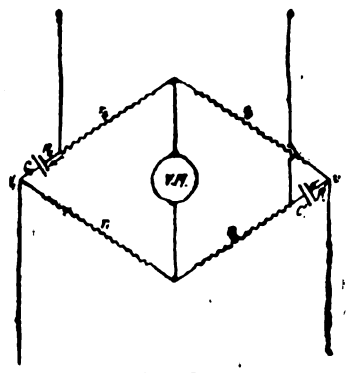

Fig. 3.

the principle. In this diagram the drop across R_1 and R_1^1 are replaced by opposing E.M.F.'s, and by this alteration Fig. 2 is developed into a Wheatstone bridge. If the ratio arms are slightly out of balance, the current through the voltmeter will be proportional to the expression $\{V_1 - v_1 - (aC_1R_1 + \beta C_1^1 R_1^1)\}$. a and β are figures whose value are adjusted by altering the ratio arms. If aR_1 equals the resistance of the outer and βR_1^1 the resistance of the neutral, it is clear that the voltmeter will register in proportion to the voltage obtained at the far ends of the feeder. For getting the average of several feeding points, a multiple-contact switch, as in Fig. 1, would be employed, and a similar shunt to S in Fig. 1 would be necessary. In this case the resistance ρ may be lower, since r_1, r_2, r_3, r_4 will prevent any appreciable interchange of current.—S. L.

Answer to No. 397 (*awarded* 5*s.*).—In the distribution of electricity over a large town by direct current, it is necessary, in order to get approximately the same pressure at feeding points, with different size feeders of different lengths, and carrying different loads, to run these off three, or possibly four, omnibus bars, which are connected to independent dynamos and supplied at different pressures. The pressure at each feeding point is determined by pilot wires, which are led to a pilot switch, by means of which any feeding point can be connected to the voltmeter and the pressure noted. Thus, two voltmeters will serve a large district with 30 or 40 feeders on the three-wire system.

It has been thought that if the *average* voltage for the whole set of feeders, or the feeders in any particular district, could be read on the voltmeter, the task of keeping a fairly constant pressure on each feeder would be more efficiently performed by the average switchboard attendant. This would probably be the case within limits. But it must be remembered that a good *average* voltage alone cannot be relied on as an indication of a good service, since it gives no definite information as to the pressure on any one feeder. In fact, the pressure at one feeding point might be 10 per cent. low, and at another 10 per cent. high, without affect-

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ing the average or giving any indication of the fact to the attendant who relied on average readings only. It is necessary, therefore, to be able to read the voltage on each individual feeder. This may be accomplished on a two-wire network by the use of the following apparatus suitably connected up: A potentiometer resistance, $r_1 + r_2$, for each set of feeders for which the average voltage is required. A low-reading Weston voltmeter and suitable switch for connecting any one feeder, or the set for the average. A set of series resistances, one for each feeder, giving about ·2 volt drop at full load. The potentiometer resistance, $r_1 + r_2$, should be as high as the sensitiveness of the voltmeter will allow, and is joined across the 'bus bars. The connections are shown in Fig. 1. x_1, x_2, x_3 are resistances

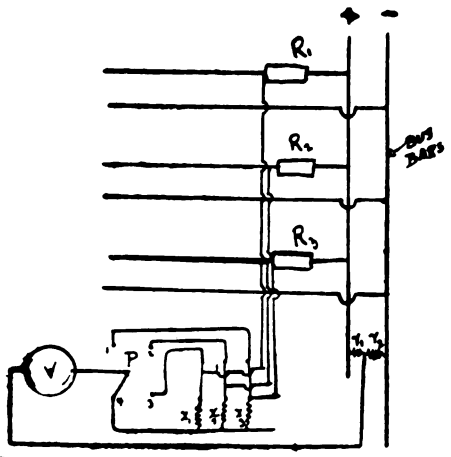

FIG. 1.—V, Voltmeter. R_1 R_2 R_3, Series Resistances in + Feeders. r_1 r_2, Potentiometer Resistance. P, Switch. x_1 x_2 x_3, Resistances in Voltmeter Leads.

of such a value as to prevent any serious exchange of current between the various feeders. The principle underlying the method is as follows: Let $r_1 = \frac{1}{n}(r_1 + r_2)$. Let R_1 be the series resistance for feeder (1), then R_1 must be $\left(\frac{1}{n-1}\right)$ of the whole feeder resistance, go and return. The voltmeter is then connected between the junction of the resistances, r_1, r_2, and the feeding-point side of the feeder resistances, as shown in the sketch. The voltmeter then measures $\frac{1}{n}$ of the 'bus-bar pressure, less $\frac{1}{n}$ of the drop in the feeder—*i.e.*, $\frac{1}{n}$ of the feeding point pressure. It will be seen that by this method pilot wires are dispensed with, which is the chief advantage of the method. The arrangement shown is suitable for a two-wire network only, and the average voltage can only be obtained if all three feeders are switched in. By using a resistance, $r_1 - r_2$, for *each* feeder connected across the feeder instead of the 'bus bars, the average can be got even if some feeders are disconnected.

By introducing further complications, the method can be applied to three-wire networks, but it is necessary to have a series resistance in each of the feeder outers and also in the neutral, while two potentiometer resistances will be required for each feeder—one on each side of the system. The method becomes, in fact, too complicated and costly. Further, in practice it is not necessary to use neutral feeders on most of the feeders, so that the method is of little use for three-wire networks. The writer believes that the chief use for this method will be found in the case of long transmission lines, where the saving of pilot wires with the attendant cost of upkeep would be quite worth the additional expense of the apparatus required. In this case alternating current would be dealt with, and in place of the resistance, $r_1 + r_2$, we should use a transformer with a ratio of n : 1, a resistance and self-induction being inserted in the line having values respectively of $\left(\frac{1}{n-1}\right)$ of that of the line resistance and self-induction.

For further particulars and diagrams, the reader is referred to a paper read before the Glasgow Local Section of the Institution of Electrical Engineers in February last by Mr. M. B. Field, on "A Method of Compensating Voltmeters for the Voltage Drop in Long Feeders."—E. M.

Question No. 398.—Describe in detail the principle and method of making the cross-connections which are provided sometimes on multipolar parallel-wound armatures, presumably for the purpose of equalising the currents in the various circuits of the armature winding. Also state in what types and sizes of machines it is necessary to provide these cross-connections.

Best Answer to No. 398 (*awarded* 10*s.*).—It has been found practically impossible, with ordinary appliances, to make the various magnetic circuits of large multipolar machines alike. This is generally due to differences in the air-gaps, in the quality of iron, or in the number of turns in the various magnet coils. Such differences result in some of the parallel circuits of the armature generating higher voltages than others, and it is not uncommon to find differences of 5 or 6 per cent. existing between the voltages measured from brush to brush when running on open circuit, the various brushes of similar sign being, of course, disconnected from one another. In an ordinary parallel-wound armature the effect of these differences is to cause the higher-voltage brushes to do more and the lower-voltage ones less than their share of the load, and in extreme cases some sets may actually have their current reversed—*i.e.*, part of the armature may be acting as a motor at the expense of the other portions. These differences in the currents collected from the various sets of brushes naturally tends to cause sparking of some sets, unless each set is separately shifted to the sparkless position for its particular current, and even then it may be impossible to avoid sparking at the more heavily loaded brushes. Further, the correct setting of the brushes relatively to one another and to the poles for one load would not necessarily be correct for other loads, so that this method of overcoming the difficulty is impracticable.

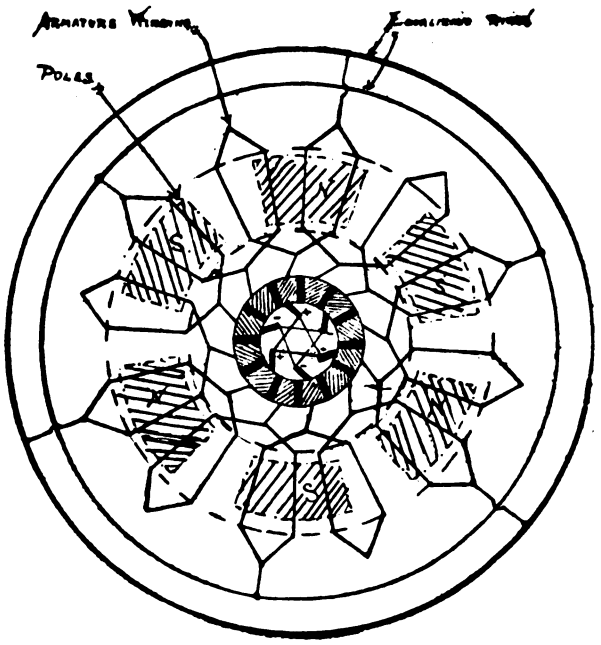

FIG. 1.—Armature fitted with two Equalising Rings.

Since increased armature reaction in a dynamo tends to reduce the terminal volts, and in a motor with *forward* lead of brushes tends to raise the terminal volts, it is obvious that the action is self-righting, and the distribution of currents in the armature should reach a steady state for each particular external load; the high-voltage parts having the field weakened by increased armature reaction, and the low-voltage parts having the field strengthened by reduced armature reaction, or even by increased current in the reversed (motoring) direction. It is, however, sometimes noticed that, instead of becoming steady, the current gets up a swing (probably due to the fact that the armature reaction does not immediately affect the strength of field, but requires a certain amount of time to make itself felt), and this swing increases gradually in amount, and results in destructive sparking first at one set and then at another set of brushes. This process is known as "bucking" in America. The effect of equalising rings is, firstly, by allowing the balancing currents to pass through paths moving round

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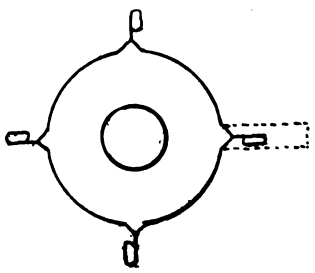
with the armature instead of through the stationary brush leads to prevent the possibility of this swinging current being developed; and, secondly, to actually reduce the amount of the balancing current in any one section by distributing the effect over several connecting points. In this way all the sets of brushes carry practically equal currents, and though the currents in the different paths in the armature are still not equal, the sparking at the brushes is practically avoided. Each equalising ring is connected to the armature winding at a number of equidistant points equal to half the number of poles on the machine—*i.e.*, in a six-polar machine, as in Fig. 1, each ring is connected to three points. Such points would, if everything were symmetrical, be always at equal potentials, and no currents will pass along the rings unless the magnetic circuits are of unequal strengths. The number of rings placed on a given armature is optional. The greater the number the more perfect will the balancing be, and on the earliest armatures fitted with the device it was usual to make a ring connection to every commutator plate. It has, however, been found that three, or at most four, rings are quite sufficient to satisfactorily balance the most unsymmetrical machine likely to occur in practice. The sectional area of the rings depends naturally on the want of symmetry in the machine, but anything from half the section to the same section as the armature conductors is usually considered sufficient. The current carried by any portion of an equalising ring is alternating, for the portion of the armature which is under a strong pole at one instant is under a weak one the next, thus reversing the direction of the excess voltage causing the balancing current. The periodicity of the alternators may, however, be very erratic, as it depends not on the number of poles, but on the sequence of strong and weak poles. With regard to the last part of the question, it is certain that all multipolar parallel-wound armatures are the better for being fitted with equalising rings, but especially is this the case with slotted machines, in which small air-gap differences are of more importance than in smooth-cored armatures. It is, however, only really necessary to fit the rings in the case of the largest machines (say, over 500 kw. or 1,000 kw.), and especially when they are subject to sudden load variations, such as occur in traction generators.—Q.

Answer to No. 398 (*awarded* 5*s.*).—The cross-connections in question are not for the purpose of equalising the currents in the various parallel circuits of the armature, but are intended to equalise the potential at the different brushes of the same sign, and so enable sparkless commutation to be obtained. In multipolar generators the field coils are almost invariably all connected in series, so that the same exciting current passes through them, and they have also the same number of turns per coil; the object being to ensure each magnet limb having the same excitation. If the reluctance of each magnetic circuit is identical, no further precaution is necessary. Unfortunately, the reluctance of the circuits varies from several causes: (1) The permeability of the metal is not always the same; this is especially true if unannealed steel or iron castings are used. (2) The joints between the machined surfaces in the magnetic circuits—for instance, between the pole-pieces and the magnet cores, and between the magnet cores and the yoke—often introduce varying magnetic resistance. There is also generally the main joint on the horizontal diameter of the yoke itself, and the resistance of this affects the magnetic circuits on each side of the joint. (3) The air-gap is often the most serious cause of variation in the reluctance. If the armature is set so that the air-gap is exactly equal at all poles, the wear of the bearings soon causes the armature to drop, and to increase the upper and to decrease the lower gaps, and at the same time the distribution of the flux in the gaps of the other poles is distorted

These three causes, together or separately, make a considerable difference to the total number of lines at each pole, and, therefore, to the E.M.F. between each pair of brushes, as the number of face conductors on the armature between each pair of brushes is constant. To equalise these differing E.M.F.'s, the cross-connections in question are used. If cross-connections are not fitted, and the commutator section under one positive brush is at a higher potential than the section under another positive brush, a current flows from the one section through the brushes and the brush leads (which are directly connected) to the other section. The resistance of the brushes is small, and of the brush leads almost nil; a small difference of potential therefore causes a large equalising current to flow, and if this overloads the carrying capacity of the brush, sparking and heating ensue. To avoid this, cross-connections are put in the armature winding, connecting all sections which should be at the same potential. In a four-pole machine each cross-connection will couple two sections; in a six-pole machine, three sections; in an eight-pole machine, four sections, and so on. The total number of cross-connections required will, therefore, be equal to the total number of sections in the armature divided by half the number of poles, though commonly about a fourth or a sixth of this number is employed, pitched evenly round the armature.

The best method of making the connection is to prolong the armature bars at the back end sufficiently to allow these connectors to be fixed outside the ordinary end connections. The extra copper required is then dead (unless there is a difference of potential to be equalised), and the working resistance of the armature is not increased. In some cases the connectors have been put inside the commutator connecting the segments, and in large machines where the commutator is large this is an excellent plan. Another method employed is the "Arnold" parallel winding. This is clearly shown in Plate 14 in Kapp's "Dynamo Construction," published by Biggs and Co. In a well-designed and well-built generator, where care is taken to adjust the armature as the bearings wear, the cross-connections are hardly necessary. As a matter of fact, there are very few machines built in this country that have them. They are used extensively, though by no means universally, in America. As far as the writer is aware, they are used chiefly for traction generators, in cases where the armature and yoke are very large in diameter.—W. A.

Answer to No. 398 (*awarded* 5*s.*). — Cross-connections in multipolar parallel-wound armatures are connections made at the ends of the armature joining bars that are at the same potential. In a four-pole machine the diametrically opposite bars are joined together, and only two sets of brushes are necessary, which must be set 90deg. apart. In a six-pole machine the cross-connections join three bars at 120deg. apart, the two sets of brushes being set at 60deg. or 180deg. apart. In an eight-pole machine the cross-connections join four bars 90deg. apart, the brushes being set at 45deg. or 135deg. apart, and so on.



Cross-connector for 8-pole Machines. Dotted line shows Lug before being bent at right angles and turned down.

In small dynamos the cross-connections are solely for the purpose of reducing the number of sets of brushes necessary, especially in enclosed motors, where two sets of brushes can be set close together, and are thereby easy to get at for adjustment. In large machines, where a set of brushes for each pole are used, the cross-connections are for the purpose of minimising the amount of sparking at the brushes and heating of the commutator due to the small differences of potential between the sections, which should be equal, causing local currents in the armature which would have to pass commutator and brushes were it not for the cross-connections. The cross-connections consist of copper discs threaded on the shaft and insulated from it with an ebonite bush and from one another with mica and tape. Each disc has lugs on it (for a four-pole machine, two; six-pole, three; eight-pole, four; and so on), which are bent round at right angles, then bent round the bar and soldered.—C. L. E. S.

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LEGAL INTELLIGENCE.

BRITISH ELECTRIC WORKS.

Alleged Fraudulent Misrepresentations.

On the 8th inst., at Liverpool Assizes, Mr. Justice Bucknill and a special jury commenced the hearing of the action of Glynn *v.* Atherton and others, in which the plaintiff claimed to recover damages under the Directors' Liability Act, 1890, against Mr. J. B. Atherton as promoter, and Messrs. Higginbottom, Marriner Brigg, Thomas Goffey, Jacob Atherton, and Robert Frederick Hall as directors, for alleged fraudulent misrepresentation and for loss and damage sustained owing to statements contained in the prospectus of the British Electric Works Company, Limited.

Mr. H. H. Asquith, K.C., Mr. T. G. Horridge, K.C., Mr. Rotch, and Mr. W. S. Glynn were counsel for the plaintiffs; Sir Edward Clarke, K.C., Mr. Rufus Isaacs, K.C., Mr. S. A. T. Rowlatt, and Mr. Burnyeat for the defendants; Mr. Pickford, K.C., appeared for Mr. Goffey; and Mr. Keogh held a watching brief for the liquidators of the company.

It appeared that the British Electric Works Company, Limited, was incorporated in the year 1899 for the purpose of acquiring the works of R. F. Hall and Co., Limited, situated at Cheston-road, Aston, Birmingham. The capital of the company was £135,000, divided into 50,000 6 per cent. cumulative preference shares and 85,000 ordinary shares of £1 each. There were also 500 debentures of £100 each; 40,000 of the ordinary shares were retained by the vendor, Mr. J. B. Atherton, and the remainder were offered to the public. The company was registered on April 20. 1899, and on the same day a prospectus was issued which contained the following material representations: "(1) This company has been formed to acquire and take over the recently completed and very efficiently equipped engineering works of R. F. Hall and Co., Limited, at Cheston-road, Aston, Birmingham. (2) The plant is mainly automatic, and is driven entirely by electricity generated on the premises. It is of the most modern design, and comprises machines of the best English, American, German, and Swiss manufacture, all arranged to economise labour and specially fitted for the business intended to be carried on. (3) Those competent to judge who have seen the works describe them as the best designed and equipped works of the kind in this or in any other country. (4) A large section of them—*i.e.*, the company's works—was planned and erected with the special purposes of manufacturing at a cost to compete favourably with foreign importations, electrical requisites—such as switches, telephones, terminals, lampholders, and other electrical accessories—and also motors and controllers for tramway and other purposes, and it is for this class of manufactures that the company intend primarily to use the works. (5) It is the intention of the directors of this company to pay special attention to telephone work, the demand for which in the near future will be very large, and with the splendid machinery at the works they are satisfied they can successfully compete, both in quality and in price, with the foreign importations now in use both in this and many other departments of electrical manufactures. (6) The company acquire valuable patents for improvements in the manufacture of electric lampholders, switches, and arc lamps, and a special department of their work will be the making of an improved type of roller bearing for reducing friction in traction machinery. (7) There is probably no department of industry in which at the present time the supply falls so far behind the demand as in the electrical trade. There is, therefore, a good opening for this company, and it will start with orders in hand to the amount of several thousands of pounds. (8) It is obviously impossible to give any statement as to profits other than an estimate, but the directors, who are nearly all intimately associated with electrical works, are satisfied that after payment of debenture interest, sinking fund, and preference dividend there will remain a balance of net profits sufficient to pay an ample dividend to the ordinary shareholders."

In opening the case, **Mr. Asquith** said that the plaintiff, on the faith of the statements contained in this prospectus, had been induced to subscribe for 500 preference and 500 ordinary shares of the company, and these were allotted to him. The company was formed in April, 1899, and for some time now the shares had been practically worthless. It was formed to acquire and carry on the business of R. F. Hall and Co., Limited, and the question of truth or falsity of the statements put forward depended to a very large extent upon the character of that company. Since 1877 Mr. R. F. Hall had been an engineer connected with the cycling industry. He had taken out a considerable number of patents, and had been connected with a company which manufactured the component parts of cycles. Between 1894 and 1897 he went into business as R. F. Hall and Co., manufacturers of cycle components, in Birmingham. During the cycle boom in 1896 and 1897 Mr. Hall acquired a site for new and extensive premises. In February, 1897, he sold his business for £25,000 to a new company called R. F. Hall and Co., Limited, which had a capital of £125,000. The works were stated to be capable of an output of 500 sets of cycle parts per week. The capital was subscribed, new premises were erected and were stocked with automatic machines worked by electric power for the carrying on of the cycle business. Unfortunately for the company, at the time when it was ready for active operations there occurred the failure of Mr. Hooley, followed by a slump in the cycle industry, which had continued down to the present day, and the company had to face a serious loss. Various attempts were made to increase the capital of the company, but in June, 1898, Lloyds Bank, holders of £21,000 debentures, commenced a debenture holder's action and a receiver was put in possession. In January, 1899, the shareholders resolved to voluntarily wind up the company, and the liquidator was brought into communication with Mr. P. B. Atherton, one of the defendants, who was managing director of the British Insulated Wire Company at Prescot, a large and prosperous concern, and there was no doubt that he and his brother, Mr. Jacob Atherton, the company's representative in London, were well known as successful pioneers in the electrical world. On Feb. 15, 1899, an agreement was entered into between the liquidator and Mr. J. B. Atherton for the sale of R. F. Hall and Co., Limited, to Atherton for £55,000, the purchase including the whole of the undertaking, the new premises and their contents, patents, and goodwill. Two months later, in the month of April, the same property was sold by Atherton to a new company called the British Electric Works Company, Limited, for £142,000. The result of the liquidation was that the debenture holders were paid in full, the unsecured creditors received 3s. 6d. in the £, and the shareholders nothing. Included in the sale were three inventions by Hall, which proved practically worthless. Dealing with the prospectus of the British Electric Works Company, counsel said the word cycle was only mentioned once, and the objects of the company were prominently set forth as being the carrying on of business as electrical and mechanical engineers. The cycle business, which had hitherto been carried on, and for which almost exclusively the plant was adapted, was only incidentally and almost accidentally referred to. The public were, in fact, asked to subscribe their money to what was described as a flourishing electrical business, but what was really an insolvent cycle concern. After 16 months' working the directors presented their first report and balance-sheet, showing an adverse balance on profit and loss of nearly £13,000. In June last the undertaking of the company, which had been wound up, was sold by the receiver, on behalf of the debenture holders, to a body called "The Manufacturers' Estates and Assets Company," for £66,000. The learned counsel submitted that if the facts he had stated were proved, plaintiff was entitled to damages. The result of the sale was that the debenture holders were paid in full; preference shareholders might possibly get one or two shillings in the £ out. Ordinary shareholders would get nothing.

The **Plaintiff** (Mr. Walter Glynn), who is a shipowner and managing director of the Leyland line, of Liverpool, gave evidence bearing out counsel's opening statement. He said there was not a word of truth in the prospectus of the Electric Works Company. If he had known that it was a cycle company he would have had nothing to do with it, and he did not think anyone else would. The first paragraph led him to believe that he was putting his money into a first-class engineering concern. Cross-examined by Sir Edward Clarke, he said the directors had deliberately put forward fraudulent misstatements. He could not readily point to a statement that was actually untrue, but the whole effect of it was misleading. He knew the names of the directors as gentlemen of integrity and practical electrical men, and had been influenced by that fact in subscribing for shares. If he had known the date of registration, or that the company was in liquidation, he would not have subscribed.

Mr. W. C. Spencer, accountant and joint liquidator of the British Electric Works Company, gave evidence of the profits of the company and the orders in hand when it was floated. The profits from February, 1899, to April, 1901, were: electrical goods, £15,520; cycle orders, £29,378; other goods, largely ammunition supplied to the Government and to Messrs. Vickers and Maxim, £54,070—total, £99,000. The orders in hand in April, 1899, were from £6,000 to £8,000, of which about £2,000 at the outside had been completed.

Other evidence was called to prove that the works had principally turned out cycle parts, and if orders had been received for electrical fittings it would have been necessary to equip the automatic machines with new tools adapted to that kind of work.

At the conclusion of the plaintiff's case, **Sir Ed. Clarke,** for the defendants, said he hoped to satisfy the Court that not only had there been no fraud at all on the part of the directors, several of whom had personally lost more money than the plaintiff, and who had no inducement whatever to put their own money and advise their friends and the public to put their money in the concern unless they believed it to be sound, but also that they believed, and had reasonable ground for believing, that the statements made in the prospectus were true. He contended that the prospectus clearly indicated that there was no goodwill, and that the company was going to open a new business. The history of the company was not the history of a bogus company, which did no business at all. So far from that, the business done, considering the circumstances, was not at all of a discouraging character.

A huge mass of evidence was called in support of the defendants' case, which occupied three or four days of this week.

The witnesses gave evidence for and against the contention that Hall's works were adapted for electricity, and the traveller for the Electric Company testified to never receiving more than two orders for electric work, one of which was not accepted. All the business he had brought was connected with the cycle trade.

At the conclusion of the evidence and speeches by counsel,

Mr. Justice Bucknill proceeded to sum up. He had not concluded when the case stood adjourned.

IN RE CENTRAL LONDON RAILWAY BILL (1901).

In the Chancery Division of the High Court, before Mr. Justice Byrne on Saturday, **Mr. R. J. Parker** made an application in this matter for a payment out of court of the statutory deposit of between £23,000 and £24,000, lodged in relation to the Central London Railway Bill, as to which there was a very short point for his Lordship's decision. It was the general practice of the House when a Bill was directed by resolution not to be proceeded with to certify for the return of the deposit and require fresh proceedings in the following session, but in the case of this Bill it had made an exception. The resolution was that the Bill be not proceeded with, and then came the words "during the session," and the question was whether the addition of these words

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would affect the return of the deposit. The words of the Act on this point were only "shall not be allowed to proceed" without any qualification. All that was required on a petition for the return of the deposit was the certificate of the chairman of the committee in the House of Lords that the Bill was not allowed to be proceeded with.

His Lordship: I understand from you that it is only by the Standing Orders, and not under the Act, that the deposit is provided for?

Mr. Parker said that was so; the Standing Orders next session would provide for the lodging of a new deposit.

The application was granted.

COMPANIES' MEETINGS AND REPORTS.

NATIONAL TELEPHONE.

The twenty-eighth ordinary general meeting of the National Telephone Company was held yesterday at the Cannon-street Hotel. The president, Mr. James Staats Forbes, occupied the chair.

After the Secretary had read the notice convening the meeting, and also the auditors' report, the **Chairman** gave a *résumé* of the balance-sheet. The actual results of the half-year's trading was given in our last week's issue. The Chairman referred to the progress as being most satisfactory, in view of the fact that the public were somewhat inclined, in London at least, to defer making any contracts with the National Telephone Company for connection until they knew what the Government were going to do. He then referred to the tabulated accounts for the past seven years given in the report, and to the apparent increase in the percentage of working expenses to net income. This percentage, which was about 60 per cent. in 1898, was for the past half-year 65·12 per cent. This increase, the chairman explained, was due to innovations in the method of keeping their accounts. In view of the uncertainty as to what would happen to the Company in the future, they, with the concurrence of the auditors, had written off more than usual from the value of their plant and stores, and had also carried more to reserve. He then proposed the adoption of the account.

A Shareholder asked the chairman if he could not inform them as to what agreement had been come to, or was likely to be come to with the Government?

Mr. Forbes objected to give any information at that stage of the meeting, as it had nothing to do with the accounts.

Mr. Kelly pointed out some errors which he thought existed in the report, as he could not see that the figures on the first page of the same agreed with the accounts on the second and third pages; also he considered they should have some definite policy by which the ordinary shareholders would be protected from the loss of their capital some 10 years hence, when the Government license expired, otherwise they would find their capital wasted. Besides making more provision in the way of reserve funds, he thought that some scheme for making new subscribers financially interested should be adopted. If, for instance, they made each new subscriber find £40, which was approximately the average cost of connection as shown by the books, they would then give the subscriber eight ordinary shares in the Company, on which he would receive interest in the usual way. He would be allowed to sell the shares, so that at the present time it would only mean an outlay of £8.

The **Chairman**, in reply, said that they had listened with great attention to the proposed scheme, which would have their consideration. He thought, however, that difficulties would arise in getting new subscribers to pay down £40. Even at the present time it was not easy to get subscribers to pay their subscriptions in advance.

The accounts were then adopted without a dissentient vote, and the following directors, who retired this year, were re-elected: Mr. James Staats Forbes, the Right Hon. Sir James Fergusson, Bart., G.C.S.I., M.P., Mr. Eli Heyworth, and Mr. Samuel Herrick Sands.

After the auditors had been elected, the chairman was again questioned as to the negotiations with the Government, but beyond stating that such negotiations were proceeding, he gave no definite information to the meeting. He expressed, however, his own belief in the future prosperity of the Company, and hinted that it might survive the normal period of its license, even as some of its directors had exceeded their threescore years and ten. He did not think it was in the interest of the Company to make any disclosures until an agreement was actually under seal. He believed that an agreement would ultimately be arrived at which would benefit the Company, and also the general public, especially in the London district.

The meeting concluded by a vote of thanks to the chairman, directors, and the members of the staff of the Company.

WATERLOO AND CITY RAILWAY.

Presiding over the half-yearly meeting of the proprietors at Waterloo Station, **Lieut.-Colonel Campbell** (the deputy-chairman) said the authorised capital was £720,000, and £599,000 had been created—namely, £540,000 ordinary stock and £59,000 debenture stock. Five hundred and ninety-nine thousand one hundred and eighty-four pounds had been expended on capital, including £4,392 during the past half-year. Seven hundred and thirty-four pounds had been spent on electrical pumps, and £3,657 had been paid to the contractors for the electrical equipment. The total expenditure to the present time was well within their original capital powers and account, and they still had £112,482 available to meet any future expenditure. They had put down £15,000 for future expenditure, but that was a mere estimate, and they did not know at the present time whether they would be called on for anything. The passenger fares during the past half-year amounted to £16,429, as against £14,357 in the corresponding period of 1900. Government duty was more in consequence (£328 as against £287), making the net amount £16,101, as compared with £14,070, or an advance of over £2,000. They considered this satisfactory, and they hoped the shareholders would also. Rents were more by £150 (£213 as against £63), and transfer fees were the same—£10. These figures together gave the total of £16,325 on the credit side of the account. On the other side they found that the working expenses during the past six months were £8,937, as against £7,773, or an increase of £1,200, but the ratio of expenses to receipts was a little less—54·78 per cent., as against 55 per cent. As a matter of fact, the actual working expenses for the half year ending June 30, 1900 (a year ago) were £9,445, and if the figures of £8,937 (actual working expenses for the past half-year) was compared with it, it would be seen that there had really been a saving of £500. The figure of £7,773 was shown in the accounts for the half-year to June, 1900, because under the working agreement the South-Western Company were not entitled to more than 55 per cent., though the actual working expenses might exceed that amount. The difference between the receipts and the expenses was not sufficient to pay a dividend at the rate of 3 per cent. on the ordinary and borrowed capital, and the deficiency (£1,567 on this occasion) was again made up by the working company under their agreement. This made £7,370 retained by the South-Western Company, and if to that was added £263 for general charges there remained a balance of £8,691 to be carried to the net revenue account. He moved: "That the directors' report and statement of accounts for the half-year ending June 30, 1901, be received and adopted."

Sir Charles Scotter seconded the motion, which was carried. A further resolution was also agreed to: "That a dividend at the rate of £3 per cent. per annum be declared on the Company's ordinary stock for the half-year ending June 30, 1901, and that the same be payable (subject to income tax) on Aug. 10, 1901."

LIVERPOOL OVERHEAD RAILWAY.

The half-yearly meeting of this Company took place at Liverpool on Tuesday, Mr. G. H. Robertson occupying the chair.

In moving the adoption of the report, the **Chairman** said the directors regretted that, in common with almost every other railway, they had to face a reduced dividend as compared with the corresponding half of last year. This was chiefly caused by the increased price of coal and the materials used by the Company, but some of these charges would be very considerably reduced during the next half-year. They were now paying 46 per cent. less for coal, and with careful management they hoped to place the Company in the same position as before with regard to dividend. They were very well satisfied with the working of the electric tramways from Seaforth to Crosby, and looked for even better results in the near future. During the past half-year there had been an increase of passengers carried by the railway and trams of 694,362, the trams alone conveying 908,936. The total number carried was 4,473,288, and the train mileage run was 398,802 miles. The Company had been singularly free from accidents, and 96 per cent. of their trains had run punctually. The structure had been very carefully maintained, and the rolling-stock was in excellent condition.

The report and balance-sheet were then adopted, and the dividends of 5 per cent. on the preference and 2 per cent. on the ordinary shares were declared. Replying to shareholders, the Chairman said the directors had been considering a scheme for the junction of the line with the Lancashire and Yorkshire Railway at Seaforth, but had so far been unable to arrange satisfactory terms.

The proceedings then closed.

BRITISH COLUMBIA ELECTRIC RAILWAY.

The ordinary general meeting of this Company was held on Monday, Mr. Horne Payne, K.C., in the chair.

In moving the adoption of the report, the **Chairman** congratulated the proprietors on the very satisfactory result of the year's operations. There had been a satisfactory growth in the business of the Company both as regarded railway and lighting departments, the latter having shown an increase in the number of lamps in use of 12,535. The supply of electrical power for commercial purposes was also satisfactory. The net earnings for the year ending 1898 were £27,870, while for the last year they were £41,092, an increase in 2½ years of no less than £13,212. The net profit for the year, including the sum brought forward, was £37,553, and after deducting interest and interim dividends there remained £19,103, and from this sum the directors had decided to write off preliminary expenses, £1,218; to provide for the balance of the year's dividend on the preference shares, £3,400; to recommend the payment of a final dividend on the ordinary shares of 2 per cent., making 4 per cent. for the year, which, including income tax, would absorb £4,421; to transfer to capital amortisation account, £5,000; to transfer to reserve for depreciation, £5,000; and to carry forward to next account, £64.

The motion having been seconded, was adopted *nem. con.*

BAKER STREET AND WATERLOO RAILWAY.

In their report for the half-year ended June 30 last, the directors state that the capital expenditure during the half-year amounts to £276,851. Of this £146,208 has been spent on land, the principal item being the cost of the Indigent Blind School, the site of the depôt and generating station. Negotiations are still proceeding for the transfer of the contracts from the liquidators of the London and Globe Finance Corporation to other parties. The sub-contractors are still proceeding with the works, the most important being the second

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tunnel under the river, which is making good progress. The engineers advise that, having regard to recent improvements in electrical traction, there will be no difficulty in fulfilling the conditions shadowed forth in the interim report of Lord Rayleigh's Committee, and that the railway can and will be worked so as to avoid any objectionable vibration. The engineers report that the western tunnel between the river shaft and Waterloo has been extended to York-road, where it joins the large station tunnel at Waterloo. A length of 20 yards of that tunnel has been constructed, and the tunnel face is within the London and South-Western Company's property. The driving of the eastern tunnel, between the river shaft and Waterloo, was commenced on May 13 last. It has now reached a point 90 yards south of the shaft, the face being partly in clay and partly in ballast, air pressure having been used since June 24. Northwards, the gap existing in the eastern tunnel between Charing Cross and the Haymarket has been filled up. This tunnel is now complete, together with its large station tunnels between the river shaft and a point in Regent-street just north of the junction of Conduit-street. The western tunnel was stopped on May 4 at a point in Regent-street, 107 yards north of Vigo-street. Between that point and Waterloo this tunnel is also complete, with the exception of the enlargement required for the station tunnel at the Victoria-embankment. In accordance with the instructions of the directors that the work should be confined to the part of the line south of Oxford-street, the tunnels being driven southwards from Baker-street Station were stopped on May 4 last. The western tunnel had then reached a point in Portland-place, 154 yards south of Park-crescent, and the eastern tunnel a point in Regent's Park, 80 yards from the north side of Park-square. With regard to the station works at Waterloo, the two lift shafts and the stair shaft have all been sunk to the full depth, and preparations are being made to construct the passages from the shafts to the tunnels. At the surface the lift chamber has been walled in, and is ready to receive the iron flooring above it as soon as delivered by the makers. At Piccadilly the station works remain as last reported—namely, the passages from the tunnels are complete as far as the shafts, but have not yet been continued round them. At Oxford-street the adjoining property on the west of the site has been underpinned, the remaining house is being pulled down, when the sinking of the 18ft. stair shaft will be proceeded with.

CITY OF LONDON ELECTRIC LIGHTING.

In their half-yearly interim report the directors state that, in accordance with the intention which he expressed at the last ordinary general meeting, Sir David Salomons, Bart., resigned the chairmanship and his seat on the Board in March last, much to the regret of his colleagues, and Mr. George Herring was unanimously elected chairman in his stead. The number of customers and lamps connected on July 17, 1901, were 10,060 and 522,497 (equivalent of 8 c.p.) respectively, and in addition to the lamps connected there were 14,483 awaiting connection on completion of the consumers wiring, etc. The gross revenue for the first six months of 1901 amounted to £126,122, an increase over the previous year of £25,572. After payment of interest on the first and second debenture stocks and loans, the net revenue available for depreciation, reserve, dividends, and special charges, etc., for the first six months of 1901 (including the amount of £11,342 brought forward from 1900), is estimated to be not less than £50,000, as compared with £19,538 (which included £1,622 brought forward from 1899) for the corresponding period of 1900. This result has been largely brought about by the reduction in the price of coal and the economies which have been successfully effected by the Company's engineer in connection with the new continuous-current plant. The interest on the first and second debenture stocks, and an interim dividend on the Company's preference shares for the six months ended June 30 last, have been paid. The directors regret to have to report that they have not yet succeeded in making any satisfactory arrangement with the Corporation with reference to the street-lighting under the two contracts which were declared void by the Court of Appeal in February last. In March last the directors proposed a conference. This was acceded to by the Corporation, but subsequently postponed at their request. Pending the result of these negotiations, the public lamps are being supplied on the same terms as heretofore. The Company's appeal against the excessive assessment of the generating station proposed by the Southwark rating authorities has been successful.

METROPOLITAN DISTRICT RAILWAY.

The directors in their report for the half-year ended June 30 last state that the total receipts for the half-year have been £200,748 against £224,429 for the corresponding half of 1900, showing a decrease of £23,681. The working expenses have been £113,195, against £108,868 for the corresponding half of 1900, being an increase of £4,327. The revenue account shows a profit of £87,552, against £115,561 earned in the corresponding half of 1900, being a decrease of £28,008. The number of passengers carried, exclusive of season-ticket holders, were 19,564,846, and the receipts, including season tickets, were £188,697, as against £212,212 for the corresponding period of 1900. The net revenue, after paying the interest on debentures and debenture stock, and the several rent charges, leaves a balance of £23,810. This amount will only admit of a payment for the half-year of a dividend on the 4 per cent. guaranteed stock at the rate of £3 per cent. per annum. Four per cent. per annum having already been paid on this stock up to Feb. 28 last, the dividend for the remaining four months of the half-year will be at the rate of £2. 10s. per cent. per annum, the residue—£523—being carried forward. If approved, the dividend for the four months ended June 30 will be payable on Sept. 1 next. The result of the working of the half-year, the report goes on to state, reveals too fully the serious consequences to the District Company of the competition of the Central London Railway, as already experienced in the preceding December half-year, now aggravated by the effect upon the traffic of the extension of the tramway system on roads running parallel to the western extension lines. The falling off in numbers of passengers has been very large, and the receipts are less by £23,700. Concurrently with this, working expenditure has increased £4,300, chiefly attributable to the enhanced price of coal, materials, and augmented rates and taxes. The general result of the net revenue account is that after meeting the debenture and other fixed charges the balance is only sufficient to allow of payment of a dividend at the rate of £3 per cent. per annum on the 4 per cent. guaranteed stock. Meanwhile, in order to cope with the severe competition referred to, there has been a revision of fares, which has already tended to diminish the possibility of further loss of passengers. Much anxious attention is being given to this fares question, which is, however, one of great difficulty and complexity in the case of the District Railway, with its relations and obligations to the Metropolitan and other companies running in connection with it. The Ealing and South Harrow line is approaching completion, and the Bow and Whitechapel works, which have involved considerable difficulties of construction and some delay in the matter of the "Housing Clauses" are now progressing more rapidly. The line will probably be ready for opening in a few months, when a considerable accession of traffic to the District Company may be anticipated. The Company's Bill promoted in the present session has passed the committee stages in both Houses of Parliament, and has now received the Royal assent. The most important provision of the Bill is the confirmation of the agreement entered into with the Metropolitan District Electric Traction Company, Limited, for the "electrisation" of the Company's lines, the conditions of which have been submitted, fully explained and unanimously approved at the special general meeting held for that purpose on June 6 last.

BRITISH ELECTRIC TRANSFORMER MANUFACTURING.

The directors' report for the year ending June 30 states that the business of the Company continues to show a satisfactory and steady rate of increase. After paying all manufacturing costs and expenses of administration, and providing for repairs and depreciation, there remains a net profit of £6,658, which, with the amount brought forward from last year—viz., £1,802—makes a total available balance of £8,460. The directors recommend a dividend at the rate of 10 per cent. per annum (one half of which was paid as an interim dividend on Feb. 4) for the year ended June 30, placing to reserve fund £2,500, and carrying forward £1,960. The directors point out that while the capital upon which the dividend is paid has been doubled during the year owing to the vendors' shares now ranking for dividend, the rate of dividend has not been reduced from that paid last year. A plot of freehold land was purchased at Hayes, Middlesex, in the beginning of the year, and new works are now being erected thereon, which, it is hoped, will be completed about October. The directors expect to be able to erect and equip these new works without increasing the capital of the Company. The Board have granted a license to the Union Elektricitäts-Gesellschaft, of Berlin, to manufacture transformers in accordance with their letters patent in Germany.

BLACKPOOL AND FLEETWOOD TRAMROAD.

The report of the directors for the half-year ended June 30 last shows that, including the sum brought forward, the balance of profit, after providing for debenture interest, is £3,557, and the directors recommend a dividend at the rate of £4 per cent. per annum, which will absorb £3,000, and writing off a sum of £500 to depreciation reserve, leaving a balance of £57 to be carried forward. The number of passengers carried during the half-year was 648,569. The receipts from all sources amounted to £10,183.

APPOINTMENTS VACANT.

Mains Superintendent, Corporation of Carlisle, £100 per annum, Aug. 20. Full particulars in our advertisement columns.

Electrician wanted who understands steam and oil engines, accumulators, etc. Full particulars in our advertisement columns.

Electrical Engineer, Bedford Corporation electricity department, £350 per annum, Aug. 20. Full particulars in our advertisement columns.

Draughtsman, to take charge of drawing office for firm of consulting engineers, £3 to £3. 10s. per week. Full particulars in our advertisement columns.

Resident Electrical Engineer and Manager, Finchley Urban District Council, £300 per annum, Aug. 19. Full particulars in our advertisement columns.

Foreman Cable Jointer (Working), Battersea Borough Council electric lighting department, £2. 10s. per week, Aug. 21. Full particulars in our advertisement columns.

Chief Assistant at the Partick Burgh Council electricity works; previous experience in a three-wire continuous-current station and thorough knowledge of batteries essential; £104 per annum. Full particulars in our advertisement columns.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Walthamstow.—The Urban District Council invite tenders for house wiring. Tenders by Aug. 30. Details in our advertisement columns.

Bournemouth.—The Town Council invite tenders for water cooler and travelling crane. Tenders by Aug. 31. Details in our advertisement columns.

Leigh.—The Electricity and Tramways Committee invite tenders for the supply and erection of one steam dynamo. Tenders by Aug. 24. Details in our advertisement columns.

Amsterdam.—The Corporation invite tenders for tramcars for electric traction with overhead wire (perhaps 140). Tenders by Sept. 2. Details in our advertisement columns.

Bournemouth.—The Town Council invite tenders for boilers, superheaters, economiser, feed pump, pipework, and accessories. Tenders by Aug. 29. Details in our advertisement columns.

Aston Manor.—The Urban District Council invite tenders for pipework, fitters' shop, and cables for their proposed electric power station. Tenders by Sept. 4. Details in our advertisement columns.

Ilford.—The Urban District Council invite tenders for the construction of about 11 miles of tramways. Specification, etc., may be obtained of Mr. John W. Benton, clerk, Council Offices, Ilford. Tenders by Aug. 31.

St. Annes-on-the-Sea.—The Urban District Council invite tenders for one 180-kw. continuous-current direct-coupled steam dynamo, the engine to be "single-acting." Tenders by Aug. 23. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of electrical repairing stores, electrical fitters' tools, tramcar truck accessories, and oil and grease. Tenders by Aug. 24. Details in our advertisement columns.

Scarborough.—The Town Council invite tenders for the maintenance of all fire-alarms, telephones, electric bells, etc. Specifications, etc., may be obtained on application to Mr. Harry W. Smith, borough engineer, Town Hall. Tenders by Aug. 22.

Edinburgh.—The Corporation invite tenders for the electric lighting installation, etc., of the second portion of the Colinton Mains fever hospital, the number of lighting points being about 800. Tenders by Sept. 9. Details in our advertisement columns.

Farnham.—The Urban District Council are desirous of contracting with a responsible firm for the supply of electricity under the requirements of their Electric Lighting Order, 1900, in their area. Proposals by Aug. 27. Details in our advertisement columns.

Brighton.—The Guardians invite tenders for installing electric light in a portion of the workhouse premises in Elm-grove. Specification, etc., may be obtained at the office of Mr. B. Burfield, clerk, Parochial Offices, Prince's-street, Brighton. Tenders by Aug. 20.

Darlington.—The Corporation invite tenders for the supply and delivery of one Lancashire boiler (first extension), one 350-h.p. engine, coupled to a continuous-current dynamo (first extension), and extension steam, drain, and feed pipes. Tenders by Aug. 22. Details in our advertisement columns.

Paregwyllt (near Bridgend).—Tenders are invited for the lighting by electricity of Paregwyllt Asylum, near Bridgend. The clerk of works will attend at the asylum by appointment to give all necessary information. Tenders to be sent to Mr. Hugh W. Davies, clerk of asylums, Bridgend, by Aug. 24.

Withington (Lancs.).—The Urban District Council invite tenders for the construction of a line of telephones between the town hall, Withington, and the refuse destructor and sewage works. Particulars may be had on application to Mr. A. H. Mountain, A.M.I.C.E., Town Hall, Withington, near Manchester.

Glasgow.—The Corporation invite tenders for the supply, delivery, and erection complete of the overhead trolley constructional work required for the extension of the tramways system. Specification, etc., can be had on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by Aug. 30.

Mansfield.—The Electric Lighting Committee invite tenders for refuse destructors (to deal with the whole of the refuse of the borough) by Sept. 5. Specification, etc., may be inspected at the offices of Mr. Robert Hammond, M.I.C.E., the consulting engineer to the Corporation, 64, Victoria-street, Westminster, London, S.W.

Croydon.—The Lunacy Visiting Committee invite tenders for the execution of the wiring for the electric installation, including ring main and feeders, sub-mains, lamp circuits, switchboards, distribution boards, fittings, etc. Specification, etc., can be inspected at the Borough Engineer's Office, Town Hall, Croydon. Tenders by Aug. 26.

Warlingham (Surrey).—The Croydon Town Council invite tenders for wiring, including ring main and feeders, sub-mains, lamp circuits, switchboards, distribution boards, fittings, etc., at the lunatic asylum, Warlingham, Surrey. Specifications, etc., can be obtained at the Borough Engineer's Offices, Town Hall, Croydon. Tenders by Aug. 26.

Aston Manor.—The Urban District Council invite tenders for water-tube boilers, stokers, and economiser, two 500-kw. steam dynamos, one 200-kw. steam dynamo, motor balancer, switchboard and testing-room, travelling crane, and arc lamps for their proposed electric power station. Tenders by Sept. 4. Details in our advertisement columns.

Middlesbrough.—The Electric Lighting Committee invite tenders for the supply and erection of mechanical coal-handling plant in connection with the municipal electricity works. Specification, etc., may be inspected at the offices of Mr. Robert Hammond, M.I.C.E., consulting engineer to the Council, 64, Victoria-street, Westminster, London, S.W. Tenders by Sept. 3.

Birkenhead.—The Corporation invite tenders for the supply, delivery, and erection at their generating station, situate in Cravenstreet, Birkenhead, of a steam engine and dynamo. Specification, etc., can be obtained on application to the borough electrical engineer, Mr. William Bates, A.M.I.C.E., Corporation Electricity Supply Station, Bentinck-street, Birkenhead. Tenders by Aug. 23.

Worcester.—The Corporation invite tenders for water-tube boilers, economisers, steam and feed pipes, pumps, steam dynamos, motor-alternator, booster, Korting condensers, electric pumps, cast-iron suction, delivery, and exhaust pipes, tank, switchboard, overhead travelling crane, and accumulators, for the new electricity works. Tenders by Aug. 23. Details in our advertisement columns.

Batley.—The Corporation invite tenders for the supply, delivery, and laying in the borough of Batley of steel rails, points, crossings bonds, and accessories, granite setts, stone setts, wood blocks, concrete, and all excavation work, and laying of the permanent way for tramway (approximately 3½ miles). Specifications, etc., may be obtained from the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by Sept. 14.

London County Council.—The County Council invite tenders for track rails and fastenings, slot rails and fastenings, tiebars, and conductor tees, and roadwork and platelaying required for the reconstruction on the conduit system of the tramway routes between Westminster Bridge, Blackfriars Bridge, and Waterloo Station respectively, and Tooting. Specifications and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

St. Helens.—The Electric Supply and Tramways Committee invite tenders for the purchase of one 120-kw. direct-driven steam alternator and exciter, horizontal engine by Robey and Co., Lincoln, alternator by Johnson and Phillips, 2,000 volts, 60 periodicity, Ferranti switchboard and instruments, arranged for two distributing circuits, two alternator circuits, and synchronising gear, eight 21-kw. transformers, 2,000 to 200 and 100 volts, steam and exhaust pipes, valves. Details in our advertisement columns.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a continuous-current 1,500-kw. dynamo working at from 550 to 625 volts, and the erection of these sets in the generating station of the South London Electric Supply Corporation, near Loughborough Junction. Also for three auxiliary 250-i.h.p. vertical high-speed enclosed steam-engines, each coupled direct to a continuous-current dynamo working at from 200 to 225 volts, and for the erection of these sets in the Council's generating station at Greenwich. Specifications and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

RESULTS OF TENDERS.

Mexborough.—The Prism Globe Company, Limited, have secured the contract for arc and incandescent street-lighting.

Sunderland.—The tender of S. Warburton, Manchester, has been accepted for the erection of car-sheds at Hylton-road.

St. Annes.—The Urban District Council have accepted the tender of Smith and Co., Southport, for wiring and fitting on the deferred payment system.

Newcastle.—The New Tramways Committee have accepted the tender of R. C. Brebner and Co. for the construction of the new tramways at Gosforth.

Ilford.—The Urban District Council have accepted the tender of H. G. Ellis (trading as the Electrical Contracting and Engineering Company), High-street, Ilford, at £205, for work in connection with the electric lighting of the town hall.

Stockport.—The Tramways Committee have received the following tenders for the electrical wiring of the car sheds:

Shaw and Co., Stockport	£145
S. Fildes, Stockport	157
D. Frith and Son, Manchester	205
National Electric Wiring Company, Liverpool	204
National Electric Wiring Company (alternative)	175
H. A. Jackson, Burnley	214
Fidler and Roberts, Stockport	151

BUSINESS NOTES.

TRACTION.

Oldham.—The Tramways Committee have placed an order for 12 additional cars.

Bolton.—The tramway receipts for July were £6,822, as against £6,586 for July last year.

Leigh.—The Town Council have resolved to make application for powers to construct and work electric tramways.

West Cumberland Tramways.—The West Cumberland Electric Tramways Bill has been read a third time and passed in the House of Lords.

British Electric Traction Co.—The directors have declared the dividend on the 6 per cent. preference share capital for the half-year to Aug. 15.

Colne.—The Corporation have come to terms with the promoters of the Colne and Trawden Light Railway with regard to the carrying out of the scheme.

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Perth.—A motion will be submitted at the next meeting of the Town Council that the Corporation proceed to acquire the tramway undertaking by arbitration.

Scarborough.—By 10 votes to 9 the Town Council on Monday decided to let a private company construct and work the proposed electric tramways in the town.

Liverpool.—Mr. James Steele has succeeded at the Liverpool Assizes in recovering £80 damages from the Corporation in respect of injuries received to his cart in a tramcar collision.

Private Bills.—In the Commons the Manchester and Liverpool Electric Express Railway Bill and the Portmadoc, Beddgelert, and South Snowdon Railway Bill have been read a third time.

Ralby-with-Hexthorpe.—The District Council have decided to support the scheme of electric light railways to be laid under the Doncaster Corporation Light Railway Order in the district.

Dewsbury.—The Town Council have decided to give notice requiring the Dewsbury, Batley, and Birstall Tramways Company to sell to the Corporation so much of their undertaking as is within the borough.

Ipswich.—Sir Frederick Bramwell has held an arbitration as to the price to be paid by the Corporation for the Ipswich tramways undertaking, which the Corporation have now definitely decided to purchase.

Carlisle.—Among the new regulations for the working of the tramways is one to the effect that the cars shall be free from the clatter of machinery such as to constitute any reasonable ground of complaint.

Birkenhead.—The Board of Trade inspection of the three new electric tramway routes, Higher Tranmere, Claughton, and Park-road North, took place on Tuesday, and the following day the service along these lines was opened.

Jarrow.—In connection with the electric tram service between Jarrow and South Shields, the British Electric Traction Company purpose erecting a bridge of light construction across the River Don near the old church at Jarrow.

Brighton.—An extension of the electric railway along the beach, from the Aquarium eastwards, has just been completed, whereby passengers can be carried as far as Blackrock, where the line connects with the sea-going car to Rottingdean.

Doncaster.—A proposal of the Tramways Committee, submitted at Wednesday's Town Council meeting, to take a slight deviation in the route through the markets, and to take part of the wool market and use one bay of it as a car-shed, was agreed to.

Ashton-under-Lyne.—Progress regarding the proposed tramways for the borough was reported at Wednesday's Town Council meeting, and an offer of 2d. per yard for a plot of land, situate in Mossley-road, for the purpose of a car-shed to hold 45 cars was accepted.

Sedgley.—The British Electric Traction Company have assured the Urban District Council that everything in their power will be done to get the work authorised under the Dudley and Wolverhampton tramways order completed within the shortest possible time.

Light Railways (No. 2) Bill.—This Bill, which has for its object the extension of the operation of the Light Railways Act, and the appointment of another commissioner at a salary of £1,000 a year, was read a second time in the House of Commons on Wednesday.

Erdington.—The recommendations of the special committee (noted in these columns last week) for the construction of electric tramways in the district has received the approval of the Corporation, and it is intended to promote a Bill in Parliament to authorise the scheme.

Merthyr.—Notice has been given to the Urban District Council of the intention of the British Electric Traction Company to apply to the Board of Trade for their approval to the transfer of their undertaking at Merthyr to the Merthyr Electric Traction and Lighting Company.

Middlesbrough.—Colonel Von Donop, of the Board of Trade, on Monday inspected the new line of the Imperial Tramways Company laid between the Royal Exchange and the Clarence Ferry, Middlesbrough, and the new cars, which have been specially built for that portion of the traffic.

Imperial Tramways Co.—The directors of the Imperial Tramways Company, Limited, have declared an interim dividend for the half-year ending June 30 at the rate of 8½ per cent. per annum. The interim dividend for the corresponding period of last year was at the rate of 7½ per cent. per annum.

Newport (Mon.).—The arbitrators have fixed the purchase price to the Corporation of Messrs. S. Andrew's interest in the horses, tramcars, and lands and buildings at £15,295, £9,000 of this being for lands and buildings. The County Council have decided to make a contribution of £9,000 to this object.

Richmond.—It was reported at the last meeting of the Town Council that, in accordance with the resolution passed at the previous meeting of the Council, the London United Tramways Bill was successfully opposed before the House of Lords Committee, the portion of it relating to Richmond being thrown out.

Birkdale.—The District Council have resolved to give the usual statutory notice for purchasing the undertaking of the Birkdale and Southport Tramways Company within the urban district, in accordance with the agreements entered into between the Council and the British Electric Traction Company in February last year.

Sheffield.—An open-air meeting of ratepayers has unanimously adopted a resolution strongly protesting against the 2d. tram fare to Nether Green in view of the fact that the fare to other outlying parts of the borough is only 1d. At their meeting on Wednesday, the Corporation decided to maintain the 2d. fare to Nether Green.

West Bromwich.—The Town Council have instructed the borough surveyor to prepare the necessary plans and specifications for the reconstruction of the permanent way of the old tramways (about 12 miles of track) in conjunction with the consulting engineer, and have appointed Mr. R. C. Quin, of Blackpool, to that position.

Leeds.—The Corporation have adopted a resolution of the Tramways Committee that whilst unable to entertain the request for extra pay on Sundays and holidays, they are quite willing to consider some scheme by which the tramway employés may have a more frequent day's holiday (say one day in eight) and shorter hours on each Sunday.

Stretford.—At the last meeting of the District Council it was stated that the Tramways Committee would do all in its power to press for payment of wayleave rent from the date of the notice of purchase of the Manchester Tramway Company's lines until such time as the Corporation of Manchester took up the lease to work the traffic by electricity.

Blackpool.—The *Blackpool Gazette* announces that Mr. R. C. Quin, the borough electrical and tramway engineer, has formally given notice that he intends to vacate the position he has held at Blackpool for some years. According to our contemporary, Mr. Quin has so many offers of consulting work as an electrical expert that he would prefer to have an entirely free hand.

Halifax.—The Town Council have accepted the recommendation of the Tramways Committee to adopt the arrangement (noted in last week's issue) to have boxes attached to tramcars, and letters placed in such boxes by the public to be collected by the Post Office officials at certain hours during the day, the terms and number of collections to be fixed by the postal authorities.

Glasgow.—The work of erecting the overhead equipment on the portions of the tramway system still operated by horses is being pushed forward, and the Govan routes from Paisley-road Toll to Linthouse are now open for electric traction. It is anticipated that the electric cars will be running to Ibrox and Halfway House by the end of this week, so that the through service between the city and Govan will be carried on.

Superiority of Electric Traction.—Speaking at the half-yearly meeting of the shareholders in the London Road Car Company, Lieut.-Colonel C. F. Colville said: "The directors are fully aware that other means of transportation may in the near future supersede that of the horse, and are making enquiries and experiments. The shareholders may be sure we are not asleep as to the question of electricity."

Tramway Strikes in Italy.—The employés on the electric tramways at Rome have gone on strike, and the car service is almost entirely suspended. The strikers number 1,200, and 50 cars which are still running are being guarded by carabineers. The latest message from Rome states that the strikers have held several meetings, but perfect tranquility has been maintained. The tramway employés of Naples and Milan have also struck.

Aberdeen.—The work of tramway extension in Great Western-road, by the laying down of a double line of track from Mannofield to Holburn-street, is now approaching completion. It will be some little time, however, before the electrical equipment of the route, which is about a mile in length, is completed. As no accommodation has yet been provided at Mannofield for electric cars, it is proposed in the meantime to give a service of horse cars.

Gateshead.—The Parliamentary Committee have called the attention of the Town Council to the fact that injury has occurred to children who had fallen by being jammed underneath the fenders placed in front of the tramcars, and that this tends to the opinion that such fenders are not sufficient for the purpose intended. The Town Council have adopted a schedule of ½d. tram fares in the borough and of 1d. fares on light railways.

Birmingham.—An inquest was held last week on the body of William Hubball, who was run over by an electric tram on the Bristol-road route. In returning a verdict of "accidental death," the jury expressed the opinion that the safe-guards as now arranged on the trams were defective. They were also of opinion that the protector would be more effective if it projected in front of the car, and that some appliance should be carried with the car to lift it in case of emergency.

Colchester.—With regard to a suggestion which has been made that the tramways order should be amended so as to empower the Town Council to adopt, if desired, a system of cars or omnibuses propelled on the electric trolley principle, but without tramlines, the Board of Trade have written that such a proposal could not be entertained by them under the Tramways Act, 1870. They would receive a deputation on the subject if the Council still desired. The Council, however, have decided, under the circumstances, that a deputation would serve no useful purpose.

Bristol.—The tramway trouble is now practically over. The company announced on Tuesday that they had appointed all the drivers required to all the vacancies caused by the discharge of their employés. The usual service of cars has now been resumed. At a trade union meeting some speakers said the men had been beaten because of the unfortunate state of the labour market. Others denied that the struggle to establish trades unionism amongst the tramway workers was at an end, and professed a determination to continue the effort to secure for the men liberty to combine.

Dudley.—At the recent Birmingham Assizes Miss Sarah Thomings sued the Dudley, Trowbridge, and District Electric Traction Company for damages in respect of personal injuries sustained in a recent tramway accident. It was stated, in evidence, that a car going from Dudley to Netherton left the rails on the occasion in question, and finally dashed into a wall in the side of the street. It was contended that the accident was due to negligence on the part of the company's servants, and in the result the jury awarded the plaintiff £75 damages. Arising out of the same accident Dr. O'Dowd has recovered £50 damages from the company for injuries to his ribs and left leg.

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Hyde.—At the monthly meeting of the Town Council this week it was stated that the proposed tramways would be laid at the earliest possible moment. With regard to the recent hearing of the Tramway Bill before a committee of the House of Lords, the proceedings proved what a dangerous thing it was to allow any private company to come into a town. The Oldham, Ashton, Denton, and Hyde Tramway Company made a stubborn fight against the Bill, and yet it was surprising on what small grounds they fought. It has been decided to form a general board, consisting of six members of each of the four corporations, for the purpose of carrying out the joint tramways scheme.

Tramcar Accidents.—On Saturday last accidents occurred on three important electric tramway systems in England—namely, Devonport, Liverpool, and Margate. At the last-mentioned town a tramcar was descending the steep incline of Fort-hill when it left the rails and dashed into and wrecked the front of a draper's shop. Five people were injured, most of them seriously. Two passengers were injured in Liverpool, where the trolley wire snapped and fell to the pavement. Some of the outside passengers on a car sustained electric shocks, and others in their alarm jumped over the top rail to the ground. At Devonport two persons were seriously injured through the collision of two cars, owing to the failure of the brakes of one while descending a hill.

Cheltenham.—A coroner's jury last week enquired into the circumstances surrounding the death of two men who were killed by the overturning of an electric car during a trial trip. The evidence showed that while descending a hill the brakes of the car failed to act, with the result that in turning a curve it left the rails and overturned. The jury came to the conclusion that the men died from injuries accidentally sustained by the overturning of an electric car which was not under proper control, but they attached no blame to anyone. They considered that in consequence of the steep gradients and curves on Cleeve-hill, the proposed tramcars were too heavy to be used with safety to the public upon the hill portion of the tramway system, and expressed their approval of the steps being taken to improve the brake power.

Ayr.—The Tramways Committee reported at the meeting of the Town Council on Monday on the reports of the slow progress being made by Messrs. Hurst, Nelson, and Co. with the completion of the cars, and the town clerk was instructed to intimate to them that the Corporation are disappointed that the cars have not yet arrived, that the system is ready for the use of the cars, that a large loss will thus be entailed upon the Corporation, that the cars should have been completed some time ago, and that the Corporation must hold them liable in terms of the contract. Mr. Fuller, burgh electrical engineer, intimated that he had visited the contractors' works, and, from what he could see, he was of opinion they would be unable to deliver two complete cars in less than three weeks, unless the work were pushed on very rapidly, and, in his opinion, to the detriment of the cars.

Bradford.—When the new section of the Corporation tramways to Queensbury was opened recently the fare charged from Horton Bank Top to Queensbury was 2d., while the return journey was made for 1d. As the result of protests the Tramways Committee have now fixed the fare at 1d. either way. The Tramways Committee recommends the City Council to enter into an agreement to take over the lines leased to the Bradford Tramways and Omnibus Company and the Bradford and Shelf Company as and from Feb. 1, 1902, upon the terms previously arranged and ratified in the Bradford Act of this year. This recommendation has received the approval of the Town Council. The Corporation have already started the conversion of the Leeds-road line so as to adapt it for electric traction, whilst the Idle and Thackley extension lines are nearing completion. The latter lines will run to within one mile of Apperley Bridge.

Cardiff.—The provisional agreement between the Corporation and the directors of the Cardiff Tramways Company for the purchase of the company's lines for £40,000 has been unanimously confirmed. It is proposed to obtain the sanction of the Local Government Board to the borrowing of the money. The company have commenced the reconstruction of their line between Clifton-street and Broadway. At a meeting of the Finance Committee on Tuesday, the town clerk and borough engineer presented reports with reference to the borrowing powers of the Corporation under the Act of 1898, which empowered the Council to obtain a loan of £850,000 for tramway and other purposes—£421,000 was taken for tramways, and, in addition to this, £5,449 had been spent. It was resolved that the borough engineer be asked to report on the point whether the cost of paving all the roads was included in these borrowing powers.

Yarrow.—A public meeting was held recently at Yarrow to consider the proposed Yarrow Valley light railway scheme. It was explained that the proposed line would start at Selkirk and run to St. Mary's Loch. The distance is 16 miles 12 chains, and this part of the railway system would cost about £67,000. It is proposed to connect the railway with Selkirk Station with a tramway, at a cost of about £3,000—total cost, £70,000, exclusive of cost of land. A revenue of £80 per week would represent £4,160 per annum, and say for working expenses one-half—£2,080 per annum—which would leave a fair balance for interest on the capital. A motion was unanimously carried to the effect that it is desirable that a railway should be formed between Selkirk and St. Mary's Loch, and a committee was appointed to approach the Duke of Buccleuch and other proprietors interested to ascertain if they would be willing to consider the scheme favourably.

Newcastle.—At a special meeting of the Tramways Committee the sub-committee recommended the appointment of Mr. Rossignol as general manager and electrical engineer of the new tramway system, at an increase of £250 a year over the £500 per annum received by him as resident engineer. It was eventually agreed that before proceeding further with this appointment the sub-committee should be authorised to obtain information from other towns as to whether it is advisable that the duties should be wholly performed by the electrical engineer, or whether they should be shared by a general commercial manager. During July 2⅞ miles of single track have been completed, and 2⅝ miles are in progress. This makes a total of 22½ miles complete out of the 31 miles at present contracted for. It was further stated that the new system would probably be ready for traffic by the end of October or early in November. The work at the power station as well as on the overhead system is proceeding satisfactorily.

Walsall.—In their last report to the Town Council the Tramways Committee state that they have had an interview with the managing director of the tramway company with respect to a suggestion made by him, that, instead of waiting for the expiration of the lease for three years from Jan. 1 last, arrangements should be entered into at once between the Corporation and the company for the reconstruction and re-equipment of the old lines and the construction and equipment of the proposed extensions and for the whole being worked by the company on terms to be agreed, the Corporation providing the electric current required at an agreed price. In order to ascertain the views of the Council, they submitted a proposal to the General Purposes Committee that, subject to satisfactory terms being arranged, it would be expedient to lease the tramway lines and the proposed extensions. This recommendation, however, was not adopted by the General Purposes Committee, and the Tramway Committee intimate that they will proceed to obtain tenders for constructing and equipping the extensions authorised.

Rotherham.—The Earl of Jersey, G.C.B., and Colonel Boughey, C.S.I., Light Railway Commissioners, sat on Monday at the Rotherham Borough Court House to publicly enquire as to the expediency of granting the application for the construction of a light railway between Rotherham and Laughton, known as the Rotherham and Laughton Light Railway. It was stated by counsel for the promoters that railway No. 3 had been withdrawn. The chief object of the laying-out of the railway was the development of the mineral estate, which was part of one of the largest virgin coalfields in England. The estimate for the two railways Nos. 1 and 2 was just over £80,000, including the land, contingencies, and everything. The proposed capital was £90,000, with the usual borrowing powers. A considerable body of evidence having been taken, Lord Jersey said the commissioners were not prepared to recommend the line. The coalfield was a very small one in comparison with that for which the big railway companies were competing, and undoubtedly there would be competition with the Shireoaks line.

Sunderland.—The recently completed section of the municipal electric tramways extending to Grangetown has been inspected by Colonel Von Donop on behalf of the Board of Trade, and the route is now open to the public. The inspector, however, has recommended the Corporation to substitute drooping lifeguards for those which are at present fixed on the cars. The resignation of Mr. Wm. Morrison, traffic manager, has been accepted. The Tramways Committee recommended the Town Council at their quarterly meeting on Wednesday to extend the electric tramways (single line) down the High-street to the East-end, near the barracks, at an estimated cost of £7,480 for laying the line, and £10,006 for road alterations and paving. Consideration of this matter was adjourned, but the Council agreed to take the requisite steps for obtaining a provisional order for extending the tramways from the Hylton-road and Kayll-road to Pallion railway station, and also for deviating the tramways already authorised to be laid in Fulwell-road by taking them through Gladstone-street and Ravensworth-terrace to Roker-avenue. The estimated cost of the extension to Pallion Station is £9,180.

Protecting St. Paul's.—Whatever danger there may be to St. Paul's Cathedral through the existing tube lines north and south of the structure, says the *Daily Chronicle*, it is now considered certain that no new underground railways will be constructed at a nearer distance, as was feared. Of the two tubes which have threatened the cathedral very seriously, the one which proposed to pass under the south side of the churchyard was viewed with greater apprehension. This was the scheme of the Victoria, City, and Southern Electric Railway, which would have put its lines almost under the foundations of the south transept, the weakest part of the cathedral. That Bill, however, is dead. The second danger was that of the Piccadilly and City Railway, which proposes to pass down Carter-lane, the first street immediately south of the cathedral. Sir Douglas Fox, engineer to the company, is now in negotiation with the Dean and Chapter, and although the precise terms of the arrangement which it is proposed to offer cannot yet be disclosed, it is understood that the Carter-lane route is to be given up. Sir J. Wolfe Barry, who is at present in Scotland, is retained by the Dean and Chapter to defend their interests from the engineering standpoint.

Warrington.—The Corporation have approved a plan submitted by Major Cardew showing the proposed alterations of the old gasworks which it is proposed to utilise for car-sheds It has been further resolved that the London and North-Western Railway Company be requested to proceed with the construction of the rails over the level crossing at Wilderspool, and that Major Cardew be authorised to make arrangements with the company as to the cost of the works; that Major Cardew be authorised to arrange with Mr. Ewart, the contractor, for the construction of the tramway from Warrington Bridge to the level crossing and for a short distance on the other side of the crossing; that the poles for the overhead equipment to be erected in Wilderspool-causeway and the widened portion of Knutsford-road be placed in the centre of such roads, and that provision be made for the lighting of the roads by alternate arc and incandescent lamps to be fixed to the poles; and that Tramway No. 10 be proceeded with and tenders obtained for the construction of the works. The Board of Trade have sanctioned the borrowing by the Corporation of £60,050 for tramway purposes. The Council will now apply for prolongation of the time for the completion of the tramways.

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Tramway Competition.—Lord Stalbridge, presiding over the half-yearly meeting of the London and North-Western Railway Company on Tuesday, said the main feature of the traffic was an increase in the average value of the passenger and the loss in the short-distance traffic—due doubtless to the competition of the electric tramways. These electric tramways and light railways were increasing all over the country. In some cases they acted no doubt as feeders to the main lines of railways, but in many cases they diverted the local traffic from the railways. A shareholder also remarked that the electric tramway traffic would no doubt go on, and the question was what should be done. The whole of the railways were raised under parliamentary supervision, and it was perfectly monstrous that in their free country the municipalities should be entitled to come in and deplete them of their legitimate traffic. There was no industry in the country which had been of such advantage to the people as the railway interest, and it was absurd that when the price of every other commodity had been raised, they were not enabled to raise their rates. Presiding at the meeting of the Great Northern Railway Company on Friday, the chairman, Mr. W. L. Jackson, M.P., told the proprietors that the company was associated in misfortune with every other railway concern in the kingdom. Electric traction accounted for a loss of 300,000 of their passengers.

Staffordshire.—With respect to the applications of the Potteries Electric Traction Company for sanction to a scheme of light railway extensions in the district, the County Council have made the following representations—viz.: that, owing to the narrowness of the Bucknall and Werrington road from Hanley boundary to Townsend in places, and to the large amount of traffic thereon, the carriageway should be widened to at least the full statutory tramway width—*i.e.*, 9ft. 5in. on each side of the railway; that the (Weir) county bridge is not only too narrow, but is also too weak for carrying the light railway, and that if the scheme is sanctioned arrangements should be made for strengthening as well as widening this bridge; that the Hanley and Smallthorne road from Hanley boundary to Sneyd Green is unsuitable for a light railway owing to its extreme narrowness. At the last meeting of the Council the clerk submitted letters and plan from the British Electric Traction Company as to the taking up of the existing Wolverhampton and Willenhall tramway, and the relaying of same, together with the views of Heath Town Urban District Council on the proposal which he had communicated to the company and the Board of Trade as the objections of the County Council as the "road authority." It was resolved that the matter be referred to the Tramways and Light Railways Sub-Committee, with power to negotiate with the traction company and report thereon.

Middlesex.—The County Council have appointed Mr. W. Howard-Smith, A.M.I.C.E., assistant engineer, at £600 a year, to take charge of the tramway schemes. At the last County Council meeting the Tramway Committee reported that they had taken the necessary steps to oppose the Finchley and Hendon Tramways Bill in the House of Commons, as they are of opinion that it may be possible to come to some arrangement under which the tramways proposed to be authorised by the Bill may, if the Bill becomes law, be worked in connection with the County Council's light railways. The Light Railways Committee reported that instructions had been given for the withdrawal of certain sections of lines comprised in the extensions order No. 3, including so much of that railway as lay between South Hill-avenue, Sudbury-hill, and a point at the foot of the hill in Peterborough-road, near the Harrow Metropolitan Railway Station. The committee proposed to consider the question of an alternative route between South Hill-avenue and the foot of Peterborough-hill, in view to this section being promoted in November next. The committee had not thought it desirable to withdraw any of the lines comprised in No. 4 order. The Chairman said there were reasons why what he had to bring forward with regard to this latter order should not be discussed, which the clerk would be pleased to explain to any member at the close of the meeting. It was agreed that the Light Railways Committee should be empowered to take any steps in regard to order No. 4 which might be found necessary during the vacation.

Electric Traction in Germany.—A Foreign Office report shows that no branch of German industry during the last decade has shown such marvellous development as electricity. The German electrical plants have considerably enlarged their works, and the capital sunk in them is about £35,000,000. The engineers look to railways as the future field, but at present there is only a small experimental railway at Wannsee, which connects Berlin with that suburb. Up to this time it is only working as far as Zehlendorf, a place in the neighbourhood, but the results are at present favourable. Two large firms have called into existence a German "Studien Gesellschaft" for electric quick railways. Soon after the formation of this society the Prussian Minister for War placed at their disposal the military railway, Berlin-Zossen, a distance of 20 miles. Quick trains driven by steam at present average a speed of 40 to 45 miles per hour—occasionally of 50 to 60 miles—but the company hope to achieve a speed up to 155 miles per hour. The biggest scheme on foot is one directed by Messrs. Philippi and Griebel for connecting Berlin and Hamburg with a quick electric railway at an estimated cost of £7,000,000. A 10-minute service is proposed morning and evening, but later on an eight-minute and even a five-minute interval is contemplated. Each carriage is to carry 60 passengers, so that by ten-minute intervals 360 passengers can be transported, and in 16 hours 5,760 persons daily in each direction—together, 11,520 persons; whilst with eight-minute intervals 144,000 passengers can be carried. Three wagons, working at five-minute intervals, can carry 69,000 persons.

Salford.—It was reported at the last meeting of the Town Council that the action which had been taken by the Corporation to oppose the proposals contained in the Manchester and Liverpool Electric Express Railway Bill of last session, had resulted in inducing the Commons' Committee to adopt the suggestion put forward on behalf of the Corporation that the railway, so far as it was to be constructed in the borough, should be constructed in tunnel. At the monthly meeting of the Town Council various correspondence relating to the negotiations between the Salford and the Manchester Corporations with regard to the recent tramway trouble was produced, and a long discussion ensued. A resolution was proposed: "That this Council expresses its regret that the Tramways Committee have not as yet succeeded in providing tramway transit into and from Manchester, in accordance with the resolution passed at the last meeting of the Council, and hereby requests such committee to use all expedition in the matter." Eventually, however, the motion was withdrawn, and the discussion ended. At the last meeting of the Electricity Committee the Electrical Engineer stated that Messrs. Glover and Co. would undertake to complete the laying of the following cables by the undermentioned dates if the Corporation would waive their right to penalties up to Sept. 30: from Strawberry-road works to feeder box 20, on Broughton Bridge, and from Strawberry-road works to feeder box 26, in Bury New-road, enabling cars to be run from Blackfriars Bridge along Great Clowes-street and Great Cheetham-street West, to Kersal, by Sept. 30, 1901; from Strawberry-road works to feeder box 17, in Bolton-road, enabling an improved service of cars to be run from town to the Height, by Oct. 31, 1901. The electrical engineer also stated that cable work already provided for would allow of a service of cars from town to Pendleton by about Sept. 30, and that the cables to Regent-road sub-station were to be completed by Aug. 25.

Military Motor Trials.—The programme for the trials of self-propelled lorries for military purposes has now been arranged. The districts embraced contain very steep gradients, so that the vehicles will have as thorough a test as possible. The routes are as follows: (1) Aldershot, Hale, Odiham, Hartley Row, Hartford Bridge, Blackwater, Bagshot, Chobham Ridges, Frith Hill, Frimley Green, Farnborough Station, and back to Aldershot; (2) Aldershot, Farnham, the Hog's Back, Guildford, Worplesdon, Bisley, Donkey Town, Bagshot, and back to Aldershot; (3) Aldershot, Aldershot Station, Ash, Wyke, Puttenham, Peper Harow, Milford, Hindhead, Tilford, Farnham, and back to Aldershot; (4) Aldershot, Hale, Odiham, South Warnborough, Alton, Farnborough, and Aldershot; (5) should it be decided to make the journey from Aldershot to Chatham, the route will be from Aldershot to Farnham, Guildford, Merrow, Gomshall, Dorking, Reigate, Redhill, Westerham, Seal, Borough Green, Leybourne, Ditton, Maidstone, and Horsted to Chatham. Captain Lloyd, R.E., secretary of the War Office Committee on Mchanical Transport, in a circular letter to local authorities, states that it is anticipated that no lorry, when fully loaded with fuel, water, and carried load, will weigh more than seven tons. This weight will probably be borne on four wheels, and the driving wheels, on which the greater portion of the weight—say five tons at the outside—will be borne, must, by the conditions of the competition, be at least 9in. wide across the tyres. The trailers, which may possibly be two-wheeled vehicles, are not likely to weigh, when fully loaded, more than 3½ tons. The number of vehicles competing is estimated at between 30 and 40, though it is possible that a smaller number may be eventually be brought to the trials. The committee have addressed a letter to the local authorities concerned expressing the hope that there will be few, if any, places along the routes chosen over which such moderate loads as those anticipated cannot be safely borne. They further ask the local authorities to give them every facility for carrying out these most important trials, and, should the nature of the roads chosen render objections necessary, they ask that alternative routes may be suggested.

LIGHTING AND GENERAL.

Stroud.—The question of the electric lighting of the town is being held over for a time.

The Pacific Cable.—The Pacific Cable Bill has passed through Committee in the House of Commons.

Dublin.—The Corporation have obtained sanction to a loan of £254,000 for electric lighting purposes.

Montrose.—The Lighting Committee have approved the electric light company's design for leading lamps.

Macclesfield.—The Royal assent has now been given to the Corporation's electric lighting provisional order.

Nantwich.—The preliminary plans for the Urban District Council's electric lighting scheme will be submitted next week.

East Molesey.—The clerk has been instructed to apply for a provisional order for the lighting of the district by electricity.

Felixstowe.—A special meeting of the whole Council will shortly be held to consider the question of electric lighting in committee.

Morecambe.—The Corporation have decided to take preliminary steps towards borrowing £2,000 sanctioned for electric light purposes.

Cape-Australian Cable.—The Cape-Australian cable of the Eastern Extension Telegraph Company is expected to be open before the end of next October.

Personal.—We hear that Mr. C. E. Hume, main superintendent at Bristol, has been appointed resident engineer at Twickenham lighting station.

Blackrock.—The Urban District Council have arranged terms with the National Telephone Company for providing the town with a telephone service.

Carnarvon.—The Town Council have authorised the Electricity Committee to communicate with their parliamentary agents with a view to obtaining an electric lighting provisional order.

Sleaford.—The Urban District Council have decided to complete the borrowing of £6,798 for electric lighting purposes. The electric light will be switched on in the town on the 2nd prox.

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Friern Barnet.—It was reported last week that the Board of Trade have authorised the Urban District Council to supply in their district electric energy for public and private purposes.

Derby.—Arrangements have now been made to extend the electric lighting mains to the Parkfield Estate, at a cost of about £450. The mains are also to be extended to West-avenue and Wilson-street.

Wakefield.—The electrical engineer is about to prepare a scheme and estimate for lighting with electricity the more important streets in which electric mains are laid, and not included in the scheme already approved by the committee.

Pokesdown.—The Urban District Council have agreed to support the application of the Bournemouth Corporation for an electric lighting provisional order in preference to the application of the Poole Electricity Supply Company.

Cleckheaton.—It was reported at the meeting of the District Council on Tuesday that the Local Government Board had sanctioned the borrowing of £24,990 for the purposes of the Council's electric lighting and refuse destructor scheme.

Hebburn.—The District Council have decided to transfer to the Northern Counties Electricity Supply Company the Council's electric lighting provisional order. It has been agreed that the public lighting shall not be restricted to the compulsory area.

Partnership.—Mr. Jas. Calmon, of 23, Temple-row, Birmingham, informs us that he has taken Mr. D. J. D. Morgan, late of the Electrical Trades Supply, Limited, into partnership, and that the firm will henceforth be known as Calmon and Morgan.

Normanton (Yorks).—The Urban District Council have given their consent to the West Riding Traction and Electrical Supply Company making application for a provisional order for the supply of electrical energy for power purposes within the Council's area.

Heywood.—Consideration of tenders for the supply of electric motors for the electricity station has been adjourned until the next meeting of the Electric Lighting Committee. A telephone is to be fixed from the electricity works to the municipal buildings.

Staffordshire.—The County Council have resolved not to object to the Postmaster-General laying telegraph cables on the sides of the main roads for which permission has been asked, subject to the positions of the same being as suggested by the chief surveyor.

Grantham.—We understand that the Telephone Committee of the Town Council have already obtained promises from 73 subscribers to the proposed municipal telephone system. It is estimated that the annual cost of working a municipal system will be under £500.

Rochdale.—The local School Board has signed a petition to the Corporation for the establishment of a municipal telephone system. A long discussion took place on the question of municipal telephones at the last Town Council meeting, but nothing definite was arrived at.

Whitby.—The Urban District Council have confirmed the minute of the Electric Lighting Committee as to the charges for the supply of electric light to private consumers. The charge has been fixed at 6d. per unit for private supply for lighting, and 3d. per unit for power and heating.

Tynemouth.—The Town Council decided on Wednesday to borrow £23,000 for the extensions contemplated at the electricity works. The applications for power and current, it was stated, were coming in so satisfactorily that within a short time it would be a profitable undertaking.

Colchester.—The Corporation have obtained sanction to the borrowing of £15,825 for electric lighting purposes. The engineer's latest report shows that the output of electricity during June was 4,464 units, as compared with 2,720 in June of last year. The number of consumers has increased from 105 to 178.

Electrical Workers.—At a meeting of electrical workers at Glasgow, under the auspices of the Electrical Trades Union, several addresses on the benefits of organisation were delivered by Mr. H. Newell (secretary of the London Building Trades Council), Mr. A. Ewer (general secretary of the Electrical Trades Union), and others.

Cowdenbeath (Fifeshire).—We hear that this mining town is to have the streets lighted by electricity. A steam-engine and dynamo are to be placed at a colliery adjoining the town, and the current will be distributed to about 320 electric incandescent lamps erected on the gas-lamp pillars. Messrs. Hunter and Jack, Glasgow, will carry out the work.

Penarth.—We note that the generating station which has been erected by the Electrical Power Distribution Company is now complete, and supply will probably be commenced within a few days. The pair of Mordey Universal dynamos which have been installed, are designed and built to supply on the continuous-current system at a pressure of 230 volts.

Aylesbury.—The Urban District Council have decided to consult Mr. F. H. Medhurst on the proposals for the lighting of the town by electricity before proceeding further in the matter. It was stated at the last Council meeting that proposals had been received from the Metropolitan Electrical Power Distribution Company and Messrs. Taylor and Co.

Poole.—In reply to a protest from the Town Council the Board of Trade have refused to revoke the Poole and Branksome Electric Lighting Order, 1897, stating that the Board were not prepared to do so at the present time, but that if at the expiration of a year the undertakers were still in default the Board would then be prepared to consider the matter.

Ashton-under-Lyne.—The two following recommendations of the Electricity Works Sub-Committee have been referred to the General Purposes Committee: (1) that application be made to the Board of Trade to borrow £30,000 for extensions, alterations, etc., at the Wellington-road works, and (2) that the laying of a main along Manchester-road be proceeded with.

Ipswich.—The Town Council have rescinded their previous resolution on the subject, and have decided that the proposed generating station and destructor shall be placed upon the site known as the Seven-Acre Field. The Electric Lighting Committee and Public Health Committee will accordingly take the necessary steps to amend the plans for erecting the buildings.

Perth.—The Corporation have agreed to extend the electric lighting main to St. Stephen's Church for the lighting of the church hall. Mr. Lambert has reported that he cannot recommend the extension of the distributing network in Blackfriars-street, the demand being comparatively small. The mains in the Dunkeld-road district, however, are to be extended at a cost of £280.

Colne.—The General Purposes Committee are considering the advisability or otherwise of lighting the public streets by electric light, and the engineer has been instructed to test the different makes of meters and indicators on the market, and afterwards procure tenders for the supply of these. The electrical engineer estimates the cost of lighting the town hall by electricity at £190.

Eastbourne.—The question of the proposed purchase of the telephone undertaking was discussed at the quarterly meeting of the Town Council. The committee recommended that the terms on which the National Telephone Company was prepared to sell its undertaking be accepted. The terms are 21 years' purchase of the last year's profits. In the result, however, the report was referred back for reconsideration.

Birkdale.—The *London Gazette* gives notice of the intention of the promoters to transfer the undertaking authorised by the Birkdale Electric Lighting Order, 1898, to the Birkdale District Electric Supply Company. The transfer is proposed to be made in consideration of £700, and the Urban District Council will reserve the right to purchase the undertaking at the end of 14 years from the date of the deed of transfer.

Sunderland Telephones.—A device has been adopted in the National Telephone service at Sunderland by which the subscriber has only to remove the receiver of the telephone from the rest and place it to the ear, and then wait for the exchange operator applying for the number required. After the conversation is finished the replacing of the receiver again notifies to the exchange that the call has been completed.

Sheffield.—A recommendation was received at Wednesday's meeting of the Town Council that application be made for sanction to borrow £83,257, in respect of capital expenditure, in connection with the electric supply undertaking up to June 30 last, and also £500,000, the estimated expenditure on mains and ordinary extensions of the undertaking up to June 30, 1902, and the purchase of land and the erection and equipment of a new power station.

Boston.—At the request of the Corporation Mr. A. Collins, A.M.I.C.E., London, has submitted to that body a report upon the electric lighting of the borough. Mr. Collins recommends the Council to adopt the continuous-current distribution system. He estimates the cost of the scheme at £28,500, and a profit of £2,153, when the works are fully loaded, and suggests that the Council should charge 4·75d. per unit for private and 2·25d. for public lighting.

Stock Exchange.—The Stock Exchange Committee has appointed Wednesday, Aug. 21, special settling day for the Motor Manufacturing Company's further issue of 5,334 shares of £1 each, fully paid, Nos. 247,633 to 252,966. The committee have received an application to allow the following security to be quoted in the official list: British Electric Traction Company's further issue of 30,000 6 per cent. cumulative preference shares of £10 each, fully paid, Nos. 160,001 to 190,000.

Stockton-on-Tees.—The Rural District Council decided on Wednesday to apply to the Board of Trade for a provisional order empowering them to supply electricity for lighting and motive power. It is not proposed to erect an electric power plant, but to purchase in bulk from the Cleveland and South Durham Electric Power Company or the Stockton Corporation, and retail it to ratepayers in the principal villages of the district—namely, Eaglescliffe, Norton, Preston-on-Tees, Billingham, Carlton, Hartburn, and other places in the district.

Share Market.—At the end of last week there was nothing whatever doing in electrics and tractions. While electrics were stagnant, however, tractions were steady, but without business. City preferences were ¼ lower at 11⅞-12½. The new week opened with Power Gas at the same—viz., 1⅛-1⅜ premium, and Babcock and Wilcox ordinary 2⅞-2⅞. City Electrics were enquired for on the improved interim report, and were quoted 8-9. Tractions were steady and unchanged. In electrics the next day Westminsters were good, but Notting Hill were ¼ lower at 14⅞-15¼. Tractions were inactive. Potteries preference fell ¼ to 9⅞-10¼. Yesterday electric debentures were in demand, but there was very little doing in the shares.

Ayr.—The following report of Mr. A. J. Fuller was adopted at the last Town Council meeting: "I beg to report that the whole of the works have run satisfactorily during the last month. With regard to extensions, these are being pushed on as rapidly as possible, and I am very pleased to be able to report that with the arrival of a small making-up pipe, we shall be in a position to supply current for the tramways at the main switchboard at any time. The lighting feeders have been laid up to the Wallace Tower, and the remaining cables for the main supply have been tested and are on the way. Progress: Number of consumers as per last report, 469; number connected during the month, 6 total, 475. Lamps connected per last report, 20,465; lamps connected during the month 140, total (equivalent 8 cp.) 20,605. Units generated per last report, 40,454; units generated during the month, 24,318—total, 64,772." The Board of Trade have forwarded new regulations for ensuring the safety of the public and a sufficient supply of electrical energy.

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West Bromwich.—The Electric Lighting Committee's recommendation to make the alternative charges for electricity during the summer months on the basis of a flat rate at 4d. per unit from April 1 to Sept. 30, and the maximum demand system from Oct. 1 to March 31, was considered at length by the Council at their last meeting. Eventually the matter was held over till next meeting.

Hull.—The Electric Lighting Committee met on Tuesday and considered a report of the electrical engineer on the breakdown of the electric lighting system on Saturday last on the occasion of the severe storm. It appeared that the heavy rain had flooded the mains, and also damaged the generating plant, but that repairs were well in hand, and no further inconvenience need be anticipated.

Birkenhead.—The latest report of the Electricity Committee shows that during the quarter ended June 30 last there had been an increase of 4,461 units consumed over the same quarter last year, and there were seven more consumers. The town clerk has been instructed to give the necessary statutory notices for the laying of electric cables for street-lighting purposes in some 15 or 16 streets and squares.

Bury.—The Electric Lighting Committee reported at Tuesday's meeting of the Corporation that the Hospital-road extension had been completed. Three additional connections had been made, representing an increase of 87 8-c.p. lamps. The recording meters for the battery had been received, and were satisfactory. It was stated that the favourable results in regard to electric lighting were exceeding anticipation.

Lincoln.—The Electricity Works Committee have resolved to adopt an alternative rate for the supply of electricity for motive power of 2½d. per unit for the whole consumption, or of 4d. per unit for the first hour and 1d. per unit per hour for the whole consumption after the first hour on the maximum demand system, and to supply motors where required at an annual rental of 12½ per cent. on the cost of the motor and of fixing.

Leeds Telephones.—A resolution will be introduced at the next meeting of the City Council affirming the advisability of establishing a municipal system of telephone communication in the city. It will also be proposed to appoint a special committee to consider the question and report. It is said that this step is prompted by the numerous complaints that have been received concerning the existing service from business men and others.

Bradford.—A proposal for the establishment of a municipal telephone system in Bradford was discussed at a meeting of the General Purposes Committee last week, and a sub-committee has been appointed to investigate the subject. The Electricity Committee recommend the Council to increase the salary of the electrical engineer by £100 per annum at once, with a further addition of £100 per annum to take effect in 12 months' time.

Blackpool.—The Town Council have accepted the recommendation of the Electric Lighting Committee that alternating current be supplied for power purposes at 2½d. per unit. It was stated at the last meeting of the Town Council that hitherto electrical motors had not been satisfactory with the alternating current, but now there were motors in the market, of English make, which came out as economical and efficient as motors using the direct current.

Engineering Price-List.—We have received from the publishers, Messrs. Jas. Truscott and Son, the summer issue of "The Engineering Price-List," which is now in its ninth year of publication. While containing a large list of advertisements from a great number of firms, its disadvantage as a work of reference is that only firms advertising are included. Hence, while certain sections are well represented, only scanty information is to be obtained in others.

Belfast.—The Electrical Engineer stated at the last meeting of the Electricity Committee that he had received an application from Messrs. Harland and Wolff, Limited, for an installation of 250 h.p. for motor purposes, but that it would be necessary to expend a sum of close on £2,500 in order to put the department in a position to supply the necessary current. Under these circumstances Messrs. Harland and Wolff are to be asked to make an offer to the committee.

South Dublin.—Prof. George Forbes, F.R.S., has submitted to the Guardians a report on the proposed lighting and heating of the house by electricity. The report showed that a saving of £127. 7s. 9d. could be effected yearly by adopting the electric lighting, even if accompanied by gas. The principal saving, however, would be effected in the heating of the house from the exhausted steam. It was calculated that the saving in this respect would be £878. 15s. Consideration of the scheme has been postponed for 12 months.

Widnes.—At Tuesday's Town Council meeting the Electricity Committee reported with reference to the electrical provisional order that the confirming Bill had now received the Royal assent, and it was resolved that a sub-committee be appointed to consider and report as to the best practicable steps to be taken with a view to the generation and supply of electricity for power and lighting purposes within the borough, and also as to the desirability of making any provision for the establishment of a system of electric tramways in connection therewith.

Summer Outing.—The employés in the lamp works of the Sir Hiram Maxim Electrical and Engineering Company held their annual excursion on Thursday week. The party, numbering over 100, and accompanied by Mr. A. W. Hill (works manager), Mr. E. J. Sander (late works manager), and several members of the staff, left Liverpool-street Station at 7.35 a.m. *en route* for Clacton, where they arrived shortly after 10. The weather was perfect, and a thoroughly enjoyable day was spent by all. The majority of the party left for Liverpool-street on the homeward journey at 7.30, the remainder having made arrangements to stay at Clacton over the Bank Holiday.

Manchester Telephones.—Following upon the recent conference of representatives of Manchester and Salford Corporations, at which the question of a joint telephone board was considered, a meeting was held at Manchester on Tuesday of the joint sub-committee of corporations and district councils. The draft scheme which was formulated in May last, and submitted to the first joint conference by the town clerk of Salford, was discussed at length, and eventually a working basis was practically agreed upon. This is to be laid before the various local authorities in the area, who are to be requested to send representatives to a conference to consider the whole question in about a month's time.

British Thomson-Houston Co.—This company have already had to issue a new list of their polyphase induction motors, although the previous one was only dated January of this year. The new list, besides giving details of the standard sizes manufactured by this firm, also shows how such motors have been successfully used in practice. Pamphlet No. 105, issued by the same firm, deals with electrical hoisting and haulage machinery. Both direct-current and polyphase induction motors have been used by the company on such works as is shown by the illustrations given. The hoists are listed according to the horse-power of the motors and the speed of the weights lifted. This pamphlet is a most useful one for reference.

Century Electrical Exhibition.—With regard to the forthcoming Twentieth Century Electrical Exhibition, opening Dec. 16 at the Westminster Aquarium for six weeks, we are informed that although as yet but a small portion of the trade have been approached, a considerable amount of space is now let. Exhibitors already include Messrs. Geipel and Lange, the Simplex Steel Conduit Company, the Consolidated Telephone Construction and Manufacturing Company, Pritchetts and Gold, the Ingersoll-Sergeant Drill Company, Bastian Meter Company, Foxcroft and Duncan, Flather and Co. (of Leeds), Hedges, McKrell and Co., J. Defries and Son, Limited, Harry Cox and Co., Limited, and the British Manufacturing Company.

Drury Lane.—We understand that the two hydraulic and the two electric lifts at Drury-lane Theatre are being supplemented by a fifth, so that the several sections of the great stage can henceforth be separately raised, lowered, or tilted. Further alterations to the gridiron will enable all the fly arrangements to be worked from an electric switch, instead of, as hitherto, by hand labour. Mr. Arthur Collins is also introducing elaborate ventilating mechanism, associated with fans, for the purpose not only of correcting draughts, but of making the building warm in winter and cool in summer. In the interests of the new system of electric lighting, which is incidentally designed to yield beautiful scenic effects, the theatre's chief engineer is bound for America, to inform himself of the latest appropriate discoveries.

Naval Electricians.—It is reported that the Admiralty have decided to form a new rating of electricians for the navy for the purpose of attending to the repairs to the extensive electrical apparatus now in use. Candidates for this branch must be between the ages of 21 and 28 years, and will require to pass an examination which will be educational, theoretical, and practical. Accepted candidates will be entered as acting electricians, and must agree to serve for a term of 12 years. On entry they will undergo a course of study at one of the torpedo depôts, and if found duly qualified will be confirmed as electricians. The weekly rates of pay, according to class and service, will range from 38s. 6d. to 52s. 6d. Pensions will be awarded after 22 years' service under the ordinary continuous service conditions. The Admiralty, it is said, have authorised the immediate entry of 100 electricians, and preference will be given to candidates who have had experience as fitters in electrical shops.

London Gazette.—A second and final dividend of 5d. per £ has been declared in the estate of A. W. Hirst (trading as Hirst and Co.), St. Michael's-road, West Croydon; payable at Official Receiver's Office, 24, Railway-approach, London Bridge, S.E., from Aug. 27. The partnership formerly existing between W. J. Cooper and R. M. Power, trading as heating and electrical engineers under the style of Cooper and Co., 83 and 84, Bromsgrove-street, Birmingham, has been dissolved by mutual consent. A receiving order has been made out in the estate of W. R. Beckton, electrical and general engineer, 37, Stradella-road, Herne Hill, Surrey, and carrying on business at 17, Brownlow-street, Holborn, on debtor's petition. The first meeting in the estate of the above will be held on Aug. 21 at 2.30 p.m. at Bankruptcy-buildings, Carey-street, W.C., and the public examination at the same place on Sept 24 at 11 a.m. A receiving order has been made out in the estate of T. Morley, electrical engineer, 16, Whalley-road, Accrington, on debtor's petition.

Catalogues Received.—Messrs. Ward and Goldstone, of 45, Dutton-street, Strangeways, Manchester, have just issued a new list of the electrical supplies manufactured by them. Their high-voltage fuses and distributing fuse-boards for lighting work seem to be very convenient and serviceable. The fuse is taken through a W-shaped recess in a porcelain block, which offers a good cooling surface to extinguish the arc on the fuse going. The other advantage is that the fuse wire is visible through the glazed front of the case, so that one can easily see which fuse has gone. The other accessories include a line of main switches in glazed cases and a large number of electrical fittings. At the end prices and details for electric bell work are given.—Messrs. William McGeoch and Co., Limited, of London, Glasgow, Birmingham, and Sunderland, have sent us three of their new lists. These deal respectively with their high-voltage key type of lampholders, high-voltage main switches, and starting switches. All the articles in question appear to be well thought out and designed on good lines, while the prices strike one as being reasonable.

Lowestoft.—The sanction of the Local Government Board to a loan of £20,000 for electric lighting purposes has been received by the Town Council. At the last meeting of the Town Council the engineer (Mr. Bruce) reported that on the 2nd inst. there were connected to the supply 145 consumers, representing 7,525 8-c.p. lamps. There are 55 consumers waiting to be connected, representing, roughly, 2,000 8-c.p. lamps. The borough accountant presented the electric lighting

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accounts for the six months ending June 30 (the current, however, was not switched on until Feb. 12). These showed receipts amounting to £651. 6s. 4d. The payments had amounted to £550. 13s. 5d., leaving a balance of £100. 12s. 11d. The management and other expenses had amounted to £1,133, towards which £1,063. 19s. 9d. had been taken from the district rate. The capital expenditure to June 30 had been £26,830; amount yet to be expended, £23,170. The estimate of amounts required for the half-year ending Dec. 31 next included wages, coal, etc., £1,186; instalment of loans, £1,450—total, £2,636. Income was estimated at £1,423, and leaving a balance of £1,213 to be provided.

Musselburgh.—On Monday the position of affairs relative to the Musselburgh electric lighting scheme and the Musselburgh-Portobello electric tramway scheme was discussed at a special meeting of the Town Council. The Town Clerk reported that he had been in communication with the promoting company, and had received a telegram from the manager of the company to the effect that the position as regarded the lighting order was unchanged; finance was the serious difficulty as regarded both orders; the capitalists were considering the terms of concession too onerous; a meeting with the Council was suggested. The Town Clerk said the time for installing the light was up this month. Two years had elapsed. One year of the time for the formation of the electric tramway had elapsed, and if the company allowed this year to go they would have to make application for an extension of time, which application would certainly be opposed by the city of Edinburgh, who were against any company getting into their boundary. He had pointed this out to the company, and also that the Council were anxious that the scheme should go on at once. It was eventually decided that the Provost and Law Committee of the Council should confer with the manager of the company.

Marconi's Wireless Telegraphy Co.—In a circular to the shareholders in Marconi's Wireless Telegraph Company, Limited, the directors state that the development of Mr. Marconi's inventions is, in their opinion, making excellent progress, although they do not consider it desirable to publish particulars for the present. Additional expenditure is now required to further the business, to provide for which the directors have resolved to make a further issue of capital, and they now offer the shareholders, *pro rata* to their respective holdings, 40,000 shares at £2 each on terms. Messrs. Leonard Clow and Co., representing a financial group, including some of the directors, have in the meantime agreed to provide the Company with a sum of £30,000 on loan at 5 per cent. interest per annum, in further consideration of which the group has received the right to call for the allotment on or before Dec. 31, 1902, of such shares as may not have been accepted by the shareholders, as follows: (1) in the event of the total number of shares taken being less than 20,000 on the difference between such number and 20,000 at £2 per share, and on the remaining 20,000 shares at £2. 10s. per share; and (2) in the event of the total number of the shares so taken being 20,000 or more, on the balance of the 40,000 shares at £2. 10s. per share.

Wireless Telegraphy in the Atlantic.—The arrangements made "for shortening by almost a day the voyage between the United States and England" will be gathered from the following paragraph in the *New York Herald*: "By the establishment of the *Herald's* wireless telegraph station on the Nantucket Lightship the Transatlantic voyage is virtually shortened by almost a day—that is to say, passengers by incoming vessels equipped with the Marconi instruments will enter into communication with the American contingent, and through it with the whole world from 14 to 16 hours earlier than is the case at present. The installation of the station is rapidly approaching completion. By the end of the current week everything will be in readiness for the reception and dispatch of telegrams. It is the "Lucania," sailing from Liverpool on Saturday, Aug. 10, that will be the first Transatlantic steamer to greet the New World with a wireless message sent from a ship in mid-ocean. It is by the merest accidental combination of circumstances that this is the case, the "Lucania" being the first ship to sail from these shores after the completion of the arrangements on the Nantucket Lightship, but it is singularly appropriate that the old Cunard Company, the pioneer line of Transatlantic steamships, should inaugurate this magnificent achievement of Latin science, genius, and inventive skill, one that is destined to rob a long ocean voyage of the sense of isolation that for many is one of its greatest terrors."

Dewsbury.—The electricity accounts for the year just ended show a loss of about £257, for whereas now there is an adverse balance of £55. 7s. 10d., 12 months ago there was a credit balance of £201. 9s. 9d. This is accounted for by extraordinary expenditure. The cost of generating electricity and of repairs and maintenance last year amounted to £1,574. 9s. 9d., as compared with £1,275. 3s. 7d. in the previous year. The coal bill advanced from £495. 18s. 7d. to £780. 11s. 2d., and repairs cost £134. 10s. 11d., as compared with £111. 12s. 8d. For the distribution of electricity £332. 14s. 8d. is put down in this year's abstract, whereas the amount in last year's was only £93. 9s. 1d. One item alone goes a long way towards explaining this difference—namely, £150. 4s. 6d. for alteration of incandescent lighting, rendered necessary by increase of voltage. There is also £114. 6s. 8d. for attending to and repairing public lamps, the item last year being only £57. 7s. 10d. Rates and taxes have also gone up from £197. 12s. 11d. to £260. 19s. 6d. For the sale of current there was received £4,404. 19s. 11d., as against £3,861. 12s. 11½d., and for meter rents, etc., £138. 5s. 1d., compared with £121. 11s. On the general working there was a margin of £1,741. 3s. 11d., and this sum is carried to the net revenue account, on which the total income is £2,004. 13s. 1d. Against this there is interest (£972. 2s. 7d.) and contribution to the sinking fund (£1,032. 10s. 6d.), hence the debit balance of £55. 7s. 10d. The balance-sheet gives the assets as £41,032. 0s. 6d., and the liabilities as £35,888. 12s. 4d., leaving a surplus of £5,143. 8s. 2d. Last year's surplus was £4,204. 18s. 1d.

PROVISIONAL PATENTS, 1901.

JULY 30.

15384. Improvements in electric conductors and cables. William Ernest Hitch, 11, Burlington-chambers, New-street, Birmingham.

15385. Improvements in or relating to telegraph receiving apparatus. Alexander Marr, 18, Cawdor-road, Fallowfield, Manchester.

15399. A simple improved clutch mechanism for electric arc lamps. John Lenderyon, Brookwood, Rogerstone, Monmouth.

15412. Improvements in electric interrupters for induction coils. John Francis Hall-Edwards, 18, Southampton-buildings, Chancery-lane, London.

15427. An improved process for the electrolytic deposition of metals. Pascal Marino, Quentin Marino, Guy Marino, and André Ratchkowsky, 45, Southampton-buildings, Chancery-lane, London.

15448. Improvements in recorder bebbins for use in submarine telegraphy. Marie Joseph Pelenc, 18, Buckingham-street, Strand, London.

15460. Improvements in electric clocks. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Actiengesellschaft Magneta, Switzerland.)

15461. Improvements in electric clocks. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Actiengesellschaft Magneta, Switzerland.)

15463. Improvements in secondary battery plates. Berthold Kuettner, 37, Chancery-lane, London.

15465. An improved holder for electric incandescent lamps. Frank William Cue and Percy William Paris, 37, Chancery-lane, London.

15467. Improvements in and connected with wireless telegraphy and other signalling. Jagadis Chunder Bose and Sara Chapman Bull, 70, Chancery-lane, London.

15474. Improvements in systems of telegraphic distribution. Philip Middleton Justice, 55, Chancery-lane, London. (The Rowland Telegraphic Company, United States.)

15475. Improvements in systems of telegraphic intercommunication. Philip Middleton Justice, 55, Chancery-lane, London. (The Rowland Telegraphic Company, United States.)

JULY 31.

15483. Improvements in electric switches. Thomas William Broadbent and Ernest Brook, Market-place, Huddersfield.

15490. Improvements in unipolar dynamo electric generators and motors. Rankin Kennedy, 8, Markham-avenue, Leeds.

15496. Compound electric safety fuse and switch. Thomas George Weatherhead, 9, Moreton-place, Pimlico, London.

15499. An improved glove or hand covering for use in the handling of electrically-charged bodies or the like. Joseph Wilkinson and Thomas Dawson Clothier, 8, Quality-court, Chancery-lane, London.

15508. Improvements in safety devices for overhead electrical circuits. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Albert H. Armstrong, United States.) (Complete specification.)

15509. Improvements in electric controllers. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (John B. Linn, United States.) (Complete specification.)

15514. Improvements in or relating to electrical primers, vent sealing tubes, and the like. Harold Thomas Ashton, 111, Hatton-garden, London.

15517. Improvements in electric railways. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

15522. Improved system of wireless telegraphy with tuned microphone receivers. Victor Isidore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

15524. Improvements relating to electrically-driven centrifugal blast fans. Hermann Grüll, 45, Southampton-buildings, Chancery-lane, London.

15530. Improvements in and relating to the driving mechanism of automatic electric switches. Paul Thieme, 322, High Holborn, London. (Complete specification.)

15536. Improved apparatus for the reinforcing and standardising of filaments of glow lamps. Ferdinand Fanta, 1, Queen Victoria-street, London.

AUG. 1.

15563. Improvements in fuse boxes for use in connection with the supplying or transmitting of electrical energy. Malcolm Walker, 17, Hanover-street, Keighley.

15579. Improvements in or relating to electrolytic apparatus. Alfred Julius Boult, 111, Hatton-garden, London. (The American Alkali Company, United States.) (Complete specification.)

15618. Improvements in electrical instruments. John Gray and Patrick Hamilton, 18, Southampton-buildings, Chancery-lane, London.

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15598. Improvements in printing telegraph machines. Alfred Lyster Shepard, 8, West Kensington-gardens, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 3, 1901, being date of application in France.) (Complete specification.)

AUG. 2.

15653. Improvements in method of and apparatus for controlling automatic electric circuit breakers. The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, Bush-lane House, Cannon-street, London.

15659. Improvements in or relating to the lighting of railway tunnels by electricity. George Westinghouse, Westinghouse Building, Norfolk-street, Strand, London.

15664. Improvements in electric clocks. Thomas John Murday and the Standard Time Company, Limited, 19, Queen Victoria-street, London.

15671. Improvements relating to dynamo-electric generators and motors. Alexander Churchward, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15674. Improvements in the construction of storage batteries. Allessandro Gabitti, Clun House, Surrey-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 2, 1901, being date of application in Italy.)

15680. Improvements relating to dynamo-electric generators and motors. Alexander Churchward, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15686. Improvements relating to commutator brushes for dynamo-electric generators and motors. Alexander Churchward, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15689. Improvements in electric incandescence lamp-holders and switches therefor. John Robert Quain, Royal Colonial Institute, Northumberland-avenue, London.

15691. Improvements in electric railways. Charles Edgar Betts, 4, South-street, Finsbury, London. (Irving Walters Betts, United States.)

AUG. 3.

15714. Improvements in electric alarms. Denis Vial, jun., Fife House, Kingston-on-Thames. (Complete specification.)

15753. Improvements in telephone exchanges. Franz Stock, Birkbeck Bank-chambers, Southampton-buildings Chancery-lane, London. (Complete specification.)

15755. Improvements in or relating to electric governors. Henry Allen Pryor, 70, Chancery-lane, London. (David Curle Smith and Reginald C. Young, Western Australia.)

15769. Improvements in the manufacture of incandescing electric lamps. William Lawrence Voelker, Clun House, Surrey-street, London.

AUG. 6.

15802. Cork insulating strip. Julius Hosford Stone, 52, Chancery-lane, London. (Complete specification.)

15804. Improvements in telephone selecting devices. William David Watkins, John Wesley Bolster, Frank Linden Naylor, Glennie Davies, Edward Lorenzo Coryelle, and Rufus Albert Berry, 111, Hatton-garden, London. (Complete specification.)

15816. Storage batteries and alarms therefor. Robert McAllister Lloyd, 1, Queen Victoria-street, London. (Complete specification.)

15817. Storage battery boxes or jars. Robert McAllister Lloyd, 1, Queen Victoria-street, London. (Complete specification.)

15818. Storage batteries and insulation thereof. Robert McAllister Lloyd, 1, Queen Victoria-street, London. (Complete specification.)

15819. Storage batteries and ventilation thereof. Robert McAllister Lloyd, 1, Queen Victoria-street, London. (Complete specification.)

15826. Improvements in armatures for dynamo-electric machines or motors. John Balch Blood, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15833. Improvements in or relating to armatures for electric clocks. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Actiengesellschaft Magneta [Electrische Uhren ohne Batterie und ohne Contacte] Switzerland.)

15845. Improvements in electric fans and motors therefor. Edgar Wright Brown, 18, Buckingham-street, Strand, London. (Complete specification.)

AUG. 7.

15876. Improvements in or relating to electrical storage batteries. John Henry West 61, Sydney-street, Chelsea, London.

15879. Improvements in subterranean conductors of electric railways. Paul Grams, Temple-chambers, Temple-avenue, London.

15880. Improvements in surface-contact electric railways. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

15881. Improvements in surface-contact electric railways. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

15882. Improvements in electric brakes. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

15902. Electric battery cells, the better construction of, for the removal of deposits. Arnold Owen Jones, 55, Cochrane-street, St. John's Wood, London.

15909. Improvements in and relating to the electrodes of electrical accumulators. Reginald William James, 1, Queen Victoria-street, London. (Jean Jacques Heilmann, France.) (Complete specification.)

15911. Electric circuit breakers or cut-outs for electric conductors, cables, and the like. Gaston Bellang', 40, Chancery-lane, London.

15916. Improvements in and relating to conduits for electric or other cables. James Fulton Cummings, 45, Southampton-buildings, Chancery-lane, London.

15918. Special method of electrical distribution for traction. Charles Marillier, 45, Southampton-buildings, Chancery-lane, London.

AUG. 8.

15932. A motive power by gravity and electricity combined. Robert Warry, Sportsman's Villa, May Place-road, Bexley Heath, Kent.

15934. Improvements in wheel guards for electrically or mechanically propelled tramway vehicles. John Henry Fooks Bale, 70, Market-street, Manchester.

15937. Improvements in wagons for erecting and repairing the overhead conductors employed for electric traction. Samuel Rawlinson, W. Rawlinson, and J. Rawlinson, Penny Bank-chambers, Halifax.

15946. A rectifier for the conversion of alternating electric currents to uni-direction currents. James Beach, St. James's-street, Taunton.

AUG. 9.

15995. Improvements in or connected with electric railways and tramways on the conduit system. James Carpenter and James Sidney Carpenter, Grant and Madison's Union Bank-buildings, Canute-road, Southampton.

16004. Improvements in conduits for electric cables and the like. Joseph Place and Sons, Limited, and William Henry Place, Commercial-street, Halifax.

16036. Improvements in electrical speed indicating or recording apparatus. Archibald Stannard Cubitt, 85, Tyrwhitt-road, St. John's, London.

16042. Improved electricity meter for current strength. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (The firm of Hartmann and Braun, Germany.)

16052. Improvements in an automatic electric circuit-closing device. Gustav Rapprich, 1, Broad-street-buildings, Liverpool-street, London.

16062. Improvements in electric sparking devices for internal-combustion engines. Frederick Richard Simms and Robert Bosch, 4, South-street, Finsbury, London. (Complete specification.)

16072. Improvements in or connected with electric accumulators or storage batteries. Marie Dasecking and August Brandes, 40, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 31.

1900.

8434. Manufacture of electric incandescence bodies. Dannert.

8575. Manufacture of material for insulating electrical conductors, waterproofing fabrics, and for other purposes. Greening.

8678. Electrical signalling apparatus. Alcock.

12170. Electric meter. Mandowsky.

12175. Controlling apparatus for electric circuits. Thomson Davis Telephone System, Limited, and Thomson.

12388. Mechanical motive devices for the controlling drums or switches of electrically-propelled vehicles. Boult. (Gill.)

13901. Electrical demand indicators. Wright, Dick, and Reason Manufacturing Company, Limited.

14086. Wireless or Hertzian telegraphy. Brown.

14354. Magnetic separating apparatus. Edison Ore Milling Syndicate, Limited. (Edison.)

14355. Magnetic separating apparatus. Edison Ore Milling Syndicate, Limited. (Edison.)

15123. Electrical arc lamps. Nettlefolds, Limited, and Symons.

16466. Electro-hydraulic brakes for railway and like vehicles. Goldschmidt.

17514. Electric switches. Cowan and Hamlyn.

17675. Systems of electrical distribution. Young. (Date applied for under International Convention, March 6, 1900.)

18000. Overhead trolley poles used in electrical traction. Rowlands.

18001. Switches for electromotors. Hall.

18056. Conduit for electric cables. Kiss.

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10985. Distributing heads or terminal boxes for electric cables. Heyl-Dis and Hitch.

1901.

4215. Electric switches. Lake. (Telephon-Fabrik Aktiengesellschaft vorm J. Berliner.)

11409. Insulating supports or insulators for electric conductors. Anderson and Andersen.

11470. Printing telegraphs. Fowden.

13044. Spreading device for lightning arresters. Bertram.

13957. Controllers for electric motors. British Thomson-Houston Company, Limited. (Linn.)

14086. Construction of electrodes for accumulator batteries and moulds therefor. Gülcher.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Aug. 10	898	804	+ 93	—	—
Birmingham Tramways	,, 10	5,174	4,402	+ 772	141,267	— *b*
Blackburn Corporation	,, 9	524	497	+ 27	15,316	14,013*b*
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 10	2,143	1,904	+ 239	7,684	7,787
Bolton Corporation	,, 11	1,457	1,442	+ 15	45,450	36,132*b*
Bradford Corporation	,, 11	1,317	503	+ 814	—	— *b*
Bristol Tramways Company	,, 9	3,373	4,061	- 688	—	—
Carlisle Tramways Company	,, 10	208	204	+ 4	1,340*b*	1,283
Central London Railway	,, 10	5,825	5,043	+ 782	35,902	—
City and South London Railway	,, 10	1,781	1,555	+ 226	11,049	9,001
Cork E. T. and L. Company	,, 8	613	521	+ 92	14,571	12,662*b*
Darwen Corporation	,, 9	190	153	+ 36	4,965	3,981
Dover Corporation	,, 10	373	316	+ 57	6,606	6,156*b*
Dublin & Lucan Electric Railway	,, 11	171	106	+ 65	892	709
Dublin U. T., electric cars	,, 9	4,426	3,729	+ 697	—	—
Dublin S. District, Electric	,, 9	1,361	999	+ 362	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 10	12,041	8,826	+ 3,215	—	—
Halifax Corporation*	,, 4	2,600	1,759	+ 841	21,155	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 10	1,855	1,356	+ 499	10,691	8,076
Liverpool Corporation	,, 3	9,807	8,596	+ 1,211	271,504	233,642*b*
Liverpool Overhead Railway	,, 11	1,917	1,876	+ 41	10,572	10,375
Oldham-Ashton-Hyde Tramways	,, 9	538	524	+ 14	15,635	15,216*b*
Portsmouth Corporation	,, 10	1,334	—	+ 33	—	—
Potteries Tramways	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 11	4,001	—	—	—	—
Southampton Corporation	,, 8	1,295	822	+ 472	—	—
Southport Corporation	—	—	—	—	— *d*	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. *b* From Jan. 1. *d* From April 1. 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £460 decrease.
Barcelona Ensanche y Gracia, £34 decrease. Barcelona, £348 decrease.
Brisbane, £145 increase.
Buenos Ayres and Belgrano Electric, £368 increase.
Calcutta, £155 increase.
Cape Town (month of July), receipts, £13,440; expenditure, £6,832.
Mexico Electric (month of July), receipts, £17,600; expenditure, £10,800.
North Electric, £237 increase.
Port Elizabeth (month of June), receipts, £2,983; expenditure, £1,800.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	$\frac{7}{8}$-$\frac{7}{8}$
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-126,000	1 ..	$\frac{3}{4}$-$\frac{3}{4}$
—— Ordinary, 1-125,000	1 ..	$\frac{3}{4}$-$\frac{3}{4}$
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	100 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	6-6½
—— 5 per cent. Mortgage Debentures	100 ..	100-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4½-5
British Electrical Engineering, Ordinary	2 ..	1¼-1⅜
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	103-108
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	107-111
—— Ordinary	5 ..	14½-15½
—— 5 per cent. Pref.	5 ..	5⅜-6½
Crompton and Co.	3 ..	3¼-4
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	0-¼
—— 5 per cent. Debentures	5 ..	1¼-2¼
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	85-90
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1½-2
—— 7 per cent. Cumulative Pref.	2 ..	2¼-2⅜
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9⅞-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	109-113
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	101-104
Telegraph Construction and Maintenance	12 ..	37-41
—— 5 per cent. Bonds	100 ..	102-105
Telegraph Manufacturing, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	6 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	95-100
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	11-10
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	7⅜-8¼
—— 7 per cent. Preference	5 ..	8¼-8⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7½-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105
Chelsea Electricity Supply	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	107-110
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	11¼-12¼
—— 5 per cent. Debenture Stock	100 ..	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	99-101
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	103-106
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5⅜-6¼
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	103-106
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4½-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5⅜
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7⅛-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12 xd
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	6 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13-14
—— ,, 85,001-98,769	5 ..	13-14
——4½ per cent. First Mortgage Debenture Stock	100 ..	109-112
——3½ per cent. Mortgage Debenture, Red.	100 ..	94-97
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7¼-7½
—— £4½ Shares, New	4½ ..	6¼-6⅜
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5¼-6¼
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-3⅛
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14¼-15¼
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11¼-12¼
Electric Railways.—		
Central London, Ordinary	100 ..	101-104
—— 4 per cent. Pref.	100 ..	103-106
—— ,, deferred	100 ..	97-100
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	52-54
—— Ordinary	10 ..	5¼-5⅜
—— 4 per cent. Debenture Stock	100 ..	112-117
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	3⅞-4⅛
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-129
Blackpool and Fleetwood Tramroad	10 ..	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-4⅜
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	102-104
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6½-7
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-399,000 & 60,001-80,000	10 ..	13¾-14¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅜-1⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	102-105
—— Prov. Cert., all paid	100 ..	96-99
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅜-2
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5¼-5⅜
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	98-102
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	105-107
New General Traction, Ordinary	5 ..	3-3½
—— 6 per cent. Cum. Pref.	10 ..	4½-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10⅝
—— 5 per cent. Cum. Pref.	10 ..	11¼-12½
Potteries Electric Traction, Ordinary, 25,667-40,000	10 ..	12-13
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-10¼
—— 4½ per cent. Debenture Stock	100 ..	105-108
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	6s. ..	5/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	30 p.c. ..	30 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	3⅜-3½
—— 6 per cent. Cum. First Pref.	10 ..	11-13
—— 6 per cent. Cum. Second Pref.	10 ..	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-4⅜
—— 4 per cent. Deb. Stock, Red.	100 ..	89-92
—— 3½ per cent. Deb. Stock, Red.	100 ..	94-97
Oriental Telephone and Electric Company	1 ..	⅛-1

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NOTES.

Marconi System in India.—The interesting announcement comes from India that the Port Commissioners have decided to instal the Marconi system of wireless telegraphy between Calcutta and the Sandheads and the pilot brig.

Pole Preservation.—We note that it has been discovered at Salt Lake City that common salt is an excellent preservative of poles below the ground line. Experiments are said to have shown that the liberal application of salt around the pole while the earth is being filled in effectually prevents the rotting of the base, which is very serious in some places around Salt Lake. There is, of course, at this place a plentiful supply of salt, otherwise we think the plan would be too expensive.

Memorial to the late Peter von Tunner.—We understand that it has been decided to erect in Leoben, Austria, a statue of Peter Ritter von Tunner (Bessemer gold medallist of the Iron and Steel Institute), to commemorate his great services to the metallurgy of iron. An influential committee, including several members of the Iron and Steel Institute, has been formed, with Mr. Ignaz Prandstetter (Leoben) as president, and Prof. Carl Fritz (Leoben) as hon. secretary, to collect subscriptions.

Submarine Signalling.—We referred a short time back in these columns to a system of submarine signalling invented by Mr. A. J. Mundy, and perfected by the late Prof. Elisha Gray. The Boston Submarine Signal Company, which has acquired the right to put the invention to practical purposes, has now commenced the erection of a cable-house on Egg Rock, Nahant, having first obtained a special permit from the United States Government. By this system of submarine signalling it is claimed that vessels entering Boston Harbour may determine their position when within 10 or 12 miles from the shore, thus escaping the danger of approaching too near dangerous shoals in the vicinity of the entrance to the harbour.

Detective X-Rays.—The postal authorities at Buenos Ayres have discovered a novel use for the X-rays. Until recently the smuggling of jewellry in registered letters from Europe had resulted in much illegal gain to jewellers, and it was a common thing in some cases to adopt this means of cheating the Exchequer of its due, as the Government officials could not legally open such letters on suspicion. These scruples, however, have been overcome by the employment of the X-rays, which are said to have promptly revealed watches, chains, rings, and other valuables in astonishing quantity, and in the course of one week no less than £4,000 worth of property of this description was confiscated by the authorities.

Electrical Sluicing in Gold-Mining.—The problem of sluicing ores by the use of electricity would appear to have been solved. A gold-mining company which is operating near Dahlonega, Ga., has erected an electric power plant at a point on the Chestatee River about 12 miles from the mines, where is a powerful waterfall. A pumping station was placed on the banks of the river at the foot of Crown Mountain, and a 10in. pipe was laid to a reservoir on the summit, 560ft. higher than the mill station. This reservoir, which now furnishes an abundance of water for the sluicing of the ores of the company, has a capacity of 750,000 gallons, and the triplex pump, propelled by electricity, easily forces 1,500 gallons of water per minute up into the reservoir.

Influence of Oscillations on Electrolysis.—Mr. Morris contributes to the *Elect. Chem. and Met.* a brief article on the work of Broca and Turchini, who have discovered that a disruptive discharge with electric waves of from 350m. to 400m. in length—*i.e.*, with oscillations at the rate of about a million per second—has very different effects on an electrolyte in the circuit from those produced by an ordinary galvanic current. Under certain conditions, when the electrolyte is a relatively very good conductor, disruptive sparks of great power are produced in the electrolyte itself. This shows that to oscillations, at least of the particular frequency above mentioned, the electrolyte behaves almost as a dielectric. This is undoubtedly the cause of transparency of electrolytes to light, a transparency which it was impossible to explain by means of the ordinary electromagnetic theory of light.

Electrolytic Treatment of Sprains.—In a recent issue of the *Boston Medical Journal* Dr. Leonard C. Stanford describes the method of the treatment of sprains by static electricity. The electricity is generated from a large Holtz machine. The patient is placed on an insulated platform, which is connected to the negative pole of the machine by a brass rod. An electrode, connected with the positive pole by a brass chain, gives off the spark after the circuit has been completed; the length of the spark is from 2in. to 4in. The application is made over and around the painful areas by the positive electrode. It lasts from 10 to 15 minutes, occasionally broken by a short intermission. For sprains with little or no effusion this treatment is very satisfactory. When effusion is present there seems to be little effect besides relief of the pain. Injuries of long standing are not generally so favourably influenced as those of the acute variety. Care in the administration of this treatment should be exercised, as occasionally an unpleasant reaction follows.

Electric Tramways in Sydney.—We understand from the *Australian Mining Journal* that in order to facilitate the working of the Sydney electric tramway sections at a distance from the power-house, it has been decided to utilise a high-tension polyphase current, transforming it at sub-stations to the current ordinarily supplied to the motors. For some time it has been foreseen that this would be necessary, and arrangements for carrying it into effect are now in active progress. The present practice is to supply from the main power station direct current at from 500 to 600 volts pressure, the current being conveyed by the feeders and trolley wires into the motors of the cars and returned through the rails. The rapid growth of the electric tramway system in large cities, resulting in the necessity for the supply from power-houses of many thousands of horse-power, has shown that this system has many disadvantages as the distance from the power stations increases and the headway between the trams becomes shorter. Where such conditions prevail a much more flexible, serviceable, and economical system is provided by the use of high-tension polyphase currents.

Electric Lighting in Paris.—The expiration of the electric lighting concessions which have been given for the various districts of Paris, is exercising the minds of their owners in view of the uncertainty as to how the concessionaires will be treated by the Municipality when taking over the systems. The whole of these concessions terminate on Dec. 11, 1908, but, curiously enough, we learn, an extended area was granted to a company supplying one of these sections, and the period for the new area so included does not expire until Aug. 16, 1912. We believe this is the only exception, but it is one which is likely to seriously complicate the negotiations respecting the handing over of the company's undertakings. The suggested course of a joint conference between the representatives of the companies and of the Municipality is the most advisable one, in order that the consumers of electric light in Paris may not be hampered by interruptions in their supply during the

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remaining years of the concessions. One great disadvantage of the present arrangements is that the companies are charging high rates, and are not able to carry out extension work in the way they would do if the period of their powers were more lengthy. In fact, the case very much resembles that of the National Telephone Company in this country.

Action of the Rays of Radium on the Skin.—A curious experience has occurred to Mr. H. Becquerel, who, according to our contemporary *Comptes Rendus*, has confirmed the fact, first noted by Walkoff and Giesel, that the rays of radium have an energetic and peculiar action on the skin. Having carried in his waistcoat pocket for several periods, equal in all to about six hours, a cardboard box enclosing a small sealed tube containing a few decigrammes of intensely active radiferous barium chloride, in 10 days' time a red mark corresponding to this tube was apparent on the skin. Inflammation followed, the skin peeled off, and left a suppurating sore, which did not heal for a month. A second burn subsequently appeared in a place corresponding to the opposite corner of the pocket where the tube had been carried on another occasion. Mr. P. Curie has had the same experience after exposing his arm for a longer period to a less active specimen. The reddening of the skin at first apparent gradually assumed the character of a burn. After desquamation a persistent suppurating sore was left which was not healed 56 days after the exposure. In addition to these severe "burns," the experimenters find that their hands, exposed to the rays in the course of their investigations, have a tendency to desquamate, the tips of the fingers which have held tubes or capsules containing very active radiferous material often becoming hard and painful. In one case the inflammation lasted for 15 days, and ended by the loss of the skin; and the painful sensation has not yet disappeared, after the lapse of two months.

Technical Instruction at West Ham.—The West Ham Municipal Technical Institute have just issued their prospectus for the session 1901-1902, commencing Sept. 21 next. Day classes in electrical engineering are held on Thursdays for both junior and senior students, laboratory practice being fixed for Fridays. Evening classes in physics, electrical engineering, and mathematics are held every evening. On Mondays the subject taken is electric wiring and house fitting, and Tuesdays are devoted to lectures and laboratory work in telegraphy and telephony for both junior and senior students. Wednesday, Thursday, and Friday evenings are selected for lectures and laboratory practice in electrical engineering for intermediate (*b*) students, intermediate (*a*), and preliminary students respectively. Senior students also attend on Wednesday evenings for instruction in electrical engineering, times of meeting being arranged to suit students. No class begins before seven o'clock in the evening. The lecturer in electrical engineering is the principal (Mr. Albert E. Briscoe, A.R.C.Sc. (Lond.), B.Sc. the staff including Mr. S. G. Starling, A.R.C.Sc., B.Sc. (physics and mathematics), Mr. J. Lister, A.R.C.Sc. (mathematics), Mr. J. A. Tomkins, A.R.C.Sc. (telephony), and Mr. P. M. Hooper (electric wiring instructor). Arrangements will be made whereby students who, through their official duties, are unable to attend the laboratory at the hours named can attend at other times for laboratory work Students are advised to attend the preliminary course in electrical engineering, in which the more purely theoretical part of the work is dealt with.

Electric Railroads in New York State.—A report has recently been issued by the State Railroad Commissioners giving an account of the electric railroads building and proposed in the State of New York. This shows that the trolley roads are creeping up the valley of the Hudson River towards Albany, and already there is an electric road from Albany to Hudson. Between Albany and Pittsfield, Mass., there will soon be a trolley line. Albany is already connected with Lake George by trolley, and westward of Albany the trolley lines are creeping in fast between it and Buffalo. The new Albany and Schenectady line is nearly finished. Schenectady and Amsterdam will soon be connected. Fonda and Amsterdam are also to be connected by trolley, and tracks are now being laid between the two places Utica, with its suburban roads, within a few months, it is said, will have a trolley line extending as far eastward as Little Falls. A line goes north-westward from Utica as far as Oriskany, and will soon reach Rome. An Oneida railroad company intends connecting Rome and Syracuse. Then comes a gap between Syracuse and Rochester, but recently there were filed articles of incorporation of the Monroe County Electric Belt Line, which intends to build an electric line from Rochester to Fairport, 10 miles on the road to Syracuse. The big gap between Rochester and Buffalo is to be filled at once, the Railroad Commissioners having given consent to the Buffalo, Niagara Falls, and Rochester Electric Railway to build a line 120 miles long along the Ridge road, and connecting Lockport, Niagara Falls, and Buffalo. Beyond Buffalo there are two lines to Hamburg, and it is reported that one of these lines will be extended to Angola and Silver Creek, while the Dunkirk line may be extended towards Buffalo.

Municipal Electricians.—We have received from the secretary, Mr. Frank P. Foster, the programme of the sixth annual convention of the International Association of Municipal Electricians to be held at Niagara Falls, N.Y., on the 2nd, 3rd, and 4th prox. On this occasion, we understand, special papers will be read pertaining to those matters of vital interest to the municipal electricians of the world; further, some features which have never before been attempted in convention work will be presented for the enlightenment and entertainment of the members and friends of the association who attend. Among the papers which have been especially prepared for this convention are these: "Underground Electrical Construction from a Municipal Standpoint," by Mr. Edw. F. Schurig, city electrician, Omaha, Neb.; "Inadvisability of placing High and Low Potential Wires through the same Series of Conduits, or through the same Manholes," by "A Well-Known Electrician"; "The Protection of Fire and Police Telegraph Wires from High-Tension Currents and Lightning," by Mr. W. M. Petty, superintendent fire telegraph, Rutherford, N.J.; "Improved Storage Battery for Municipal Purposes," by Mr. J. W. Aydon, superintendent fire and police telegraph, Wilmington, Del.; and "Need and Value of a Set of Rules for Outside Construction," by Mr. P. H. Trout, jun., city electrician, Lynchburg, Va. There will also be special features of entertainment provided for members and friends during the evenings, and the afternoon of Wednesday (the third day), which will include a trip through the Niagara Falls power-house. Special railway and hotel tariffs have been arranged for, and every facility will be offered to members and friends attending the convention in securing first-class accommodation on communicating either with Mr. M. J. Donoghue, superintendent of fire telegraph, or Mr. W. G. Green, 473, Second street, Niagara Falls, N.Y.

The National Telephone Company.—As was to be expected, the chairman of the National Telephone Company would not give any definite news of the negotiations pending between the directors and the representatives of the Post Office at the meeting of the shareholders last week. Any public announcements as to the probable

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success or otherwise of such negotiations would be most ill-judged if, as Mr. Forbes stated, the agreement has yet to be finally adjusted and signed. We therefore cannot say how much truth there is in the rumours which appear in the daily Press as to the three essential matters on which the agreement is likely to be arrived at. There is reason, however, in the remarks, and we trust that there is also some truth. If, as is stated, the Post Office is prepared to finance the company during the remaining years of the license, there is likely to be much less interruption with the extension of telephonic communication in the kingdom than would otherwise be the case. It is obviously absurd to expect the company, having only a 10 years' life, to raise new capital at reasonable rates when there is the great uncertainty as to how the new shareholders would stand at the expiration of the license. Again, the interconnection between subscribers on the new Post Office exchanges in London and the exchanges of the company is most essential to the success of both undertakings, as it is quite unreasonable to expect a small subscriber to have two telephones in his house, one connected to each system. On the question of rates, however, an agreement does not seem to be so essential, and we trust that the Post Office will not enter into any agreement by which the present high charges for telephone service will be maintained during the next 10 years. In fact, from the instructions issued from the Government to the Post Office, they are precluded from entering into any agreement which would influence the active competition recommended by the Telephone Committee.

Submarine Boats.—The faith of the French people in the new electrically-propelled submarine boats which have been added to the French navy is unbounded, and the recent exploits of the "Gustave Zédé" are said by experts to have demonstrated that submarines are first-class agents of destruction. Some expert's testimony to the experiments and manœuvres of this vessel in the Mediterranean at the latter end of last month has reached this country, describing the successful attempts to torpedo the admiral's ship, the "Bouvet." According to the expert, the submarine "made its plunge in a straight line towards the 'Bouvet' . . . and on arriving within 300m. it launched its torpedo, which was aimed at the admiral's ship with absolute accuracy." From this passage we conclude that the "Bouvet" was at anchor at the time, and if so, the experiment can have no bearing at all on the important question of sighting. It is quite another thing where the "objective" is making a good speed through the water, and we do not know that such "absolute accuracy" would have been obtained under these conditions. Other experiments were carried out at the same time which are said to have demonstrated irrefutably that a submarine boat can advance on a hostile squadron and strike a fatal blow. The "Morse" and the "Narval," which were tested at Cherbourg, are reported to have given just as much satisfaction as the "Zédé." It is said that the men on board the submarines suffer little or no inconvenience during the long immersions. The temperature is not only cool, but sometimes cold, so that the electric heating apparatus has to be used; and, on the whole, there is relatively less discomfort in the holds of the "Zédé," the "Morse," or the "Narval" than in those of the small torpedo boats. According to the latest return no fewer than 23 new submarines are being built in the French naval dockyards, and in about 18 months' time France will have a large flotilla of these submarine vessels.

Chinese Telephone System.—In the city of San Francisco, where a large proportion of the inhabitants originate from China, there is what is claimed to be the only Chinese telephone system in operation in the world. The *Scientific American*, in describing this system, says that these Chinese merchants were prompt to understand the saving of time and great convenience in the use of the telephone. Though looked upon for a time with some superstitious dread, familiarity has accustomed the people to its use, and it has now become an indispensable concomitant of the regular office equipment. The system in question is entirely independent from the metropolitan lines, and is for the use of the Chinese only. A white merchant using the Chinatown telephone must pay extra, while the Chinese subscribers can and do use the long-distance wires upon payment of the customary charge. Altogether there are seven Chinamen employed in the office, a chief operator, and three assistants, besides three messenger boys who are on duty day and night, the office always remaining open. In respect to facility, the Chinese telephone operators are said to be quite equal to the whites. The voice of the Chinaman, too, is superior to all others in the distinctness with which it can be transmitted by wires. In calling subscribers the operator, instead of using numbers to designate each one, as customary among the whites, is compelled to call the names of the individual or firm that is wanted, a feat of memory of which only a Chinese operator is capable. The operators of the Chinatown system are in no relation to the metropolitan office. They are hired and paid by the Chinaman who controls it. The main company instal the instruments and keep the wires in repair, allowing their Chinese agent a certain amount for each subscriber, the agent collecting the bills and securing new subscribers. The San Francisco experiment has proved a successful one financially, and is extremely popular among the Chinese, and it is believed that one result of the local experiment will be the early introduction of the telephone throughout the whole Chinese Empire as soon as conditions of peace are assured.

Wireless Telegraphy in the Atlantic.—After the success which attended the experiments of Marconi's system in the Atlantic Ocean at the end of last week, there can no longer be entertained any doubt whatever as to the value of wireless telegraphy for signalling at sea. The Cunard liner "Lucania," when still 287 miles to the eastward of New York, for which port she was making, succeeded in establishing wireless telegraphic communication with the shore *viâ* Nantucket lightship, on which the *New York Herald* has just completed the installation of Marconi's apparatus. From the glowing accounts of the trials which have appeared in the daily Press, it is easy to see that the authorities are well pleased with the results obtained. The *Herald* correspondent on board the liner has described how the vessel picked up communication with America. It was at four o'clock on the afternoon of Friday last, while the Nantucket lightship was still 120 miles to the westward, that the first real attempt to establish shore communication was made. In the words of the correspondent: "Nt, nt, nt, clicked the instrument, and the sparks spluttered and hissed as if controlled by some uncanny imp from the under world. Again and again the questioning signal was flashed out across the ocean. Silence. Then a gentle ticking was heard in the receivers, and the tape began to uncoil. 'Here they are!' shouted the operator, and sure enough, as distinctly as could have been accomplished by means of a land wire, the signal was printed on the receiving tape." It was afterwards found that at the time communication was opened the two stations were 72 miles apart. Communication was declared perfect in less than five minutes, and a message was received on board the "Lucania" announcing that her approach had been flashed to the shore. The transmission

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of messages was steadily maintained for eight hours, but it appears that the work between the shore and the lightship was not so successful as had been hoped, electrical disturbances occurring to interrupt connection. The same disturbances prevailed and caused further delays between the lightship and the station on the Massachusetts shore, and for these reasons the telegrams were late in reaching the "Lucania." Messages from passengers to their friends ashore were also retarded, but they were delivered long before the "Lucania" had reached the quarantine station. Otherwise, however, the experiments met with complete success. Thus the period of isolation in crossing the Atlantic, hitherto accepted as an unsurmountable problem, may be considerably lessened, and the dream of the *New York Herald*, that by means of a wireless telegraphic station on Nantucket lightship the voyage between the United States and England would be reduced by nearly a day, has been truly realised.

Cables and the Colonial Office.—Sir Ed. Sassoon, in a letter to the *Times* under this heading, expresses his belief that if the lines of telegraphic communication were more widely extended, if Government control—not the control of that slipshod, unintelligent, and happy-go-lucky style of which we have had but too many proofs, but some effective power to be used for the public good—were retained and the charges brought down to a reasonable figure which would permit of cables being more freely used, the gain to us and to the sister communities beyond the seas would be immeasurable. He then goes on to discuss an important question in connection with the Cape-to-Australia cable—viz., whether the principle of an expropriation clause in all contracts or leases by which landing rights and privileges are conceded is a right or a wrong one. Hitherto, the Colonial Office do not appear to have considered the matter, but Sir Edward Sassoon points out it has now become an almost accepted maxim that the State or the local body should unreservedly retain over such undertakings as tramways, electric lighting, etc., the right of purchase after reasonable notice on equitable terms, and he urges the importance of adopting the principle of an appropriation clause in all contracts giving the right to private companies to lay cables. The letter proceeds: "On behalf of my committee, I approached the Colonial Secretary, and I am glad to be able to report that he concurs in the expediency of a purchase clause, and has kindly promised to think out the necessary conditions in relation to it. . . I would point out that without this, which may leave the question of ultimate State ownership an open one, Canada will not be able to telegraph across the Pacific to India, any part of Asia, or South Africa without being forced to pay any toll the companies may choose to exact." Referring to the Pacific cable, Sir Edward Sassoon says: "Although the inevitable *amari aliquid* has been furnished us by New South Wales (herself one of the co-partners) in granting to the Eastern Extension Company privileges which must conflict with the full development of the Pacific cable, yet its future is full of the brightest promise. It promises to work cables for the full and unrestricted benefit of the public instead of that of a small group of private individuals. It represents the first spoke in the wheel of that unbridled monopoly under which the subjects of the Empire have been groaning for years past. It embodied the first consecration of the idea that intercourse between the Mother Country and her daughters should be divested of the risks attending on cables being laid on foreign soil, through shallow waters, and worked by bodies not amenable to public influence and pressure. . . We firmly believe that the gradual permeation into the public mind of the sense of our Imperial heritage and responsibilities, as well as our growing social and industrial needs, will conspire to bring it into great prominence in practical politics."

United States Patents.—The annual report of the United States Commissioner of Patents for the year ending Dec. 31, 1900, has just reached us. Altogether there were received 39,673 applications for patents in the course of the year, of which 26,418 were granted, including designs. In proportion to population, more patents were issued to citizens of the district of Columbia than to those of any State, being 1 to every 1,110. As to foreign patents, 1,070 were granted to residents of Germany, 987 to those of England, 367 to those of Canada, 341 to those of France, 117 to those of Austria-Hungary, and 79 to those of Switzerland. Referring to the American patent system, the commissioner traces its history from its origin. The American system, he states, is known and spoken of as the "examination system" in contradistinction from the English system, which has been mainly followed by other nations. The examination system is the ideal system, provided the examination can be made with sufficient care to minimise the likelihood of the issue of patents for inventions not of a patentable nature. The field of search, however, has so increased in recent years that it is only by means of a perfect classification that the great mass of matter can be so divided as to be conveniently accessible for use in the examination of any individual case. The system is by no means perfect, but, says the commissioner, it is generally acknowledged that the patent laws of the United States are more liberal than those of any other country, and that the examination, imperfect though at times it be, gives a value to a United States patent not possessed by a patent issued by a country not having an examination system. We may point out, however, that there is at least one defect common both to the United States and the English system, and this the commissioner has emphasised—viz., that too many appeals are permitted, and interference proceedings are rendered onerous and complicated by the number of motions and appeals provided by the laws and rules. The most serious defect, however, follows from the power to keep applications in the office for indefinite times through delays in amending the same The records of the United States Office show that there are pending 4,829 applications filed prior to Jan. 1, 1898. Three of these applications were filed in 1880, 1 in 1881, 4 in 1882, 3 in 1884, 3 in 1885, 13 in 1886, 7 in 1887, 13 in 1888, 19 in 1889, 23 in 1890, 45 in 1891, 64 in 1892, 103 in 1893, 154 in 1894, 368 in 1895, 992 in 1896, and 3,011 in 1897. It will be seen, therefore, that an application may be kept alive indefinitely, if it be desired. In conclusion, the commissioner expresses the opinion that it should continue to be the policy of the Government of a nation whose inventors have given to the world the cotton gin and the reaper, the sewing machine and the type-writer, the electric telegraph and telephone, the rotary web perfected printing press and the linotype, the incandescent lamp and the phonograph, and thousands of other inventions that have revolutionised every industrial art, to encourage invention in every lawful way, and to provide that, so far as may be necessary, the money paid to the Government by inventors be used for their benefit. The world owes as much to inventors as to statesmen or warriors. To them the United States is the greatest debtor, so much have they advanced American manufactures. Their labour-saving machinery does work that it would take millions of men using hand implements to perform. In this century the debt will be piled still higher, for inventors never rest.

Mr. Behr's Proposed Monorail.—Writing to the *Times* of the 10th inst., a correspondent assuming the *nom de*

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plume "Vigilans" severely criticised Mr. F. B. Behr's proposal to build a high-speed electric railway between Manchester and Liverpool on the monorail principle. The letter has called forth a smart rejoinder from Mr. Behr himself in Monday's *Times* purporting to explain away the several adverse criticisms offered by the correspondent, whose communication Mr. Behr regards as emanating from "somebody interested in the undertaking on behalf of the railway companies, who, having failed in their persistent efforts to stifle the project in Parliament, are now trying to continue their opposition through the medium of the public Press." As regards "Vigilans's" suggestion that the carrying capacity of the proposed line would probably be insufficient, Mr. Behr points out that his railway with a 10 minutes' service would run over 200 trains per day, capable of carrying over 14,000 passengers, and this could be increased to 60,000 passengers per day if required. Again, it is quite incorrect to say that this proposed line could carry no goods. The monorail can carry goods in exactly the same way as any ordinary railway, but one of the objects of the proposal under consideration is to create an "exclusive express passenger line," so as to separate completely the goods and slow passenger traffic from the fast traffic, as it has been conclusively proved that the only remedy to the present fearful general muddle in railway management lies in the separation of speeds. This, if carried out logically and thoroughly, must produce absolute punctuality, economy, and safety for all classes of traffic. Replying to a criticism as to the relations of the Board of Trade towards the scheme, Mr. Behr states that before the committee of the House of Commons passed the Bill the chairman consulted the Board of Trade, and it is self-evident that if the opinion expressed by the Board of Trade to the chairman had been unfavourable as to the possibility of building the railway with all the necessary safeguards for the safety of the public, the committee would have rejected the Bill at once. On the question of speed, the writer thinks the committee very wisely refrained from doing the bidding of the opposition to fix the speed at either 110 miles or any other speed, because the experimental railway built near Brussels about three years ago was run for nearly 12 months at a speed of 85 miles per hour, through curves of 500m. radius, with absolute safety. The committee, therefore, knew as a fact that anyhow the proposed Manchester and Liverpool railway could be worked with absolute safety at speeds much greater than those now used on the express trains of the ordinary lines, and, therefore, this line would in any case constitute a great progress in railway locomotion, and would be of immense advantage to the public, as it would enable the distance between Manchester and Liverpool to be covered in 25 minutes instead of 45, even if the speed were not greater than that attained on the Brussels line. At the same time, Mr. Behr concludes, the curves and gradients on the Manchester and Liverpool railway being much better than those in Brussels, the motive power being much greater and the weight of the trains much less than in Brussels, there could not be any reasonable doubt in the minds of the committee that it would be easy to work the proposed railway at a speed of at least 110 miles per hour with absolute safety, as against the 85 miles obtained in Brussels.

Electric Traction in London.—Mr. George Westinghouse has a long letter in the *Times* of the 19th inst. on this subject, showing how the electric propulsion of vehicles, already well extended, admits of such radical departure from the old way as to suggest that we may, by discarding many of the old ideas and methods, have a veritable revolution in the prevailing practice. In proof of this he refers to the fact that an electric railway, upon which single cars are run at frequent intervals for a distance of about 45 miles, parallel to one of the standard railways in the United States, is, after being two years in operation, carrying 20 times as many passengers as were formerly carried by steam railway between the same points. A logical deduction is that railways may with equal propriety contract for a supply of electric energy ready for use quite as well as to purchase and instal electric plants, and thereafter to buy coal, supplies, and labour for the production of electricity. Such being the case, it follows that the judicious selection of sites and the erection of the highest types of electric generating stations for the purpose should result in great saving in capital expenditure as well as in great economies in the subsequent cost of operation. Dealing with the Metropolitan and Metropolitan District Railways, the writer urges that the present is an opportune moment for establishing a "mutual electric supply and equipment company" upon a basis which will give to those companies, and subsequently to all other railways delivering traffic to the City over their lines, the most advantageous arrangement possible, it being almost self-evident, he says, that if each of the companies operating in London were to erect power stations and to electrically equip their lines upon dissimilar, or even similar, plans, the capital expenditure would for a given service be fully double that required by a company having appropriate contract relations with the different railway companies, and in which "mutual electric supply and equipment company" all such railway companies should obviously be financially interested and represented. Such mutual supply company with appropriate powers could, in the first instance, contract with either or both the underground companies to furnish a complete electric plant, including new cars and the electric line and equipment, and to maintain and operate the power plant, sub-stations, electric feeder systems, and to deliver current to the collector rail for a long term of years; to supply all current needed for other power purposes, such as for the operation of moving stairs or lifts, lighting of stations, tunnels, etc., at a low rate per Board of Trade unit; to supply current for train power and lighting service of connecting or other railways, and to maintain a qualified corps of engineers and inspectors to assist in the inspection and maintenance of the electrical equipment; the railway companies to permit the use of their real estate for the location of stations or sub-stations, etc. The foregoing suggestions involve the use of railway carriages similar to those employed upon the Central London, arranged in trains of three carriages each, two of such carriages being fitted with motors and controlling apparatus, the third being interposed. These carriages to be equipped with "unit control" and brake apparatus, and with coupling devices which will automatically unite them and the brake connections and the "unit control" electric connections at the same instant, without an appreciable loss of time. This provides for the joining together of two or more trains, and the convenient operation of the entire equipment by a single motorman at the front end of the train. The writer then goes on to advocate the use of gas-engines in preference to steam-engines for generating electricity. The decreased cost of production of electricity by means of gas-engines, as compared with the present steam-engine plants, would enable a Board of Trade unit to be sold at a remarkably low figure. The great point, however, is that the generation of electricity by a mutual supply company would result in a minimum amount of apparatus being used, and the stations employed would be so distributed as to reduce to a minimum the inconvenience resulting to the public from the installation of great independent undertakings.

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FARNWORTH ELECTRICITY WORKS AND TRAMWAYS.

The district controlled by the Farnworth Urban District Council derives its prosperity from the cotton industry. Large mills abound, and require a great number of operatives to keep them going. It is, therefore, an essential for a place like Farnworth, with its 30,000 inhabitants, that the means of communication shall be good and cheap. This the Council have recognised, and have also shown that they are quite capable of providing their own tramways and lighting. This, however, did not encourage them to show opposition to their larger neighbour, Bolton, commencing the work, and in consequence the Corporation of that town

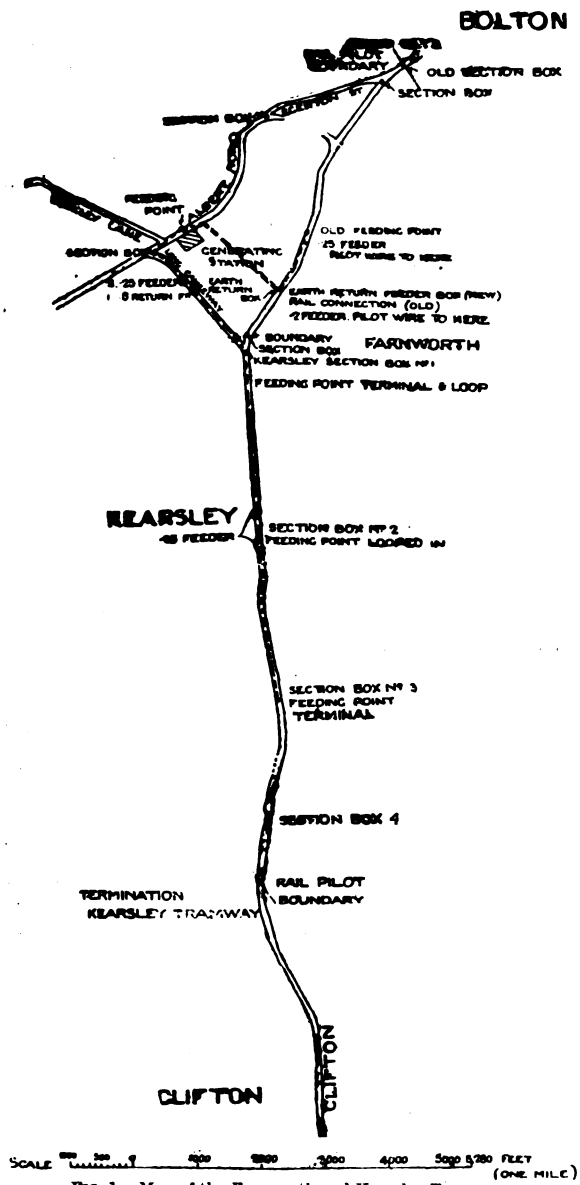
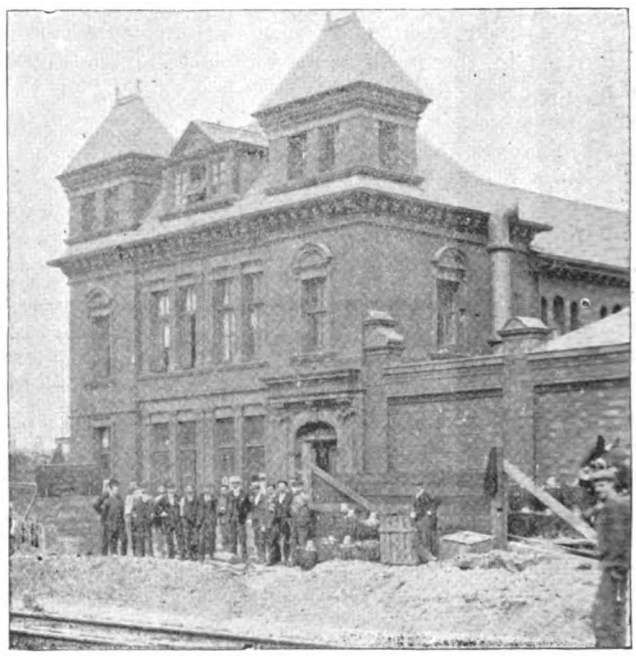


FIG. 1.—Map of the Farnworth and Kearsley Tramways.

have been allowed to work the main line of tramways through Farnworth for the first two years. This line connects up Bolton to Kearsley, and after the expiration of the present working agreement in December the Council of Farnworth will supply its own section of the lines, and also Kearsley. There is now a good service of large electric bogie cars to Bolton, which proves a great convenience to the inhabitants. The Urban District Council of Farnworth own that section of this work which lies in their area, and they erected the overhead construction. The rails are old ones, but they are to be replaced before long. Now that the local station is completed, work on the other sections of tramways in the district is being rapidly proceeded with. Thus a new line is being laid up Egerton-street and Albert-road. From the top of this road one line goes on to the boundary of the district, up Buckley-lane towards Little Hutton. At the boundary an actual junction is to be made with the lines of the South Lancashire Tramways Company. Another line goes down Worsley-road towards Walkden, and on this, again, a through junction with the South Lancashire system of tramways is to be made eventually. Besides the lines referred to above and shown on the map (Fig. 1),



The Offices of the Electricity Department.

there are several other extensions contemplated, such as will make a most complete system of tramways inside the area. The great matter for congratulation is, however, that these lines will be directly connected to those through Bolton and Kearsley, as well as to the great network of the South Lancashire Tramways Company. The question of the running of the trams themselves over these lines is now under discussion with the Bolton Corporation, and we do not doubt but that a good working arrangement will be come to whereby there will be through cars run over the whole route.

The Urban District Council of Farnworth have been advised in all matters electrical by Messrs. Lacey, Clire

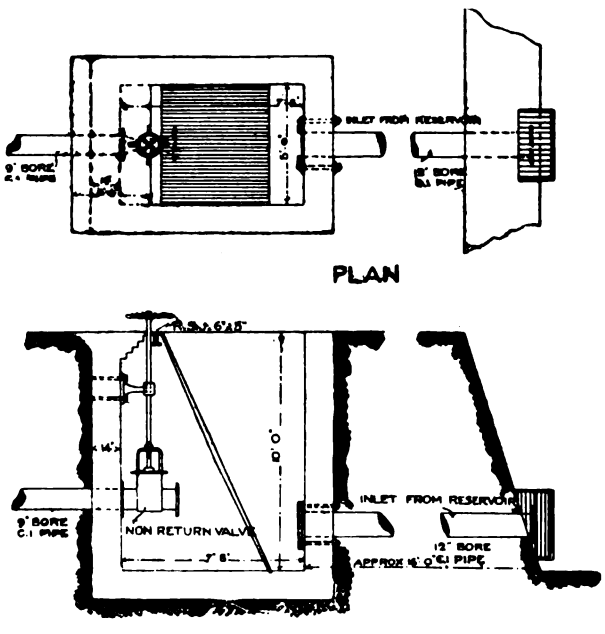


FIG. 2.—Plan and Elevation of the Straining Chamber in the Condenser Suction.

hugh, and Sillar. It was under the direction of this firm and to their design that the overhead work on the main line of tramways was erected some two years ago. These consulting engineers advised the Council that a combination of electric lighting and electric traction plant would be the most economical in their case. This advice was accepted,

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and after a Local Government Board enquiry £22,000 was authorised to be spent on the combined scheme. This loan was granted in the April of last year, and the works commenced to supply energy for electric lighting about a fortnight ago. In order, however, to encourage the consumers to come on quickly, energy is being supplied free of charge until after the opening ceremony on Wednesday next. While it is still somewhat early to be able to gauge the probable success of the undertaking so far as electric lighting is concerned, we see every reason to believe that a good load will be quickly obtained. Already the total number of applications in equivalent 8-c.p. lamps is about 4,000, and there are one or two large factories likely to take both light and power from the station mains. As regards street-lighting, the Council have authorised the erection of 45 arc lamps on the poles erected for the tramways. These lamps will be placed on alternate poles along all the streets equipped with tramways. They will be connected nine in series across the 440-volt mains. Incandescent lamps are to be placed on the same poles, and these will be used to light the streets after a predetermined hour, when the arc lamps will be switched out. It also speaks well for the Council that they have decided to give a supply at the same rates as are now charged in Bolton. In order to appease those who cannot understand and appreciate the working of the maximum demand system, an alternative flat rate of 5½d. per unit has been fixed, together with a discount of ½d. per unit if the accounts are paid within 21 days from their receipt.

The position of the site chosen for the works is a fairly central one, as will be seen from the map (Fig. 1). The site has the farther advantage that condensing water is available. Messrs. Lacey, Clirehugh, and Sillar have accordingly constructed a condensing pond, in accordance with the well-established Lancashire practice. Into this condensing pond water will be collected from a neighbouring brook, and we understand that one or two fields are also to be drained into it. When we visited the works the pond was only partially filled, and was being greatly appreciated by the children in the locality as a bathing place. The consulting engineers have arranged a strainer (shown in Fig. 2) on the suction outlet from the pond. In order, however, to keep the water free from deposit, straining and settling arrangements are also provided in the path of the inlet water from the stream in question. With respect to the buildings which the engineers have erected at Farnworth, we need only say that they are substantial, useful, and to a certain extent ornamental, but there has been no unnecessary waste of money in connection with the same. The general design of the buildings will be seen from Figs. 3 and 4, while in Fig. 5 a view of the front elevation from the street is obtained. The office accommodation in the front of the engine-room is convenient, and there is ample room above for the test-rooms stores, etc. The accumulators are placed in the basement below the offices in such a position that the regulating cells are practically directly under the back of the switchboard. This arrangement simplifies the question of the connections, and does away with the need of any mechanical transmission gear between the accumulator switch on the main switchboard and the switch itself in the accumulator-room. It has the disadvantage, however, that the accumulators are underground, and there is not quite so much free headroom as is convenient when handling these heavy pieces of electrical plant. The whole of the building work was done by Mr. S. J. Hodgkiss.

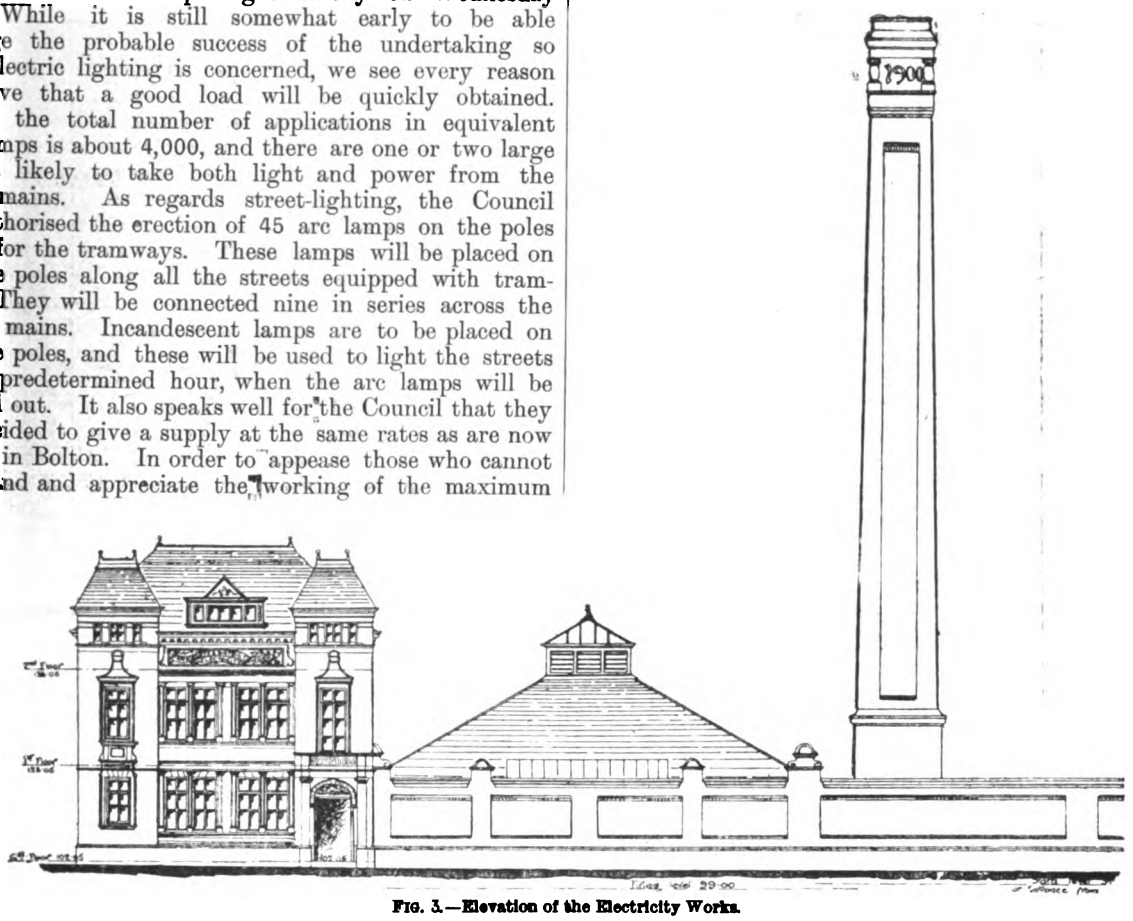

FIG. 3.—Elevation of the Electricity Works.

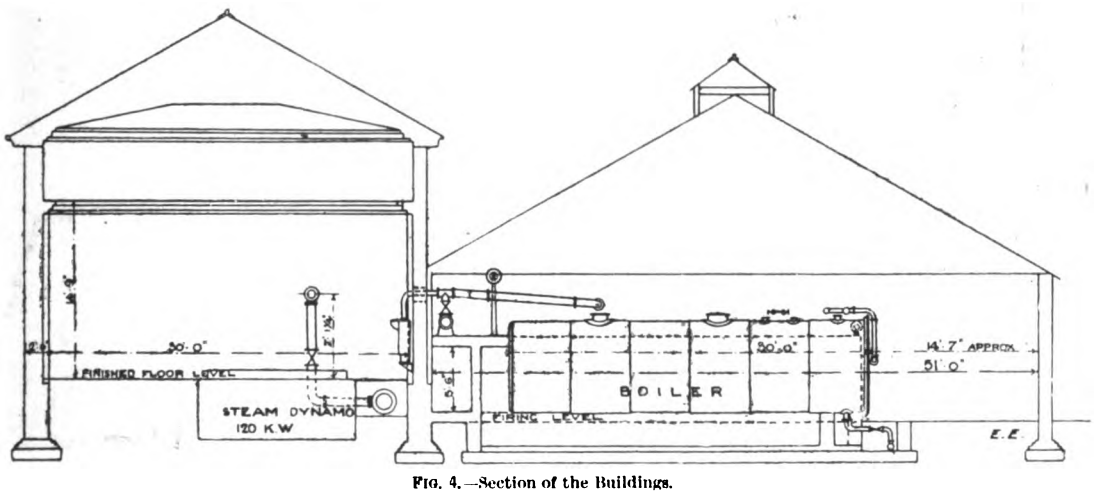

FIG. 4.—Section of the Buildings.

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Coming now to the machinery itself, we naturally commence with a review of the boilers. These are of the Lancashire type, and are three in number, as can be seen in Fig. 6. Each of the boilers, which were made by Messrs. Edwin Danks and Co., of Oldbury, is 30ft. long and 7ft. 6in. in diameter inside the inner ring of plates. The two internal flues taper from 3ft. diameter in the front to 2ft. 6in. diameter at the back. The boilers are constructed for a daily working pressure of 150lb. per square inch. They are fitted with the usual accessories, including a high-steam and low-water safety valve, a duplex safety valve of the dead-weight type (seen in the illustration), two 2½in. accessible check feed valves, a blow-off valve, a steam-gauge, and two water-gauges. The stop valve from the boiler is 7in. in diameter. The same firm also supplied the economisers, which are placed in the position shown in Fig. 7, in the main flue. This is of the Green type, with 192 pipes 9ft. long and $4\frac{9}{16}$in. diameter. The scrapers of these economisers are driven by a small electric motor, which can be seen in Fig. 6. The feed pumps were made by Messrs. Hall and Sons, of Peterborough, and are each capable of delivering 1,500 gallons of water per hour against the boiler pressure. The town's water is used for boiler feed, and a 3,000-gallon tank has been erected as a store. The steam-pipes are of lap-welded steel throughout, with flanges of mild steel welded on to the pipes. The arrangements of these pipes can be seen in the plan, while the detail of the bends and water separators between the main steam-pipe and the engines is shown in Fig. 8. This main steam-pipe is carried along the boiler-house wall, and is 10in. in diameter. The main exhaust pipe is 14in. in diameter, and is so designed that it either delivers direct to atmosphere through an automatic relief valve or else direct to jet condenser (Fig. 9). This main exhaust pipe is carried below the engine-room floor, but the valves on the branch exhausts from the engines are placed above the

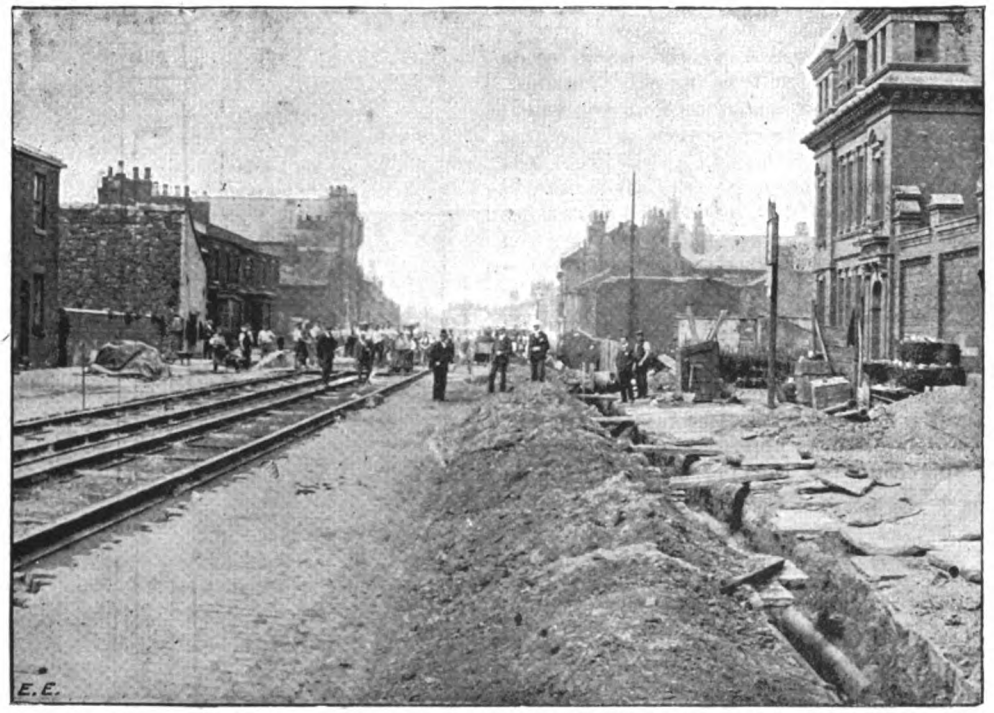

FIG. 5.—View of the Main-Laying and Tramway Track outside the Supply Station at Farnworth.

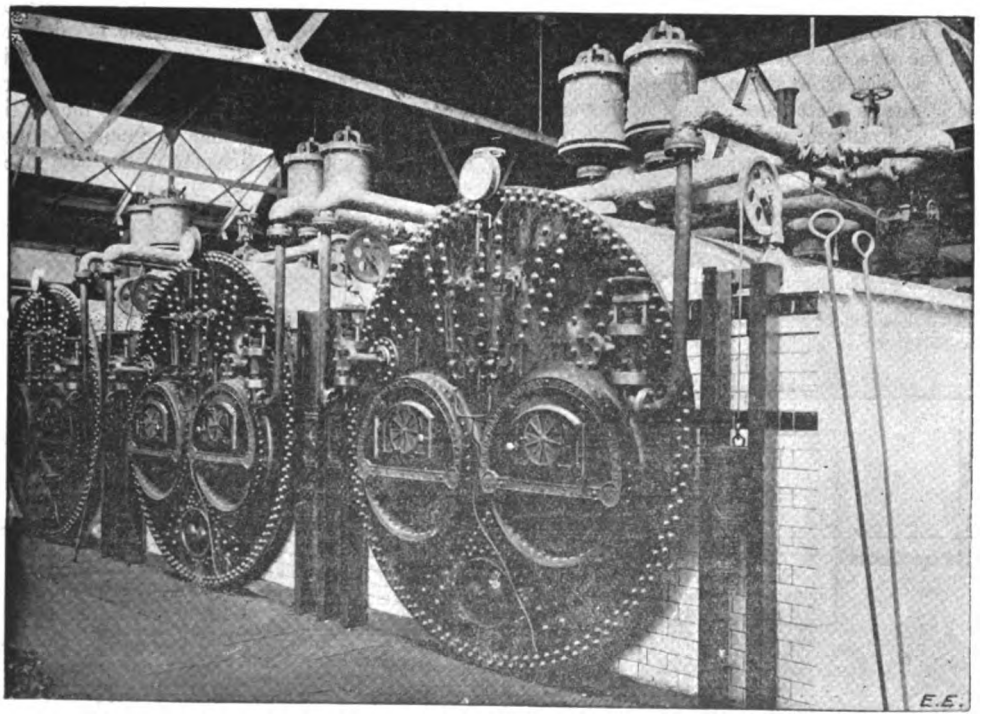

FIG. 6. The Danks Boilers at Farnworth.

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floor for convenience of access. Hopkinson valves are used throughout, and the steam-pipes are drained by Geipel steam-traps.

The engines and dynamos, as well as the balancers and boosters, were supplied by the Lancashire Dynamo and Motor Company, Limited, of Trafford Park. The engines are of the Browett-Lindley make, with high-pressure

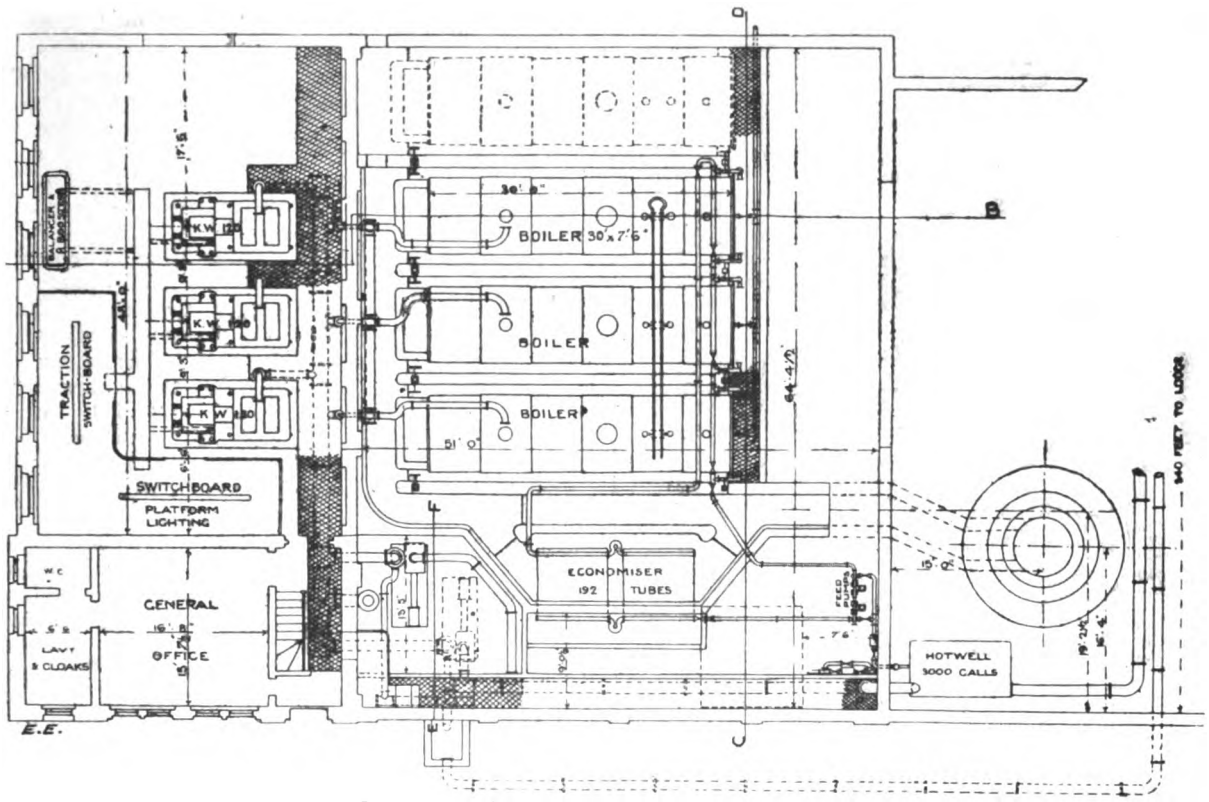

FIG. 7.—Plan of the Farnworth Electric Light and Traction Station.

cylinders 12½in. in diameter, low-pressure cylinders 21in. in diameter, with 9in. stroke. Each of these three engines (Fig. 10) is designed to give at least 200 i.h.p. at a speed of 380 revolutions per minute, with a steam pressure of 140lb. in a steam-chest, and a 24in. vacuum. Under traction work, however, these engines are able to develop at least 240 i.h.p. on emergencies. When we visited the works one of these engines was running in a

from 440 to 480. In the design of these dynamos there are several details worthy of special note. Thus the yokes are of cast iron or steel, circular in shape, and are provided with steel poles of circular or elliptical section, and a special form of pole-piece to reduce sparking. The fields are split across the horizontal diameter, to enable the armature to be readily inspected and repaired. The yoke is provided with brackets lined with white metal, to support the brush ring. The field coils are former-wound, insulated with presspahn, served with tape, and then dipped in an insulating compound and thoroughly baked. Each coil is provided with its own terminals, so that no loose wires project, thus avoiding the danger of the latter being broken up. The coils are held in their place by a brass plate both at top and bottom, enabling the air to circulate freely both

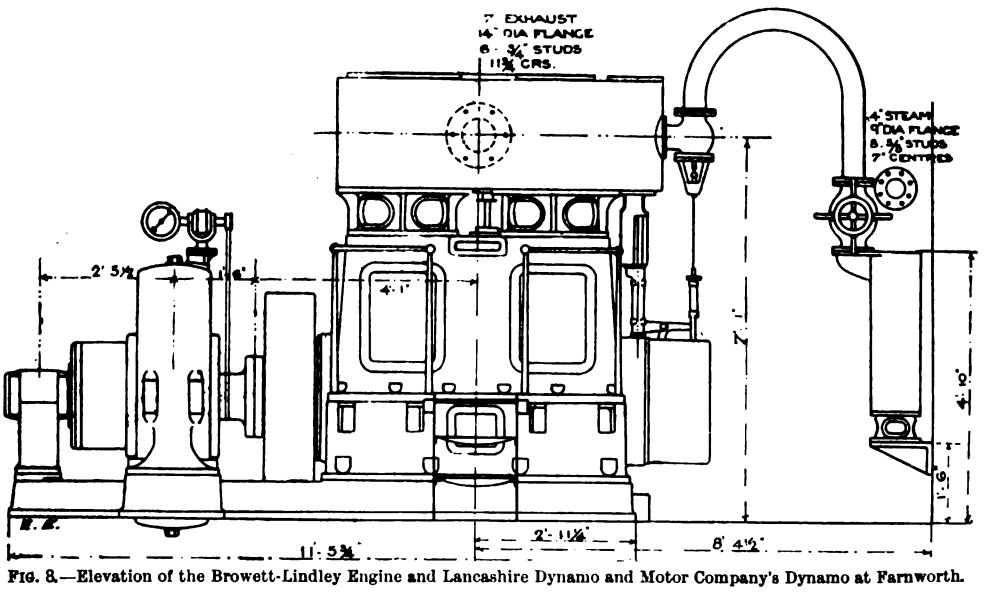

FIG. 8.—Elevation of the Browett-Lindley Engine and Lancashire Dynamo and Motor Company's Dynamo at Farnworth.

way which did credit to its makers, and showed that it was an exceedingly well balanced machine. The dynamos, which were made by the Lancashire Dynamo and Motor Company, Limited, are of the six-pole type, and can be used either as compound or shunt machines. As compound machines for traction working they are each able to give 225 amperes at 525 volts, and as shunt machines with the series coils cut out their output is 250 amperes at any voltage

inside and outside the coil, and ensuring cool running and absence of sweating. A very high insulation resistance is obtained by this method, eliminating the danger of the coils earthing if the shunt current is interrupted. The series coils are of bare copper strip wound on edge. The armatures are of relatively large diameter, with a small armature reaction, and are built up of thin varnished plates provided with slots to receive the windings. The

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armature is further ventilated by brass distance pieces to ensure cool running. The plates are securely keyed to a cast-iron sleeve, which extends to the bearing on one side and is formed into a coupling on the other, thus enormously strengthening the shaft and eliminating any strain on the

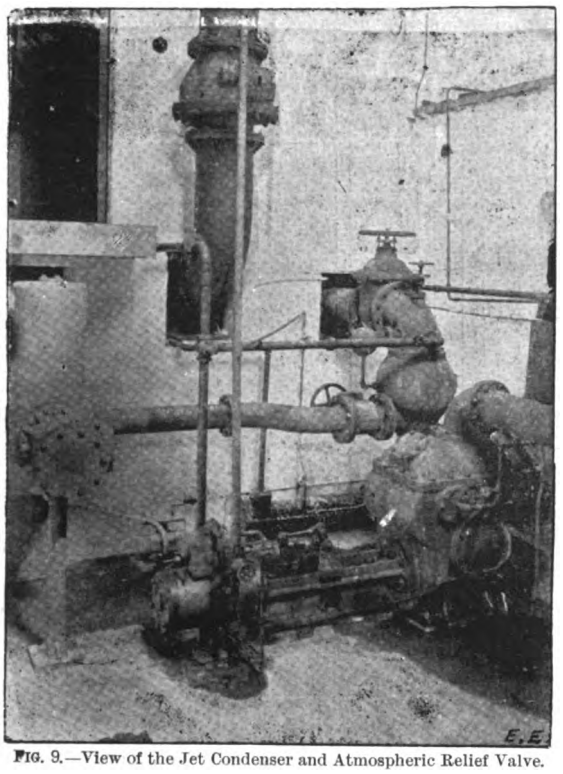

FIG. 9.—View of the Jet Condenser and Atmospheric Relief Valve.

keys in case of short-circuit. The commutator is also carried on this cast-iron sleeve. The windings are of the cylindrical barrel type. These machines on trial were found to give their emergency load of 264 amperes at 525 volts without any trouble whatever.

capacity of 120 amperes at 100 volts. The designers of the machines have saved space by coupling the frames of each booster with the adjacent balancer, so that only two bearings are required for each pair of machines, or four bearings in all instead of eight, as are frequently provided. These machines are excited from the lighting 'bus bars at from 440 to 480 volts The necessary automatic regulation of the balancer fields is obtained by means of series turns in the middle-wire circuit. The general finish of the electrical plant supplied by the Lancashire Dynamo and Motor Company under their contract leaves nothing to be desired, and there are, as mentioned above, many points in their construction which show that the firm has devoted great attention to the perfecting of details. We are not surprised in consequence to find that the firm now stand well up in the list of successful tenderers for municipal contracts.

The position of the traction and lighting switchboards in the engine-room can be seen in Fig. 11, which gives a good idea of the accessibility of the same. Fig. 12 is a larger view of the lighting switchboard, while the connections of this and of the traction board are shown respectively in Figs. 13 and 14. Both these switchboards were manufactured and supplied by Mr. Bertram Thomas, of the Cornbrook Telegraph Works, Manchester. As will be seen in the illustration, the various instruments required are mounted on substantial slate panels. These are carried on an iron framework, so that with the exception of the floor there is no woodwork near the switches and fuses. All the fuses used are of the laminated type. The various wires in parallel making the fuse are placed in separate recesses in a slate block. The ends of these grooves are filled in round the wires with plaster, so that only the central portion is exposed. The ends of the wires terminate in substantial gunmetal blocks, which can be firmly clamped on to fuse terminals. The effect of the lamination is to quickly cool any arc set up at the instant of break, and the construction of the slate block also protects the fuse terminals. The measuring instruments used on the lighting board are of the Evershed and Vignoles type. It would serve no useful purpose to describe the various

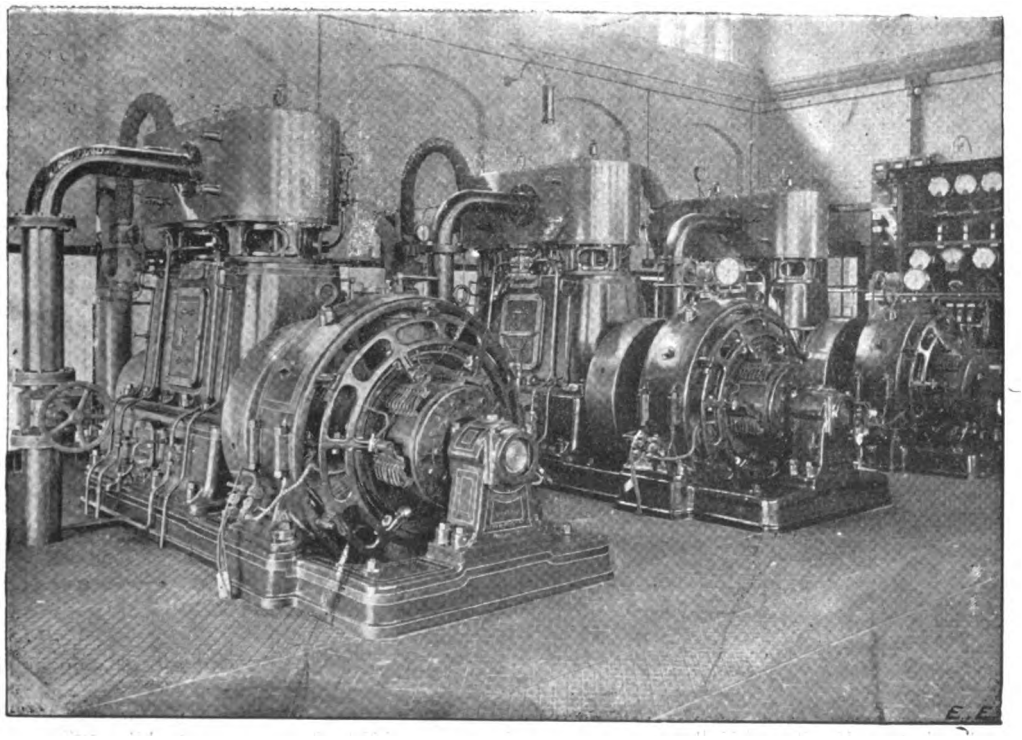

FIG. 10.—The Three 120-kw. Steam Dynamos.

The balancer-booster set consists of four of the above company's standard semi-enclosed type of machine mounted on one bed-plate. The armatures are carried on two independent shafts coupled together with a muff coupling. The combination is an exceedingly compact one, being only 11ft. 6in. over all, although the balancers have a capacity of 50 amperes at 250 volts, and the boosters a

instruments in each circuit, as they can be seen in the diagram of connections (Fig. 13). On the traction board the usual Board of Trade panel is provided with its recording voltmeters, ammeters, etc. The measuring instruments in this case are of the Weston type, while the automatic circuit breakers are of American manufacture, being the I.T.E. type. A glance behind either of these switchboards shows how

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careful the engineer of the station, Mr. J. D. Pember, and his assistant, Mr. J. F. Coates, have been in the arrangement of cables. There is an absolutely free floor in both cases, also free headroom, so that all connections are easy of access. This renders the risk of a short-circuit behind the switchboard almost impossible, whereas any slovenly work in this position is bound to cause trouble in the long run. The same firm of Bertram Thomas also provided and laid these connecting cables, and hence may share in the credit which is certainly due.

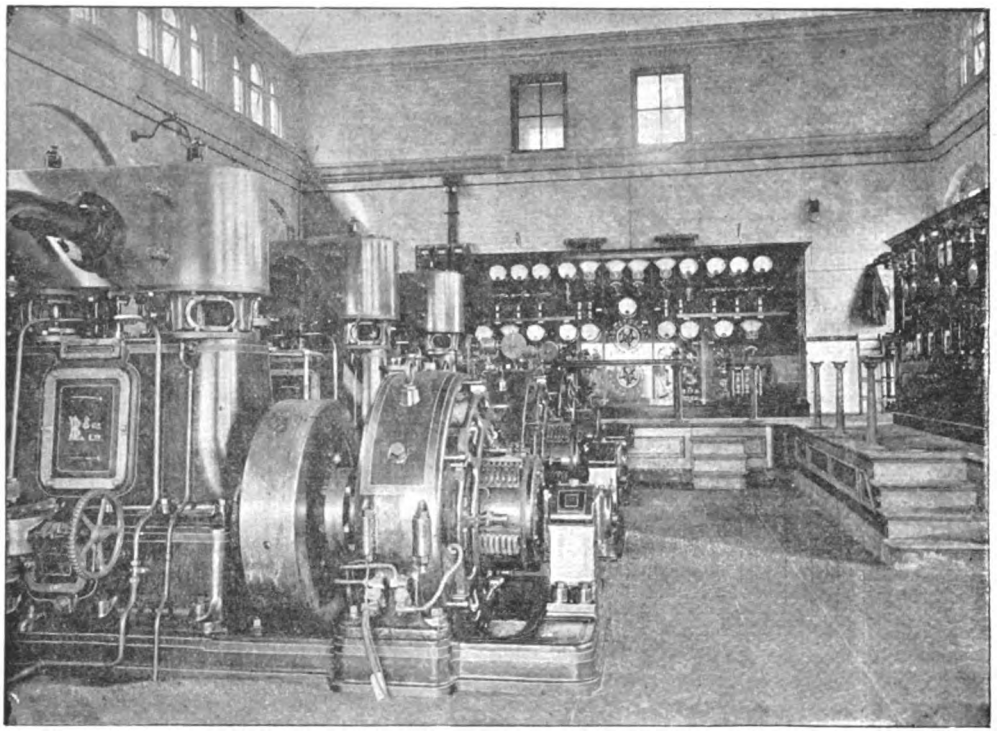

FIG. 11.—The Farnworth Engine Room.

The accumulators were supplied and erected by the Tudor Accumulator Company. They consist of 252 cells connected up in two batteries of 124 cells, with four cells to spare. These cells on a 10-hour discharge can give 40 amperes, or 180 amperes for one hour without the E.M.F. of each cell at the end of the discharge falling below 1·8. These accumulators, which are in glass cells, are mounted on two-tier stands in the accumulator-room referred to above. The connections between the regulating cells, which are in the middle of the battery—*i.e.*, at nearly earth potential—are made with bare copper conductors, which are afterwards painted.

The whole of the mains for the arc and incandescent lighting, and also the overhead tramway equipment, have been supplied and laid by the British Insulated Wire Company, Limited, of Prescot, Lancashire. The cables are steel-armoured and jute-covered, and in most cases are laid direct in the ground. The cables for some of the tramway feeders are drawn into iron pipes. The lighting feeders consist of low-tension multicore, armoured cables, with oil-impregnated paper insulation, protected with a lead sheathing. Each of the three feeder conductors are made up of $^{37}/_{18}$ wires, and with these are laid up two $^{7}/_{20}$ pilot wires. The three main conductors are of segemental shape so as to save space. The

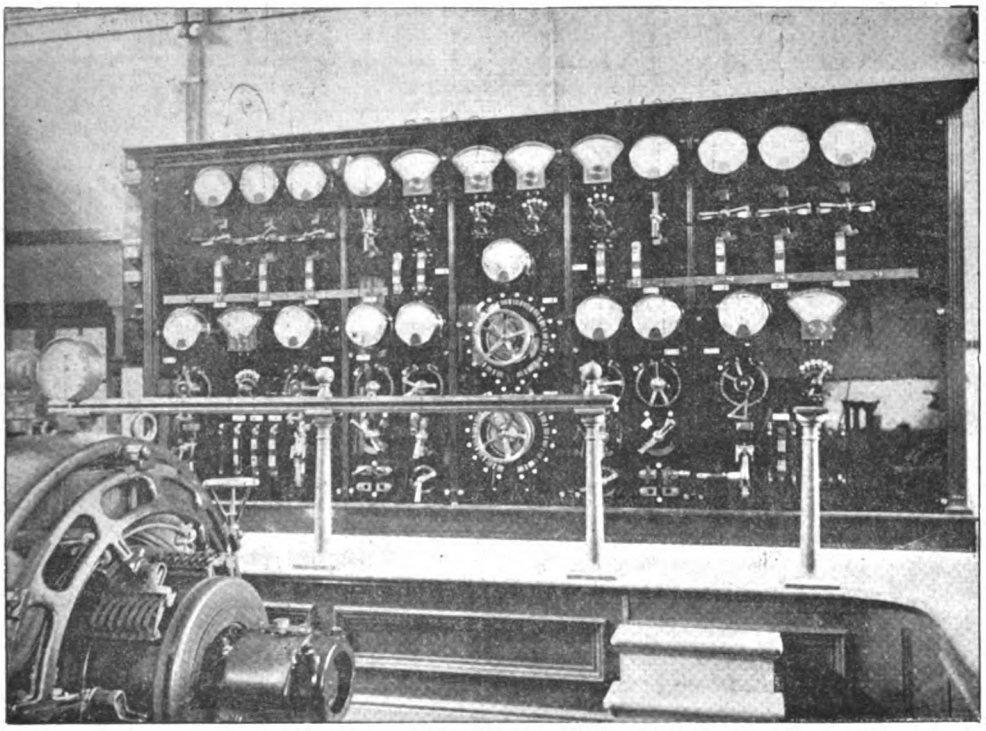

FIG. 12.—Front View of the Lighting Switchboard.

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distributors throughout the town are $^{19}/_{14}$, $^{19}/_{14}$, $^{19}/_{16}$ low-tension, three-core armoured cables of the "Cloverleaf" type (Fig. 15), suitable for a working pressure of 440 volts across the outers. The special feature of the network is the use of distribution pillars above ground at each feeding point. This firm is making a speciality of these pillars in its work in preference to the older method of underground distribution boxes. They claim that the slightly greater cost of the pillar is recouped within the first two years by the facility with which all the fittings are got at, and the consequent saving in labour. In the present instance, the finished pillar (Fig. 16) has the outward appearance of an ordinary tramway section pillar, and stands 3ft. 4in. above the pavement. It is 22in. broad and 18in. wide. The fittings inside consist of three enamelled slate panels, insulated from earth by ebonite bushes and washers, carrying 'bus bars and disconnecting link fittings for coupling up the distributors to the feeder. The fittings on each pole are further separated by fibre sheets inserted between the slate bases.

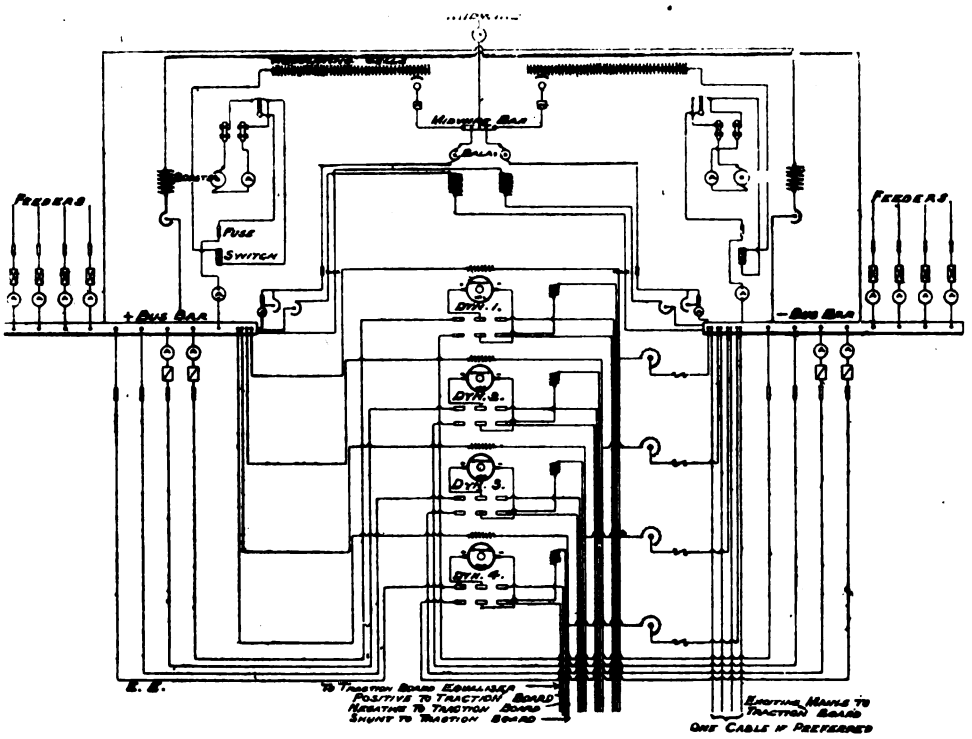

FIG. 13. Diagram of Connections for Lighting Board.

The arc lighting at present arranged consists of five circuits of nine lamps each, the lamps being the Brockie-Pell 10-ampere 32-hour type complete, with automatic cut-out and substitutional resistance arranged in the top of the lamps. The lamps are fixed in Hyde Park carriers on the side poles of the tramway equipment. Incandescent lamps will be attached to each of the above poles, and will be switched on at midnight when the arcs are switched off. A three-core $^{7}/_{16}$, $^{7}/_{18}$, $^{7}/_{18}$ armoured cable is used for the

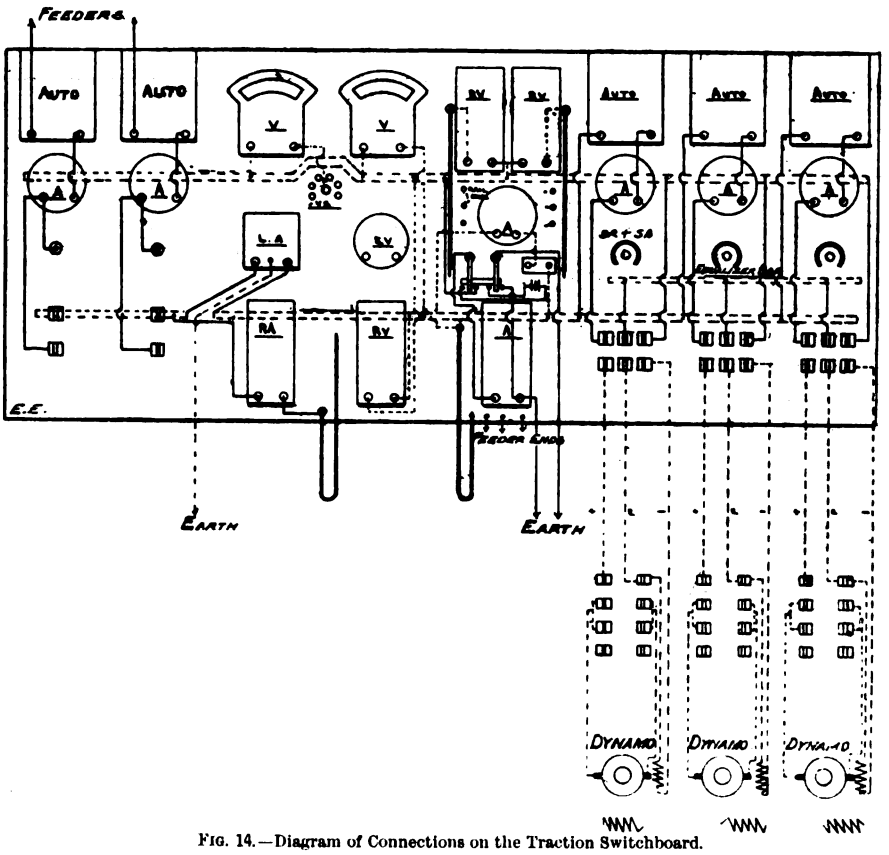

FIG. 14.—Diagram of Connections on the Traction Switchboard.

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supply to this public lighting. At the foot of each post a compound box is employed, with links arranged for the series arc leads and parallel fittings for the incandescent leads, this being the same method as successfully employed by this firm at Bexhill.

The whole of the steel poles, etc., for the overhead equipment for the tramway continuous work have been supplied by British manufacturers to the British Insulated Wire Company's order. The poles are in one section of mild-steel plate 31ft. long, and supplied by Messrs. Russell, of Wednesbury. On the first sections the span-wire

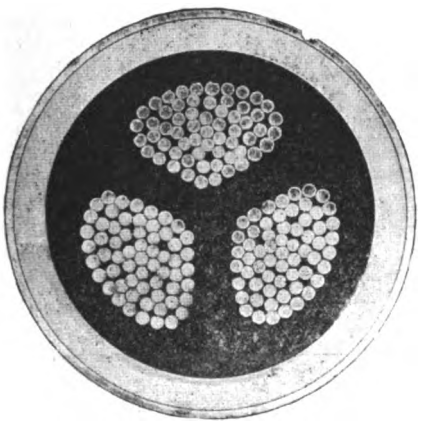

FIG. 15.—Section of Three-Core Cable.

method of construction has been adopted, with special ornamental attachments on the poles. There are two trolley wires throughout, each of 0·324in. diameter hard-drawn copper. All line fittings are insulated with "ambroin," and supplied by Messrs. Estler Bros. The feeders are $^{37}/_{18}$ L. T. S. armoured, laid direct in the ground. The overhead equipment for the work throughout from Bolton to the Kearsley boundary was done some time ago by Messrs. George Hill and Co., of the Trafford Electric Works, Manchester. This is also done on the span-wire system, and the feeders are drawn into cast-iron pipes.

FIG. 16.—Front View of Switch Pillar.

On the lines now working the cars are those of the Bolton Corporation, but the Farnworth Urban District Council have ordered the new cars for their extension lines from the British Westinghouse Company. These cars are all provided with Westinghouse double equipments. The motors are of the No. 49 B type, which has been used to a considerable extent on other tramways in this country, being expressly designed for the conditions of city tramway work. The field of this motor consists of four poles, built up of thin soft-steel plates cast into the enclosing yoke. The yoke is centrally divided in a horizontal plane, the two halves being hinged together on the side opposite to the axle, thus rendering the interior parts of the motor easily accessible. The field coils are machine-wound upon moulds, and insulated with fuller board and mica before being placed in position on the pole-pieces, where they are secured by cast brass plates bolted to the yoke. The terminals of the upper field coils are soldered to long lengths of insulated conductors, this method of connecting being adopted to ensure perfect isolation of the brush terminals from the field terminals. The two lower field coils are fitted with the usual metal terminal screws. The armature is of the slotted drum-wound type, built up of soft-steel discs traversed by air channels, whereby excellent ventilation and cool running are secured. The armature coils are connected so as to form the two-circuit winding, whereby the magnetic balance of the machine is maintained independent of the correct centralisation of the armature in the fields, ensuring sparkless running. The armature coils are machine-wound and arranged in sets of three, three separately-wound coils being enclosed together in a protecting cell of insulating material. These cells are placed in

FIG. 17.—Cable-Laying at Farnworth.

the core slots without bending or hammering, thus the insulation of the armature can be relied upon. The armature is of comparatively small diameter and light weight, resulting in a reduction of the wear and tear of the motor gearing and reduction of the centrifugal forces acting on the conductors, a considerable saving of energy by the reduction of the momentum of the moving parts, and rendering possible rapid speed acceleration and braking. The commutator is composed of 105 hard drawn copper segments insulated from each other by mica sheets. The commutator has a large diameter, allowing ample margin for wear. Motor bearings are outside the casing, thus rendering it impossible for oil to reach the windings or commutator. Each is lubricated by grease-cup above bearing, and also by a wick feed from an oil reservoir underneath. The gear and pinion of each motor are composed of cast steel and forged steel respectively. The pinion end of the motor shaft is tapered to allow easy tightening of the pinion if necessary. The gearing is entirely enclosed in a cast-iron case. The total weight of the motor, including gears and gear case, is about 1,900lb., the weight of the armature complete, with windings and commutators, being about 438lb. Access is had to the brushes through the large opening in the upper half of the case, which is covered by a strong lid. The brush-holders, which are of strong and rigid construction, are secured to the upper field casting; provision is made for adjusting them radially to allow for the wear of com-

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mutator and brushes. Carbon brushes are used. On opening the motor for inspection, by dropping the lower half of the enclosed field casting the armature may either be locked on the lower half and dropped with it, or it may be held to the upper half by suspension hooks, which are provided for the purpose, and which are very easily placed in position. These motors are worked by the Westinghouse No. 90 controllers, which are arranged to control for forward running, for backward running, for forward braking, and also for backward braking, using motors as generators. The arrangement of the connections for securing these changes in the No. 90 controller differs from that in any other type. A much smaller number of electrical contacts than is usual is required in this controller; mechanical connections between the operating and reversing levers, automatically operated, take their place, and the reversing switch and the motor cut-out switch are combined. The advantages of this substitution are evident, and need not be dwelt upon; it is sufficient to call to mind the wear and tear losses and liability of breakdown occurring with a multitude of heavy current contact pieces. The movement of the operating lever in one and the same direction from the "off" position produces normal running

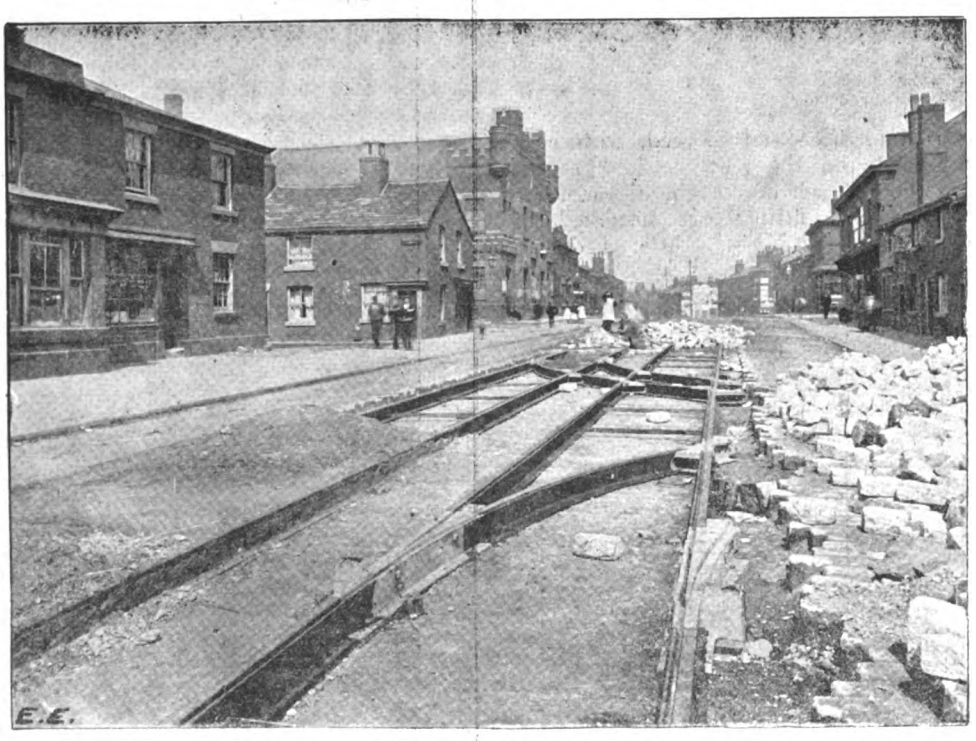

FIG. 18.—View of Special Track Work at the Entrance to the Car Shed at Farnworth.

of the car, either forwards or backwards, according to the position of the reversing lever. A movement of the operating lever in the opposite direction produces braking of the car, whether running forwards or backwards. The braking effect is secured for either direction of running by simply throwing the operating lever back beyond the "off" position. The change from running control to braking control is secured automatically by suitable mechanical connections between the main operating drum and the reversing drum of the controller. The controller is of the series-parallel type, there being three resistance steps for the series, and two resistance steps for the parallel arrangement of the motors. In the braking position there are four resistance steps. The values of the braking resistances are adjusted to give a range varying from a sufficiently low value for securing the strongest and most rapid of emergency brakes, to a higher value for the gentle braking of normal service; the braking being carried out by simply running the motors as generators on load through a suitable resistance. Provision is made in the controller for cutting out either motor and for ensuring the safe operation of the one remaining in circuit.

A large car-shed, with inspection pits under each track, is now in course of erection near by the electricity works.

We have to thank the consulting engineers for this work, Messrs. Lacey, Clirehugh, and Sillar, for their kindness in lending us the drawings from which the line illustrations were prepared. These works are to be opened by the Chairman of the Urban District Council on Wednesday next.

THE WINDING OF CONTINUOUS-CURRENT SLOTTED ARMATURES.

An interesting article on "Modern Windings for Continuous-Current Slotted Armatures" was recently contributed by Mr. Alexander Rothert to the *Elektrotechnische Zeitschrift*. The following is a translation: "During the past few years certain progress has been observable in the construction of continuous-current dynamos as compared with a previous period of relative stagnation. This may be attributed chiefly to growing competition, which forces the designer to economise both materials and space. A thorough investigation into the magnetic characteristics of the materials employed, as likewise into the cooling capacities of the machines, has enabled a much fuller utilisation of these materials.

"The tendency is for the machines to become progressively smaller and lighter, higher and higher saturations of the iron being adopted. The ventilation of the armature also contributed towards a reduction of the dimensions, since when well planned this enables the dimensions of the armature to be reduced within the range defined by the admissible magnetic saturation of the teeth. There is, however, a limit to the possibilities in this direction. It is not always possible to utilise the magnetic material in the armature to the extent desired, and for purely mechanical reasons. The teeth may be too thin at the roots when extreme saturations are in question, thereby entailing difficulties in stamping and assembling the armature plates, the teeth being easily bent during the process and rendered liable to other deformities. Even if the slots are milled the teeth are very liable to be of un-uniform thickness, individual teeth being, in consequence, much too strongly saturated and so on. For machines of medium size about 3mm. may be taken as the minimum width of the teeth. But with this width the desired degree of saturation is frequently rendered impossible, so that the material is not fully utilised. These remarks apply to multipolar machines not possessing a very small number of slots—that is to say, which are designed for 220 or 500 volts terminal pressure. Such machines require a relatively large number of commutator segments, and, therefore, have a correspond-

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ing number of slots. In order to avoid too thin teeth it is requisite to make the depth of the slots relatively greater, but this is necessarily at the expense of sparkless commutation. There is an evident inconsistency here between the considerations which govern the mechanical design of the machine and the electrical qualities of the same. From a mechanical point of view the fewer the number of slots in the armature of the machine the better. We have, then, a few strong teeth, whereby the necessary stamping or milling is minimised, while the winding is at the same time simplified. Moreover, less trouble is involved in providing for efficient insulation, since the surface of the winding to be insulated from the iron is less while there is more room at disposal for the insulation, or an equally efficient insulation of the winding requires relatively less room, whence the armature may be made smaller, the more so in proportion to the degree to which the saturation of the teeth can be increased without making them too thin. So far as good mechanical construction and minimum dimensions of the armature are concerned, it is obviously of the greatest interest to th designer to keep the number of slots as low as possible But it is well known that the limit to the possi bilities in this direction is soon reached, since, on the other hand, it is essential in the interests of sparkles commutation to provide as many commutator segments as possible. It is therefore necessary to take both considerations into account, whereby, in the case of small and medium-sized machines, the mechanical design suffers in proportion to the value of the terminal potential required. It has been sought to overcome these difficulties by providing the armature with only half as many slots as the commutator has segments. This method has been largely employed, but with varying success, and opinions concerning its value have been very divergent until within recent years. In many cases the practice was abandoned owing to the unsatisfactory results obtained. These failures were due (apart from high-voltage machines, in connection with which sufficient care is taken not to exceed a certain difference of potential between any two adjoining segments) to the commutator behaving in spite of the greater number of segments as if it had had only half the actual number of segments. The one or other of any two adjacent segments, according as the brushes were set, was invariably somewhat pitted. The parallel windings mostly in vogue at the time were answerable for this result. In series-wound armatures this defect was, of course, absent, but at the time in question the knowledge of such differences was not general, and it was left to the Americans to again bring into notice the continuous-current armature with several commutator segments per slot. While of late years continuous-current machines have been built in Europe chiefly for low pressures (65 to 110 volts, at the most 220 volts) the higher pressures, apart from traction work, being reserved for alternating currents, many continuous-current plants have, on the other hand, been put down in America for a pressure of 500 volts. The Americans standardised their machines, and soon learnt, therefore, to manufacture them quickly and economically. Moreover, in America the same armature must naturally serve for all customary pressures—125, 250, 500 volts, and so on. As a consequence American-built continuous-current machines have for several years past excelled those of European make in respect to their electrical qualities, the dimensions of their armatures being relatively much smaller. Such machines are provided almost invariably with two or three times as many commutator segments as armature slots. The advantages common to the American type of construction are now beginning to be gradually appreciated in Europe, and manufacturers have commenced to build machines with ventilated armatures and a smaller number of slots. The competition of the American traction motors has undoubtedly contributed to this result. Many European manufacturers, however, still show a certain timidity in making the change. In describing the windings of such armatures we shall, for the sake of simplicity, deal first with bar winding. The following remarks are confined to armatures having three commutator segments per slot, since this is both the most customary and most favourable proportion. The principles involved are, of course, the same when the commutator has two segments per slot. The cross-section of such a slot for 2×3 bars (corresponding to three commutator segments) has the form shown in Fig. 1. It is assumed that the bars are bent in the manner which is customary for wave windings, a group of three being represented in Fig. 2. Strictly speaking, each of the three bars comprising one group or section of the winding must be shaped somewhat differently, as will be apparent from Fig. 3, which is drawn to a larger scale. The latter figure represents one of the bends in the bars. In practice, however, it is only with thick bars that the difference need be taken into account. The space required for the insulation of the winding from the iron core is the same per slot in a tangential direction irrespective of the number

Fig. 1.

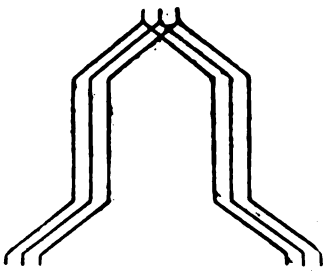

Fig. 2.

of slots, and since by this method of winding we obtain a three-fold reduction in the number of slots as compared with ordinary winding, it follows that we obtain under otherwise equal conditions the additional advantage due to three times less space being required for the insulation in question. For equal saturation of the teeth and depth of the slots the width of the teeth at their base is three times the usual width. In consequence of this, there is practically no limit to the saturation which may be obtained without reducing the width of the teeth below the minimum consistent with mechanical efficiency. The slots may, therefore, be made shallower, whereby the volume of the teeth is reduced, and consequently also the iron loss in them. This circumstance allows of the armature being made smaller, the mean length of an armature wire being rendered correspondingly less so that the sectional area of the wire used may, in turn, be slightly reduced, and so on. We thus obtain a combination of circumstances which have a mutual influence tending to a considerable reduction in the finished size of the armature, and

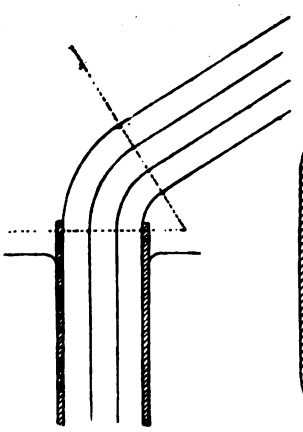

Fig. 3.

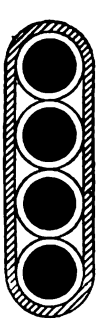

Fig. 4.

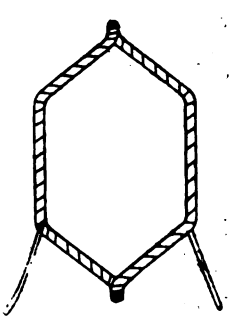

Fig. 5.

at the same time a great saving of material. By providing for effective ventilation the temperature increase of the armature may still be kept within the permissible limits. Figs. 1, 2, and 3 apply for armatures with bar winding; the application of the above remarks to former-wound wire winding is at once apparent. Should there be, in place of a single turn per armature section, several of the same, then it is no longer possible to use bar winding for series machines, at all events not for cylindrical drum windings, which alone can be considered as modern to-day, and which are fast superseding other types of windings Where there are several turns per armature section wire must in this case be employed. We substitute, in Fig. 1,

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each individual bar by an equivalent number of turns of wire as shown in Fig. 4, while in place of each of the bars, represented in Fig. 2, an armature coil of the form shown in Fig. 5 is substituted. The latter is what is known as a former-wound coil—that is to say, it is composed of wires bent to the required shape over a former, and afterwards wrapped round with tape or some other binding material. Fig. 4 shows a section of such a coil, consisting of three turns of round insulated wire. The tape serving to bind the four wires serves at the same time to insulate the different armature coils in the same slot from each other. In Fig. 6 we see in section how three such former coils, each representing a separate section of the winding, are combined or bound together so as to form one coil. These three armature coils are the equivalent of three of the bars in Fig. 1. In Fig. 7 is shown how the three separately wound former coils are laid together. To-day nearly all multipolar machines of American manufacture are wound in the manner described, notably traction motors, which invariably have two or three commutator segments per slot. In some cases the number of slots is remarkably small, four-pole traction motors with 29 slots being met with, the dimensions of the slots being correspondingly large. To a manufacturer who, according to the practice prevailing in Europe, builds machines with as many segments in the commutator as there are slots in the armature, such a small number of slots is quite foreign, and many manufacturers cannot get away from the idea that violent sparking at the commutator must arise in consequence. As a matter of fact, a machine need not spark at all on this account. For several years past the

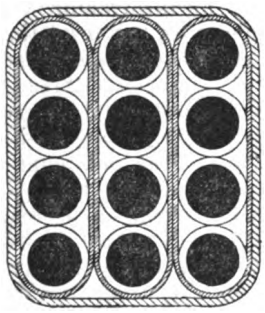

FIG. 6.

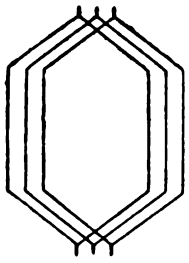

FIG. 7.

writer has constructed machines with great success on the principle in question. The machines are easy to construct, since the stamping of the core plates is simplified and the winding of the armature facilitated. In dealing with the principal features of the method of winding in question, I have up to the present confined myself mainly to their advantages. In order to be fair, I will now examine their disadvantages. While the advantages consist mainly in that greater economy is effected in the construction of the machines, the disadvantages, on the other hand, lie in quite a different direction. As a matter of fact, they concern only those who design and calculate the machines. Much more trouble is entailed in finding suitable ratios, and more calculation and trials are, therefore, necessary. We will consider some of the difficulties which arise in determining the correct dimensions of these machines While in the case of four-pole armatures having three segments per slot it is invariably possible to so dispose the winding that the three bars or sections (Figs. 2 and 7) placed together in one slot come together again in the opposite slot, it is not so simple a matter with six-pole machines. In the latter case the disposition of the bars in the slots has to be considered. In Figs. 2 and 7 the bars on the left half lie in one slot, while those on the right half are placed together in the other slot. It is naturally only in this case that the three bars or former coils can be made ready to be placed as finished former coils direct in the slots. Supposing this is not the case, then the former coils must be separately placed in the slots, which necessarily considerably complicates the winding. For four-pole machines having two commutator segments per slot, and six-pole machines with three segments per slot, a simple but not very symmetrical series winding ($a = 1$, Arnold) is possible. The unsymmetrical proportions are due to one or more of the slots not containing the full number of bars—that is to say, instead of six, only four, or instead of four, only two. Eight-pole armatures having three commutator segments per slot can be symmetrically constructed, but not with two segments per slot. However, the want of symmetry in question is inappreciable in properly constructed machines. Since it is advantageous, if possible, to use the same slotting for all customary pressures (125, 250, and 500 volts), it is essential to allow for this from the commencement, as it facilitates matters to use the same bars or former coils, executing the series winding only as simple ($a = 1$), double ($a = 2$), or treble, and so on. The above-mentioned ratios are, however, modified correspondingly, so that to a certain extent unsymmetry is unavoidable. A further frequently not inconsiderable difficulty lies in the formation of the slots, unfavourable ratios in this respect being very liable. In consequence of the considerable width of slots in small armatures, the wedge shape of the teeth is very marked. A slight difference in the depth of the slots effects a considerable difference in the strength of the tooth at that point where it is thinnest, so that the saturation may be easily too low or excessively high. These difficulties make themselves most felt when round wire is employed, since in this case the minimum graduations in the dimensions of the slots are possible. When employing wire of rectangular section, the defect may be remedied by selecting the dimensions for the wire most adapted to the particular case. But it is easy to adopt too flat a section, especially if the same slotting is to serve for different pressures or variable speeds, since in this case one and the same slot must suffice for different numbers of wires and different arrangements. Where former windings are once introduced, abnormal patterns and slots are avoided as far as possible. It is thus apparent that the manufacturer, so far as machines with relatively few slots are concerned, is certainly more restricted as to the disposition of the winding than with older-type machines having one commutator segment per slot, and that he has to overcome difficulties which are otherwise not met with.

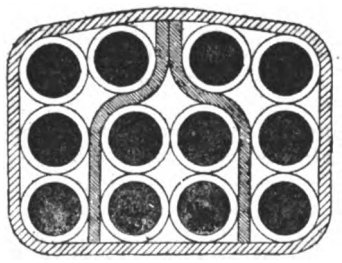

FIG. 8.

"These difficulties, with which the writer has experienced much trouble in designing machines, have suggested to him a new method, which avoids the principal disadvantages peculiar to the method of winding just described, while at the same time offering considerably further advantages. Instead of several former-wound coils, each representing a distinct section of the winding, separately shaped and then assembled (Figs. 6 and 7), the writer by his method winds all the turns comprised in a two or three section former-wound coil direct and continuously on a suitable former, and so obtained a single former coil possessing as many turns as may be necessary for the two or three sections. The manner in which the respective sections comprising the complete coil are separated we shall see later on. The advantages claimed for the writer's method of producing a combined former coil are as follows: The most essential advantage consists in that the manufacturer is much less restricted in arranging the wires in the slots. According to the above-described older method, for example, the number of wires lying side by side had to be three, or a multiple of three, in a winding requiring three conductors in one slot, while there were just as many wires superimposed as in each one of the three former coils constituting the combined coil. The writer's method, on the other hand, does not restrict the arrangement of the wires to any particular manner, so long as the total number of wires in the combined former coil is correct. According to the new method, for instance, the same number of wires as shown in Fig. 6 may be grouped as in Fig. 8. Or with two winding sections only of four conductors each per former

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coil the grouping may be as in Fig. 9, which shows the section of a complete slot, instead of in the ordinary way, as in Fig. 10. These few examples may suffice to show the manner in which flexibility of disposition may be obtained. By selecting a rectangular wire of suitable sectional area we may obtain other combinations, since we could then dispose the wires partly on edge and partly flat. This flexibility in the arrangement of the wires assists the designer frequently very considerably in proportioning the machine, especially in the case of small motors—for instance, automobile motors. It also enables us to select, in the case of the larger machines, the most adaptable section for the wire—that is to say, the section which most

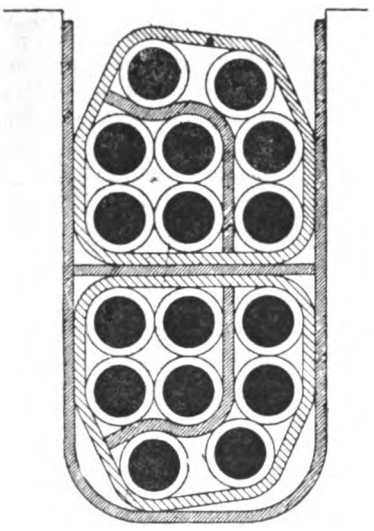

Fig. 9.

closely approximates to the square, whereby the production of the former coils is facilitated, and at the same time the space occupied by the necessary insulation economised. The most advantages are offered by this method, so far as flexibility of arrangement is concerned, when round wire is used, but this is seldom the case, except with very small machines—for instance, automobile motors.

"A further advantage of this method consists in that the individual windings adapt themselves to each other readily at the corners (see Fig. 3), whereas in the case of a combined former coil made up of three separate units, inaccuracies, if only slight, always occur at these points, because, for the sake of simplicity, all three units are wound on the same former instead of on three separate and slightly different formers, as should really be the case. As

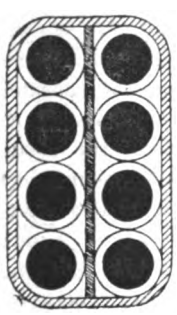

Fig. 10.

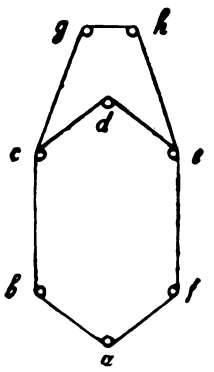

Fig. 11.

a consequence, slight corrections to the separate former coils have to be subsequently made, which is hardly beneficial to the insulation. Further, it is obvious that the insulation between the three sections (see Fig. 6) may be economised to no inconsiderable extent, because it is not called upon to fulfil any mechanical purpose, but need only be strong enough to satisfy the actual requirements of the insulation. Under certain conditions it may be entirely dispensed with. In Figs. 8, 9, and 10 insulation is shown between the sections between which the extreme difference of potential occurs. The winding as a whole may be insulated from the iron core as well as necessary, and held together by means of binding tape. By restricting the amount of insulating material in the slot to that which is absolutely necessary space is economised, which in turn enables the dimensions of the armature to be again slightly reduced.

"Up till now we have considered only the arrangement of the wires in the slot and the insulation of the same from each other and from the iron core. It remains to be seen how the combined contiguously-wound former coil is subdivided into different sections. This may be explained as follows: In the first place, the turns corresponding to one section are wound contiguously on the former, the regular winding being interrupted by a loop formed in the wire by passing it round one or more suitably-placed pegs, after which the winding of the wire is continued as before, its continuity being preserved for the time being through the diversion. Proceeding, all the turns required for the second section are wound, whereupon another loop is made in the wire, and so on until all the windings of the combined former coil are complete. The loops are cut after the necessary firmness has been imparted to the coils by the use of binding material. By severing the first loop at the proper point the end of the first section and beginning of the next are obtained, while by cutting the second loop the end of the second section and beginning of the third are obtained. We have then six ends in all, which should be connected to the commutator at the beginning and ends of the three sections. Fig. 11 represents such a scheme. The turns of the coil are wound round the points *a*, *b*, *c*, *d*, *e*, *f*; the loops leave the other windings at the point *c*, going instead of over *d* round the two pegs, *g*, *h*, and join the other windings again at *e*.

"Instead of waiting to cut the loops until after the windings have been completed, they may be cut during the process of winding if desired, or the separate lengths of wire may be employed.

"So far combined former coils with three sections have been almost exclusively spoken of, but all that has been said applies just as well to other conditions, indeed, for any number of sections per coil. All the questions relating to the manufacture of continuous-current machines dealt with above bear witness to the fact that it no longer suffices to construct a machine which shall satisfy electrical requirements. On the contrary, the greatest attention should be paid to all details concerning the dimension, construction, and winding in order to obtain a reliable, simple, easily repairable, and, at the same time, commercially satisfactory machine with the expenditure of a minimum quantity of material."

GLASGOW ENGINEERING CONGRESS.

The following is the provisional programme of the electrical section of the above congress, which section is organised by the Institution of Electrical Engineers. The meetings will be held in the natural philosophy theatre of the University of Glasgow, at 11 a.m., on Tuesday, Sept. 3, 1901, and at 10 a.m. on each of the following two mornings:

Tuesday, Sept. 3.—Short introductory address by the President; "Notes on Some of the Electrical Exhibits in the Exhibition," by W. B. Sayers (member), followed by a short organised visit to the exhibition.

Wednesday, Sept. 4.—"High-Speed Railway Car of the Allgemeine Elektricitäts-Gesellschaft, Berlin," by O. Lasche, Berlin; "Dangers from Trolley Wires, and their Protection," by Prof. A. Jamieson (member); "Electricity Supply Meters of the Electrolytic Type," by J. R. Dick (member); "Kelvin's Electric Measuring Instruments," by Prof. M. Maclean, D.Sc. (member).

Thursday, Sept. 5.—"The Relative Advantages of the Three, Two, and Single-Phase Systems for Feeding Low-Tension Networks," by M. B. Field (member); "Modern Commutating Dynamo Machinery, with Special Reference to the Commutating Limits," by H. M. Hobart (member); "Continuous-Current Dynamo Design," by H. A. Mavor (member).

Members wishing to take part in the discussion on any of the above papers are requested to send in their names to the secretary, Mr. W. G. McMillan, who will then forward them copies of the papers they mention.

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POWER SCHEME REGULATIONS.

Up to the present the regulations which the Board of Trade have issued from time to time in accordance with the powers of the Electric Lighting Acts of 1882 and 1888 have been held to apply also to the electrical work done under the various Power Bills which have been sanctioned during the last few years by Parliament. A casual glance at these regulations will at once show that they are in certain cases quite inapplicable to a large power scheme. It is natural that this should be the case, as they were drafted before any of these larger power distribution schemes had been designed or even considered as being in the *regime* of practical politics. One great object before the Board of Trade when the regulations were being made was that of the protection to be afforded to small consumers. In consequence of the simple character of the work which has to be carried out on the premises of such consumers, the consumer does not, as a rule, employ an expert electrician to advise him. He puts himself only too often in the hands of the cheapest wiring firm in the market, and the installation, when completed, is even then not worth the money paid. In view of this state of affairs, which the Board of Trade is powerless to prevent, it adopted the only possible course of making stringent regulations to prevent the undertakers from allowing high-voltage currents to leak into the consumers' cables. When, however, a large power distribution scheme is under consideration, the whole character of the work is different. A consumer installing three hundred or four hundred horse-power of motors has the advice of an expert in the matter, or even if this should not be the case, he deals with some large electrical firm which is quite capable of carrying out the work properly. The large amount of money which has to be spent both by the undertaker and the consumer then renders the cost of safety devices a comparatively small matter. In other words, we believe that the regulations of the Board of Trade for electric light undertakings concerning the introduction of extra high voltage into consumers' premises might be greatly modified when a power distribution scheme is concerned. The greatest hardships, however, against which the engineers of these power distribution schemes have to contend are connected with the feeding and distributing networks. The whole matter has been taken up by the Electrical Trades Section of the London Chamber of Commerce. An influential committee of engineers was appointed in February last to look into the matter, and their report is reprinted elsewhere in this issue. It has been forwarded on to Mr. A. P. Trotter, the electrical adviser of the Board of Trade, for his consideration. Besides the report, the committee have issued a most useful appendix, which gives a *résumé* of the regulations affecting extra high-tension power distribution in Switzerland, Germany, France, and the United States. Amongst the points in which the committee have a strong case against the present regulations, is that of the thickness of the dielectric. An arbitrary thickness such as is fixed by the Board of Trade is absurd, because it is not arranged on a scientific basis. In other words, cables could be made with the required thickness of dielectric which would not stand the working voltage required. In other instances, a thinner dielectric of a given material would actually have a greater margin of safety than would be the case if the Board of Trade rules were followed. This thickness of dielectric is clearly a matter for the undertakers and the cable makers. Both of these stand to lose heavily in the event of the dielectric being insufficient, and in consequence may be relied upon to see that the same is not unduly economised. It is absurd to insist upon the provision of excess material, which costs money without giving

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any corresponding advantage. The most important question raised in the report as affecting these power schemes is that of the use of overhead conductors. The committee suggest that these are allowed in all the countries mentioned above, and that without entailing any serious danger to the public. The outlay can be so much reduced by the use of overhead wires that the matter is one which seriously affects the cost of supply to outlying power consumers in rural districts. Extra high voltage would be required to be used on these overhead lines, and, personally, we do not think there is much more danger from the use of twenty thousand volts over two thousand volts for such work. A glance through the regulations in Switzerland, and in the other countries mentioned, seems to indicate that with a few reasonable precautions such lines are only of danger to the would-be suicide. In view, however, of the large interests involved, we think that the Board of Trade should hold an enquiry on the matter, at which witnesses could be heard on both sides. It would not be difficult to obtain from abroad evidence as to what accidents have happened, with a view of determining once and for all the precautions to be adopted to render the same practically impossible. If this were done, there are many areas in which overhead wires could be used with advantage to all concerned. The Electrical Trades Section of the Chamber of Commerce are to be congratulated on the report now before us, which we trust will have the effect the members of the committee hope for. This we take to be the prompt provision at reasonable rates of electrical energy in bulk over wide areas.

OBITUARY.

The late Dr. Richard Charles Shettle, M.D., etc., who died on the 21st ult. at the ripe age of 77 years, will be chiefly remembered in the electrical world for his conscientious scientific pursuits. Quite early in his career, on obtaining the M.D. of St. Andrew's University, Dr. Shettle relinquished general practice in order to devote a large part of his time to the study of science. He, however, was subsequently appointed medical referee to the National Hospital for Consumption at Ventnor, consulting physician to the Midland Counties Home for Incurables, the Berkshire Friendly Societies, and the Reading Dispensary; yet while filling these responsible positions with ability, he found time to experiment much in the field of electricity and magnetism. One of Dr. Shettle's earliest papers on "Electricity as the Principle causing the Vitality and Coagulating Property of the Blood," was published in the *Lancet* so far back as the year 1863. From the numerous papers that he published on this subject, mention may be made of a "New Method of Investigating the Magnetic Lines of Force in Magnets," and of several letters on the "Physiology of Death by Electric Shock." Readers of this journal may also remember that in recent years Dr. Shettle contributed some particularly able articles to its pages, notably "The Origin of Matter and Force," in 1897; "The Physical Properties of Matter: How Acquired," in 1899; "Some Remarks upon the Cause and Nature of the Electric Force," in 1900; and "Some Remarks upon a Hitherto Unrecognised Planetary Law," the same year. These and other of his literary efforts are strong evidence of Dr. Shettle's original turn of mind, as well as showing deep research in the subjects he essayed. His subjects were always attacked by him in an original manner, which is shown by the articles which we have published from time to time. Notwithstanding the deep attractions his own profession and scientific work had for him, the deceased gentleman accepted the chairmanship of the Reading School of Science and Art on the death of Dr. Wells, and he took great interest in the founding of the Reading College, of which body he was governor, contributing liberally to its physical laboratory. Dr. Shettle was also a life member of the Victorian Institute and Physical Society, of London.

THE PROSPECTS OF SINGLE-PHASE SUPPLY.

BY W. E. WARRILOW.

In glancing at the history of electric lighting in this country it is noticeable that the single-phase alternating-current system was very generally adopted by the principal pioneer undertakings. Probably the chief cause for this almost wholesale installation of single-phase plant was due to a desire to introduce as simple a method as possible, quite apart from the likelihood of its being unsuitable for demands which would arise in a few years' time—demands which would vitally affect the prosperity of the undertaking. Further observation of the course of events will show how the increasing calls for power have found single-phase engineers unready to satisfy such needs, with the result that the former rival of the system has met with greater favour, to the discomfort of alternating-current supply, while the general laying down of direct-current machinery in the last three years is common knowledge.

The most casual observer will perhaps be somewhat mystified at the squabblings of engineers over the system of generation to be adopted, though he will by reason of the imperfect state of his knowledge be inclined to endorse the opinion of the party which seems to be in the ascendancy. There is, however, none the less cause for reflection into the future prospects of the pioneer system of electric lighting, especially as that system first commended itself to engineers, and, in spite of statements to the contrary, still stands unrivalled for simplicity among methods of generation and distribution. Moreover, the future of the electrical industry is not one of small undertakings, supplying a few customers and lighting a limited number of street lamps. Such were the prospects which pioneer undertakings had to face, though even they miscalculated the growth of electricity supply. No, the view ahead is so extended that it is hardly possible to realise the ultimate outcome of the industry, though it may be said with truth that the future is wrapped up in the supply of *whole* towns with light and power. The size of generating units can now be reckoned in thousands of horse-power as compared with a few hundreds of the early days, so that gauging the future by past developments, units of tens of thousands of horse-power will not appear unlikely. Experience has taught that large units are more economical than a number of small ones, so that no limit can at present be placed as to the ultimate size of generating plant.

Now, the chief drawback to single-phase supply up to the present has been its unsuitability to operate tramways directly and to meet the demands for motors of large power. The latter is not as important an item as the former, because so many stations have motors on their mains now, and improvements are constantly being effected which are raising the standard of single-phase motors to a very high level. The chief problem is that of the tramways, and although this at first appears very formidable, it proves, on examination, to be less so. The early success of the overhead trolley tramway in America persuaded electrical engineers in this country that the system was suitable for introduction into our towns as a sound commercial concern, apart from its effect upon the appearance of the streets or its future efficiency as a method of transit. After considerable opposition, the British public have been persuaded to adopt the system, and since the insertion of the thin end of the wedge, a large number of towns have laid down their own electrical traction scheme.

Now, although the future of electric tramways appears very bright, it is possible to perceive, at no great distance ahead, a system which will supersede tramways of all kinds, be they horse, cable, or electric. The method in view is traffic by means of automobiles. The efficiency of these self-propelled vehicles will be brought before public notice at a date not far distant, and when that day arrives the doom of all tramways will be sealed. The money now expended on electric tramways would be far better invested in the development of the motorcar industry, as the future of this branch of traffic systems cannot be too highly valued; while as a rival to the tramcar, the automobile holds the field. Again, the future of the overhead system

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is by no means assured, in that its appearance will militate against its introduction into certain towns, where the overhead wires would not be tolerated, and where recourse must be had to either an underground system or some other method of transit. Considered from a broad point of view, then, and judging from the advances made in systems of traffic, it is possible to see the advent of the self-propelled vehicle as a rival, and ultimate superseder, of the electric tram.

So much, then, for the prospect of single-phase supply with reference to tramways. The next important factor is that of accumulators, and upon this point there are diversities of opinion. It is difficult to say if the efficiency of the storage battery will merit its more general adoption, though it cannot be denied that vast improvements have been effected. As a stand-by unit its value cannot be over-estimated, the advantage thus afforded at time of heavy load being very great. Still, the depreciation of the cells is no small item even now, and much has yet to be done before the accumulator can be placed among efficient electrical plant. It is not, however, intended to deny that single-phase currents cannot be utilised for storage without the aid of some rotary transforming apparatus; but whether this is a drawback to the system is an open question. It is, nevertheless, a small matter to drive a continuous-current dynamo with a single-phase motor if accumulator charging comes in great demand.

The launching out into two or three phase supply is another noticable feature of present practice, which would bring into prominence the possible crowding out of single-phase working; but here, again, it is doubtful if the opposition is of a real character. Three-phase generation and continuous current distribution is a very doubtful method of obtaining electricity, in that unnecessary complications are introduced, and the reliability of the system is thereby endangered. Cost of installation is also high, while the difficulties of maintenance are correspondingly increased by reason of the additional apparatus to be kept in repair. The advantages of the system cannot, of course, be overlooked, nor are they in any way denied, but when they are obtained at the expense of reliability, and occasion greater outlay and maintenance, their first prominence seems to recede into the background. Above all else, our experience has taught us that simplicity in everything must be aimed at, and when dealing with the future of electric supply, we are safe to predict great prospects for the system which can fulfil the principal demands in the least complicated manner. Too much attention must not be paid in such a prospect to the systems which seem to meet existing conditions, as it is doubtful if the methods now generally in favour will be able to keep up with the times for a much longer period. The experience of direct and three-phase currents will probably teach the electrical world that it has not reached finality in these systems, but that single-phase supply, by reason of its simplicity, can and will be worthy of introduction as a standard method of generation and distribution. The whole electrical industry is at present hampered for want of standardisation, of system, and until this is obtained, it is useless to consider standardisation of plant. There must be but one system of supply, and that of as simple a character as our experience has taught us to regard in that light. Up to the present time neither direct, two, or three phase current methods can lay claim to simplicity, in spite of the fact that they are becoming more generally adopted, and the remaining method (single-phase) alone has any pretensions to that standard which our experience would have us aim at. It is evident that all confidence in the system has not quite departed, as great extensions have been made to most of the early stations, and several large undertakings have been set on foot, equipped with single-phase plant of modern design. The chief feature worthy of notice is the energy with which the motor problem has been dealt, and the results obtained speak well for the prospects of the system for power purposes. This is highly important, as the principal demand upon future stations of any size will be for motive power chiefly to operate mills and workshops, and should electric automobiles become the order of the day, it will be no very hard matter to charge the cells at a single-phase station.

Considered as a whole, single-phase working has so much in its favour as a simple method of generating and distributing electricity, that the prospect of its wider use becomes greater every year. Although a large amount of opposition is now to be noticed, it does not follow that single-phase systems are on the decline, nor is it essential that further efforts to improve them are no longer made. It becomes more evident every year that no pains are being spared to bring the method up to such a standard that opposition will be impossible on grounds of efficiency and simplicity. There is, of course much ground to cover yet. Light load losses have to be reduced considerably in order to raise the all-round efficiency of the plant, and in this direction the increase of motor customers will do much to improve the load factor during the hours of daylight, while the lighting of the streets from the mains, supplied by the same transformers which feed the low-tension network, will keep the larger units running during the small hours.

The original motor difficulty has proved of a temporary nature, as single-phase motors are now obtainable with a good starting torque, and of high efficiency, their extreme simplicity, moreover, being a powerful factor in their employment for special classes of work, such as hauling in fiery mines, or in explosive gases, where sparking in any shape would be dangerous. The general mechanical design of the motor also goes a long way towards making it popular for power purposes, as simplicity is so much needed in the operation of all machinery.

Judging from the past history of single-phase working, then, it may be assumed that the future prospects of the system are not as dull as many would suppose, nor can it be predicted in any way that the method is on the decline. In spite of the opposition at present evident in the shape of direct and three phase generation, there is every possibility of the single-phase system ultimately surviving, and become the standard means of obtaining electricity. In making for standardisation, the prospects of single-phase working are still brighter, as direct currents can only be employed within a stated radius, and though three-phase currents can meet most conditions, for economy or simplicity they do not compare with single-phase. Restrictions of distance, then, limit the development of direct-current generation, and excessive cost the unchecked advance of three-phase working, so that for these reasons the ultimate standardisation of either is very doubtful. The field, then, lies before the single-phase system, which may be so far improved to meet the necessary demands, with the greatest simplicity at the least cost, items which form important factors in methods of generation and distribution, which our experience will teach us should be adopted as a standard for all electrical work.

MANCHESTER ELECTRICITY WORKS.

The following is the report of the Electricity Committee for the year ended March 31, 1901, together with abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.:

The number of consumers at the close of the year was 3,790, being an increase of 550 on the previous year. The total number of lamps connected was: incandescents (of 8 c.p.), 279,860; arc, 2,316; as compared with 237,145 and 2,139 respectively. In addition to these, there were 672 motors in use, representing 6,560 h.p., being an increase on the preceding year of 172 motors, equivalent to 4,510 h.p. The maximum demand on the works at any one time during the year was 6,876,000 watts. The total output of electricity from the works during the past 12 months amounted to 9,639,973 units. The quantity measured and accounted for was 7,944,540, showing a loss of 1,695,433 units, or 17·58 per cent., due to loss in distribution. The total mileage of mains laid at March 31—*i.e.*, 159 miles 485 yards—represents an increase of 49 miles 440 yards on the previous year. The revenue derived from sales of current, etc. (which works out at 3·08d. per unit charged for) amounts to £101,631. 2s. 7d., and the working expenditure to £59,288. 9s. 5d., showing a gross profit of £42,342. 13s. 2d. Out of this sum, the following requirements had to be met—viz., interest on mortgage debt, etc., £20,222. 0s. 8d., sinking fund, £14,651. 4s. 7d., instalment of loan repaid, £3,953. 17s. 5d.—total, £38,827. 2s. 8d.; showing a surplus or net profit of £3,515. 10s. 6d. This surplus, plus the amount withdrawn from the reserve fund (£484. 9s. 6d.), makes up the amount paid to city fund in aid of rates £4,000. The following statement exhibits the financial position of the undertaking at

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March 31, 1901: total capital expenditure, £863,293. 1s. 2d.; mortgage debt, £722,273. 7s.; amount of mortgages redeemed to date by action of sinking fund, etc., £67,837. 13s.; balance at credit of reserve fund account, £13,172. 2s. 11d. Your committee regret that in consequence of the protracted delay in getting the Bloom-street generating station equipped for the output of electricity, and acting upon the advice of their consulting engineer (Dr. A. B. W. Kennedy, F.R.S.), they have been compelled to postpone the consideration of all applications from new consumers for supplies of current until they are advised that this station can be available to assist with next winter's load. Since the appointment of Dr. Kennedy in January of this year to design and equip the Stuart-street generating station and the various sub-stations in connection therewith for the first installation of 15,000 h.p., rapid progress has been made in this direction, and your committee are pleased to report that tenders have already been accepted for the whole of the engines, generators, boilers, etc., required for this installation. The various contractors are now proceeding with the work, and it is confidently expected that a proportion of this plant will be erected and ready to supply current by May 31, 1902. At the Bloom-street station the iron and steel work of the first pair of boilers and a portion of the first engine and generator are now erected in position. Tenders have been obtained to the specifications of the newly-appointed chief engineer (Mr. G. F. Metzger) for the various plant required to complete the equipment of these works, and it is anticipated that one set of generating plant will be in readiness for the output of electricity at the beginning of October, and to assist in meeting the heavy demands for current during next winter. Upon the completion of the above work at Stuart-street and Bloom-street stations your committee will be in a position to provide the energy required for working most of the tram routes which the Tramways Committee are preparing to work electrically in May next year, and also to furnish an efficient supply of current to several of the out-districts whose electric lighting orders have been taken over by the Corporation. For the purpose of carrying out the various extensions contemplated, it has been necessary to seek additional borrowing powers, and the Local Government Board, after holding an official enquiry on the matter, have recently notified their formal sanction to the raising of a further sum of £810,110 for the electricity undertaking.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal	£14,314	17	2			
Oil, waste, water, and stores	2,867	6	6			
Sundries	585	5	3			
Wages at generating station	4,137	17	3			
Repairs, maintenance, etc., of buildings and machinery	6,250	15	3			
Current used on works and maintenance of lamps	496	6	6			
				28,652	6	1
Distribution of Electricity.						
Wages	2,223	4	10			
Sundries	610	16	4			
Repairs, maintenance, and renewals	8,607	9	5			
				11,441	10	7
Rents, Rates, and Taxes.						
Chief rents	481	7	5			
Rents of sub-stations and offices	534	4	9			
Rent of telephones	63	4	2			
Rates	4,959	13	7			
Income tax	978	18	9			
				7,017	8	8
Management Expenses.						
Salaries—engineer's department	4,255	0	2			
Salaries—secretary's department	1,965	6	7			
Stationery, printing, and advertising	984	2	2			
General establishment charges	1,688	1	8			
				8,892	10	7
Law and Parliamentary Charges and Expenses.						
Law and parliamentary charges	1,423	4	5			
Ditto *re* transfer of orders	480	8	8			
Stamp duty	285	2	1			
				2,188	15	2
Special Charges.						
Insurances	27	19	4			
Bank commission	142	14	6			
Contributions to thrift fund	181	6	3			
Commission on loans	495	2	5			
Repairs, etc., of furniture	9	19	7			
Official clothing	159	1	10			
				1,016	3	11
Bad debts—amount written off				79	14	5
				59,288	9	5
Balance carried to net revenue account				42,342	13	2
				101,631	2	7
Cr.				£	s.	d.
Sales of current per meter—Manchester				98,291	16	9
Ditto Withington				1,700	3	7
Ditto Moss Side				975	3	3
				100,967	3	7
Public lighting—Manchester				362	18	4
Rental of meters—Manchester				230	15	1
Cottage, etc., rental				70	5	7
				£101,631	2	7

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Mortgage debt—loans as per capital account	722,273	7	0
Interest accrued on mortgage debt	3,792	11	6
Deposits held as security for current supplied	2,872	12	10
Interest accrued on ditto	220	5	9
Trade accounts owing	15,617	13	2
Temporary loan, Manchester Ship Canal Company	60,000	0	0
Parr's Bank, Limited	51,395	10	6
City fund—street-lighting	241	8	4
Amount at credit of reserve fund	13,172	2	11
Balance	67,837	13	0
	£937,423	5	0

Cr. Assets.	£	s.	d.
Amount expended as per capital account	863,293	1	2
Stocks on hand	8,060	1	7
Accounts due for current supplied	33,790	3	4
India 3 per cent. stock (proportion of reserve fund investment) at cost price	10,025	15	0
Other accounts due	367	14	2
Cash in hand and at bank	7,273	16	1
Reserve fund investment	13,172	2	11
Law and parliamentary charges	1,440	10	9
	£937,423	5	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units		9,639,973
Quantity sold { Private consumers	7,750,548	7,794,098
Quantity sold { Public lamps	43,550	
Quantity used on works		150,442
Total quantity accounted for		7,944,540
Quantity not accounted for		1,695,433
Number of public lamps		29

Total maximum supply demanded, 6,876,000 watts, equivalent to 229,200 lamps of 8 c.p.

TRANSMISSION OF POWER MAINS.

The following is the report by the Electrical Power Mains Regulations Committee of the Electrical Trades' Section of the London Chamber of Commerce:

The Electrical Power Mains Regulations Committee was appointed by the Electrical Section of the London Chamber of Commerce in February, 1901, with a view to considering whether and what modifications are desirable in the existing Board of Trade rules and regulations affecting electric power supply and transmission, having regard to the situation created by the passage of the Electric Power Acts in the session of 1900. The committee consisted of the following members: R. Percy Sellon (chairman of the section), A. Siemens (deputy chairman of the section), Wm. L. Madgen (deputy chairman of the section), S. Z. de Ferranti, F. E. Gripper, A. J. Lawson, E. Manville, C. H. Merz, A. M. Sillar, C. P. Sparkes, J. J. Steinitz, A. Campbell Swinton, E. G. Cruise (technical secretary).

The general course adopted by the committee was to obtain the opinions of its members and others interested as to the adequacy of the existing Board of Trade regulations, and also as to the special regulations imposed in the Manchester, Midland Corporation, and Walker-Wallsend power supply undertakings, these being the only important electric power transmission schemes which had been attempted so far in this country. The committee further decided that it would be of importance to compare regulations existing in foreign countries as to electric power transmission and supply, notably Switzerland, Germany, France, and the United States of America.

The leading points which came under discussion and investigation were as follows: (1) The maximum tension in volts to be used for a transmission of electrical energy at extra high pressure; (2) the maximum energy in kilowatts allowed to be transmitted through any one cable, and whether trunk mains must be always laid in duplicate—also the manner of laying the trunk mains; (3) the supply of a metal sheath of electrical continuity round the extra high-tension cables, and this sheath to be other than the lead covering; (4) the thickness of dielectric in underground extra high-tension cables; (5) the employment of bare wire overhead transmissions in suitable rural districts; (6) the nature and construction of sub-stations and the maximum energy to be allowed in any one sub-station—also the amount of obligatory attendance in a sub-station; (7) the maximum pressure allowed on to consumers' premises; (8) the inspection of the lines and earthing devices, etc.

These questions were carefully considered in the course of numerous meetings of the committee, in the light of foreign practice, in regard to which the regulations referred to were obtained. It was found that in the Continental countries referred to regulations exist in regard to public safety, and the safety of telegraphic and telephonic lines and of the lines of other electric power transmissions in the same districts, which, taken as a whole, are more favourable to the free development of undertakings of this nature than the existing regulations in Great Britain.

The committee arrived at the conclusion that an effort should be made to procure some modification of the existing Board of Trade regulations, and their views were embodied in the following letter issued by the secretary of the London Chamber of Commerce to Mr. A. P. Trotter, electrical adviser to the Board of Trade:

"London Chamber of Commerce, Botolph House, Eastcheap, London, E.C., June 19, 1901. A. P. Trotter, Esq., electrical adviser to the Board of Trade, 6, Richmond-terrace, Whitehall, S.W. Sir,—

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Referring to my letter of March 13 addressed to the Fisheries and Harbour Department of the Board of Trade, and the Department's reply of March 28, I am now desired to forward you a memorandum of the views of the sub-committee of the Electrical Section of this chamber, which has for some time past been considering the question of the conditions under which electrical power distribution schemes in this country may be carried out, I am further to ask if, after consideration of the suggestions submitted by the committee, you would be good enough to allow a deputation of their number to wait upon you in reference to the matter.—Yours faithfully, KENRIC B. MURRAY, secretary."

MEMORANDUM.

1. *Voltage of Supply.*—Speaking generally, the committee submit that the Board of Trade should be prepared to sanction distributing systems at voltages at least up to 20,000 volts between any two conductors, on the undertakers describing and adopting an approved method of working, and on the understanding that precautions are adopted similar to those which have been found successful in other countries. The committee do not think that an arbitrary limit should be fixed even at 20,000 volts, as cases may arise where higher voltages are desirable, but in such cases admit that undertakers might reasonably be asked to specify in detail, for the approval of the Board, the character of the extra precautions they propose to adopt.

2. *Power Conveyed by Mains.* — The committee consider that limitation of the size of mains, or the output which they may carry, is unnecessary and incompatible with natural development, though they think that the Board might reasonably require that undertakers should as far as possible arrange their system of mains to include an alternative route in case of accident. Where, however, more than 2,000 kw. is habitually to be transmitted by one main, the undertakers might be required to notify the same to the Board of Trade for the purpose of record; and the committee would regard as reasonable a regulation to the effect that, after exceeding a capacity of 8,000 kw., a central station should not transmit more one-fourth of its total energy by one set of mains without notification to the Board of Trade, but that not more than two sets of mains should be required up to 4,000 kw.

3. *Laying and Protecting of Cables.*—The committee strongly urge on the Board of Trade that the regulations under this head should be open and elastic. Most of the power transmission work which has been done abroad has been carried out by means of overhead wires, and there do not exist at present such large and complicated networks of underground mains for power distributions as are contemplated in the power distributions in this country. There can be no doubt that the use of underground mains on a large scale will ultimately lead to great improvements, diminishing their cost and increasing their efficiency, and it would be highly undesirable that rigid regulations should be laid down before experience has been acquired and thus stand in the way of legitimate experiment, development, or invention, and place undertakers in this country at a disadvantage compared with undertakers abroad. Where the conductors are interwoven into a single cable and where the neutral point of the system is earthed, the committee submit that the use of a metal sheath in addition to the lead covering should be optional, provided suitable mechanical protection is afforded.

4. *Thickness of Dielectric in Cables.*—The committee would point out that they can find no rule in any country abroad or in America making a particular thickness of dielectric compulsory. They submit that the present Board of Trade rule is not founded on any scientific basis, and since it was made further advances have shown that great thickness of dielectric is sometimes actually a disadvantage. Abroad, makers after careful experiment have successfully adopted much thinner layers with advantage, while there is a great saving in cost. The committee suggest that undertakers and cable makers should be left to settle this matter between themselves.

5. *Permission to Use Bare Overhead Conductors.*—The committee would particularly point out the fact that the Board of Trade regulations have hitherto practically entirely prohibited overhead work in the United Kingdom, except under such onerous regulations as to make it impracticable. There are large areas in this country and in the districts over which Power Supply Bills have been granted, the character of which is similar to districts where bare overhead wires have been successfully and safely used on the Continent and in America at very high voltages for the past 10 years. The great development of power transmission on the Continent and in America has been largely by bare overhead wires, in a form which has been entirely prohibited in this country, and great industries have arisen based on their use which have no counterpart here at all. The committee are strongly of opinion that permission to use overhead wires outside crowded city areas is vital to the commercial success of power schemes over large districts, and suggest that on this point the regulations should be brought into line with those current in other countries.

6. *Sub-Stations and Transformers on Consumers' Premises.*—The committee consider that undertakers should be permitted to place transformers up to the voltages contemplated above on consumers' premises in sub-stations above or below ground provided they are properly designed, drained, and ventilated, and that the amount of power to be installed in sub-stations should be left to the undertaker's discretion.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS

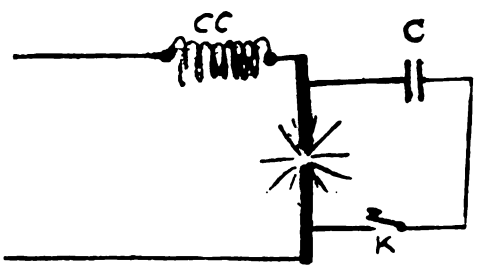
405. In a central station an increasing demand is made to get accumulators charged. What would be the best method of catering for such customers supposing the required charge ranges from ·5 to 5 Board of Trade units, and the voltage from 4 to 50 volts?—S. L.

406. Having nearly completed a four years' apprenticeship: (1) wiring (indoor and overhead), (2) turning, (3) erecting and fixing gas-engines, dynamos, and motors, (4) winding, I desire to enter a central station. Could I start as junior assistant, or is further experience required? As such, what would be my duties and salary?—E. A. L.

ANSWERS.

Question No. 399.—Describe a simple method of getting high-frequency alternating currents from a direct-current arc lamp. How can the frequency be altered?

Answer to No. 399 (*awarded* 7*s.* 6*d.*).—The following is taken principally from an article in the *Elektrotechnische Zeitschrift*, on "Neue Wirkimgen des Gleichstromlichtbogens," by Prof. W. Penkert, which appeared in No. 23, June 6, 1901, and to which further reference may be made, as it is impossible to discuss the matter here in full.



In a continuous-current arc there are very rapidly occurring variations of current, and these are used to get the desired high-frequency currents. A condenser, C, is put in parallel with the carbons of an arc (see sketch), and a key, K, is put in the circuit so as to cut out the condenser when required. A choking coil, C C, is put in the main arc circuit so as to "choke off" the alternate current into the arc and condenser circuit, and keep it from being neutralised by the continuous current. In the case mentioned, a hand-regulated lamp was used with carbons 11mm. diameter, burning at six amperes. The condenser had a capacity of 7·7 microfarads, and the arc was adjusted to be about ⅛mm. long. At this point a sort of resonance seems to occur, and a very shrill noise is produced by the arc. Within small limits the length can be varied with accompanying variation in the pitch of the sound produced, but outside these limits no sound is heard. The reason for the sound is that the condenser is rapidly charged and discharged as the main arc current varies, and the alternate currents so produced add themselves to the continuous current in the arc, and influence the gas at the arc so that it sends out sound waves.

For the periodicity of the alternate current the ordinary formula may be used:

$$n = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$$

where n = vibrations per second;
L = self-induction of alternating-current circuit;
C = capacity of alternating-current circuit;
R = resistance of alternating-current circuit.

L and R are small, hence $\frac{1}{LC}$ is great compared with the second term, and we may write the period of swing:

$$T = \frac{1}{n} = 2\pi\sqrt{LC}.$$

The writer of the article measured the periodicity thus: An ammeter was put in the condenser circuit suitable

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for alternate currents (hot-wire instrument), and showed 20 amperes to be flowing. This varied with the length of arc, and could be lowered to 10 amperes, but the current was only present while the arc was "whistling." Also a Cardew voltmeter and a Weston were both put across the arc, which was still taking six amperes. When the condenser circuit was open, the Weston and the Cardew read alike—namely, 36 volts. If the condenser circuit were closed, the arc "whistled," and the potential difference rose, the Weston reading 55 and the Cardew 68, while the ammeter gave a reading of 17 amperes. Here the Weston registers the continuous-current tension, and to this is added an alternating E.M.F., the resultant of the two being shown on the Cardew. If G = the continuous-current tension, and if e_2 = the instantaneous value of the alternating tension $= e_0 \sin \frac{2\pi t}{T} = e_0 \sin \omega t$, say, then the instantaneous value of the resultant

$$E = e_1 + e_0 \sin \omega t.$$

Now the Cardew gives a reading proportional to the mean value of E^2, and this for the first half a period is

$$\frac{2}{T}\int_0^{\frac{T}{2}} (e_1 + e_0 \sin \omega t)^2 \, dt = e_1^2 + \frac{4}{\pi} e_1 e_0 + \frac{e_0^2}{2}.$$

Similarly for the next half of the period we would have

$$\frac{2}{T}\int_{\frac{T}{2}}^{T} (e_1 + e_0 \sin \omega t)^2 \, dt = e_1^2 - \frac{4}{\pi} e_1 e_0 + \frac{e_0^2}{2},$$

which gives for a complete period the sum of the two above

$$E^2 = e_1^2 + \frac{e_0^2}{2}.$$

Now if E is the measured alternating tension, then

$$e^2 = \frac{e_0^2}{2},$$

and hence $E^2 = e_1^2 + e^2$.

Hence since E = 68 and $e_1 = 55$ we have

$$e = \sqrt{E^2 - e_1^2} = 40 \text{ volts.}$$

This is the charging tension of the condenser. Now, the charging current as read on the ammeter may be expressed in terms of the capacity $2\pi n C e$.

Hence $17 = 2\pi n C e$.

whence

$$n = \frac{17}{2\pi C e} = \frac{17 \times 10^6}{2\pi \times 40 \times 7{\cdot}7} = 8{,}780 \text{ periods per second.}$$

The principal point to be noted here is the large current dealt with at a high frequency and low tension as compared with high-frequency currents produced, say, from a Tesla coil, which have always very high tension. With these currents all the phenomena of ordinary alternating currents can be produced, such as impedance effects, skin resistance effects, and so on. The article quotes several sets of experiments fully; to describe these would, however, take too long here.—T. C.

Answer to No. 399 (*awarded* 7*s.* 6*d.*).—A great deal of experimental work has been carried out on the direct-current arc in order to determine, amongst other things, the relation between the current through the arc and the potential difference across its terminals, the length of the arc or vapour column and the potential difference, the resistance of the arc, etc. Our knowledge of the subject has lately been greatly enriched by the publication of a paper by Mr. Duddell on "Rapid Variations in the Current through the Direct-Current Arc." The author considers the effect of varying the current on (1) potential difference between the terminals; (2) light emitted; (3) shape of the craters; (4) the vapour column. A number of very interesting conclusions are arrived at, which may be shortly stated.

1. The effect of increasing the current through a direct-current arc between two solid carbons is to *increase* the potential difference for about $\frac{1}{5000}$ second, after which the potential difference decreases.

2. A variation in the light emitted by the arc can be detected by special means, due to a variation of current not more than 3 per cent. from the mean, even though the frequency of the variations be as high as 4,300 per second.

3. A rapid periodic variation of the order of 1 part in 10,000 from the mean current will alter the vapour column of the arc sufficiently to produce sounds, and, *vice versâ*, sound waves will cause the current to vary.

4. The direct-current arc can be used as a telephone transmitter and receiver.

5. In the direct-current humming arc the potential difference, current, and light emitted vary periodically, the frequency of these variations being the same as that of the rotation of the arc as a whole and of the *pitch* of the sound produced.

6. In the hissing arc the potential difference, current, and light emitted vary irregularly, the hissing proper being due to the oxygen of the air obtaining access to the crater surface.

7. Under certain conditions the direct-current solid arc will emit a musical note when shunted with a self-induction in series with a condenser.

8. When emitting the musical note the arc transforms direct current into alternating current, the frequency of the latter being determined by the self-induction, capacity, and effective resistance of the oscillating circuit.

9. A direct-current arc in series with a non-inductive resistance, shunted by a condenser of several microfarads, will generally be extinguished if the electrodes are metal, and *not* if they are cored carbons.

10. If the resistance in series be highly inductive, then, when the arc is extinguished, a violent rise of potential difference between the terminals of the arc occurs.

11. The rise of potential difference which occurs when an inductive circuit is broken by a switch, the contacts of which are shunted by a condenser, is much higher if the switch contacts are metal than if they are carbon.

We will consider paragraphs 7, 8, 9, and 10 rather more in detail. By shunting an ordinary direct-current arc between solid carbons, with a condenser and an inductive resistance, we are at once in a position to obtain high-frequency alternating currents. The value of the inductive resistance should not exceed two ohms, and solid carbons must be used, not cored. The frequency can be altered by altering the self-induction and capacity. Neglecting the resistance of the condenser circuit, the periodic time of the circuit is given by $\tau = 2\pi\sqrt{LF}$, L being the value of the self-induction in henrys, and F the capacity in farads of the condenser used. The frequency of the alternate current will be $\frac{1}{\tau} = \frac{1}{2\pi\sqrt{LF}}$. Frequencies as high as 10,000 and as low as 500 may be thus obtained. If δV be a small instantaneous change in the potential difference between terminals of the arc, δA the corresponding small change in current, r the resistance of the condenser circuit when condenser is short-circuited, the condition requisite for obtaining alternating current is given by

$$-\frac{\delta V}{\delta A} > r.$$

Now, it has been found experimentally that with cored carbons $\frac{\delta V}{\delta A}$ is always +, whereas with solid carbons the value of $\frac{\delta V}{\delta A}$ is always −. The best conditions for obtaining a supply of energy to the condenser circuit are to make R, the resistance in series with the arc, large and r small. The current in the condenser circuit may amount to three or four amperes R.M.S. value. If more power is required, several arcs may be connected in series and shunted with condenser circuit across the lot. As soon as the condenser circuit is applied the arc begins to hum (under suitable conditions), the pitch of the note being that of the periodic time of the circuit as given by the formula above.

An explanation of the production of alternating currents in this way may be as follows: as soon as the condenser circuit is applied to the arc, the latter is robbed of its current and suddenly extinguished (paragraph 9); the potential difference then rises, the condenser is charged up and discharges itself through the heated vapour of the arc, relighting same, only to be again extinguished. The reason this action will not take place with metallic electrodes

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appears to be because the arc is extinguished too suddenly (paragraph 11). It has been suggested that the reason why it does not take place with cored carbons is because the arc does not go out quickly enough. The paper and the discussion thereon are full of interesting data, and the reader who is interested in the subject should procure a copy and study it.

The following table of values is given by Mr. Duddell as suitable for production of a "musical arc":

Carbons both solid.	Open arc.		Enclosed arc.
Diameter	9mm.	...	13mm.
Arc length	1·5mm.	...	1mm.
Arc current	3·5 amperes	...	5 amperes
Resistance in series, R	42 ω	...	about 28 ω
Self-induction (henrys)	$5{\cdot}3\times10^{-3}$	...	$5{\cdot}3\times10^{-3}$
Resistance of L and leads	·41 ω	...	·41 ω
Capacity of condenser, F (microfarads)	1·1 to 5·4	...	1·1 to 5·4
R.M.S. current through condenser when F = 5·4	3 amperes	...	4·5 amperes

—E. M.

Answer to No. 399 (*awarded* 5*s.*).—In 1892 Prof. Elihu Thomson discovered and patented a method of obtaining high-frequency alternating currents from a direct-current arc. Unaware of the discovery and patent of Prof. Thomson, Mr. W. Duddell in his paper before the Institution of Electrical Engineers on "Rapid Variations in the Current through the Direct-Current Arc," on Dec. 13, 1900, published the result of his researches, and reperformed some experiments showing how these currents could be obtained from a direct-current arc. He found that by shunting an arc through a condenser it became intermittent, and gave out a musical note; also by interposing a loose coil of wire in the condenser circuit the result was

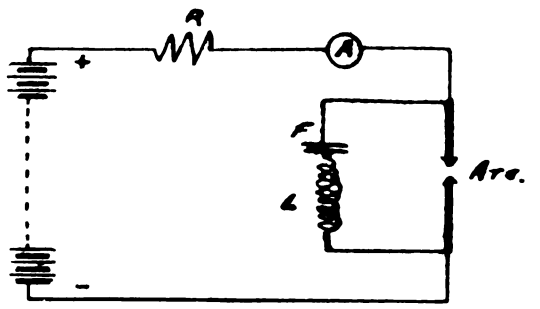

Fig. 1.—R, Resistance; F, Condenser; A, Ammeter; L, Self-induction.

greatly increased. He gave the accompanying "diagram (Fig. 1) of connections" and "table of data":

Table of Data.

Carbons both solid.	Open arc. Conradty.		Enclosed arc. Electra.
Diameter	9mm.	...	13mm.
Arc length	1·5mm.	...	1·0mm.
Arc current	3·5 amperes	...	5 amperes
Resistance in series, R	42 ω	...	about 28 ω
Self-induction of L (henrys)	$5{\cdot}3\times10^{-3}$	...	$5{\cdot}3\times10^{-3}$
Resistance of L and leads	0·41 ω	...	0·41 ω
Capacity of condenser, F (microfarads)	1·1 to 5·4	...	1·1 to 5·4
R.M.S. current through condenser when capacity = 5·4 microfarads	3 amperes	...	4·5 amperes

An alternating current of from three to five amperes can be obtained in the condenser circuit, *the frequency of which can be altered by altering the self-induction and capacity.* Mr. Duddell found the upper limit to be 10,000 ~ per

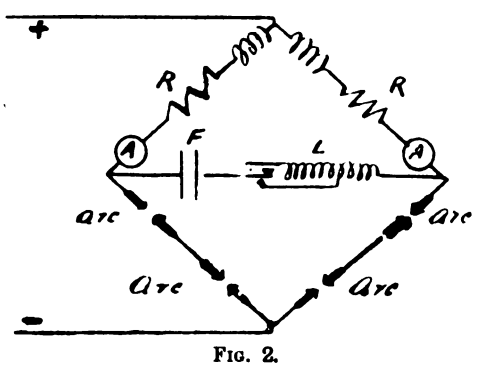

Fig. 2.

second, and the lower limit, if such existed, to be well below 500 ~ per second. Any alteration in the frequency is at once apparent by the change of the pitch of the note given out from the arc. For working off 200-volt mains, Mr. Duddell found the following arrangement (Fig. 2) satisfactory. By this arrangement the effect of having four arcs in series, consequently more current in the condenser circuit, is obtained. The connections for the condenser circuit should be made on the carbons, and not at the lamp terminals. A condenser suitable for high voltages should be used as the potential difference rises to several hundred volts.—E. T. W.

Question No. 400.—Discuss the relative advantages and disadvantages of direct and polyphase currents as applied to mining.

Answer to No. 400 (*awarded* 7*s.* 6*d.*). — It is now becoming universally acknowledged by mining and electrical engineers that for the transmission of power in coal and other mines, electricity is by far the most economical agent, and can be readily adapted for most of the purposes required. The question as to whether it is best to use continuous or polyphase currents, however, is one on which there is much diversity of opinion, and though in the past continuous current has been mainly used, everything points to the more general adoption of polyphase currents in the future. There is little or no doubt that for many purposes, especially where variable and fine adjustment of speed is required, continuous currents have advantages over polyphase motors. On the other hand, there are circumstances where polyphase motors will meet all the requirements, and where they can be used to advantage. The case of mining is one of these, and a consideration of the circumstances will show this to be the case. The principal uses of electricity in mining are lighting, pumping, haulage, and coal-cutting.

It will be best to consider the adaptability of continuous and polyphase currents for each of these purposes, and further consider the separate systems from the standpoints of (1) initial cost; (2) cost of running; (3) cost of upkeep; (4) flexibility; (5) safety.

For lighting, continuous current is superior to polyphase, especially where many arc lamps are employed. In mining most of the lighting is done by incandescent lamps, arc lamps being found as a rule unsuitable for using underground, especially in "fiery mines." For mining work, therefore, one system has little advantage over the other.

Pumping.—There are many large pumping plants working at the present time satisfactorily on both systems, the polyphase plants being particularly used in mines.

Haulage.—For most purposes of haulage continuous motors are superior to polyphase, especially where runs are short and stops are frequent, the superior acceleration of the continuous motors being an advantage. In most mines, however, the system of haulage is by means of endless ropes running at a constant speed. In this case the continuous has little advantage, if any, over the polyphase system.

Coal-Cutting.—This is, perhaps, the severest test a motor can be put to, as the cutter is continually getting jammed. One authority gives this as a particular case in which the polyphase is superior to the continuous-current motor, for with the former there is simply a hum, while in the latter cases the fuses blow, and very often the armature gets burnt out. He could cite a case where at least one or two armatures burnt out weekly. Besides being expensive, these frequent stoppages retard production.

It will be seen, then, that for mining purposes polyphase currents are equally well adapted to most purposes as continuous currents, while for some they are superior.

1. *Initial Cost.*—Most authorities agree that there is little difference in the initial cost of the two systems; if anything, the advantage is with the polyphase. The copper required for distribution for the three-phase star system with a neutral return is 27, as compared with 28 for a three-wire continuous-current system, but the slight advantage of the polyphase is lost due to the insulation and fixing of four wires in place of three.

2. *Cost of Running.*—It would be difficult to compare the relative costs of running, as conditions vary within wide limits. One advantage of the continuous system is that batteries may be used to advantage. On the other hand, polyphase motors having no commutators require less attention, with a corresponding saving in labour. Comparing

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the efficiencies of the motors, continuous current has the advantage, as given in the table by Mr. Earle:

MOTOR EFFICIENCIES.

Direct current	82%	85%	86%	91%	92%	92%
Polyphase	75%	80%	84%	88%	90%	91%
Brake horse-power ...	3½	6	10	25	50	100

Owing to the low price of fuel at the pit's mouth, and consequently the reduced "works cost," efficiencies are comparatively not so important as if the current is taken from a supply company.

3. *Cost of Upkeep.*—In this item polyphase working has a decided advantage. Owing to the absence of commutators and brushes, which is a serious item with continuous motors, this cost is done away with; further, the superior mechanical construction of the polyphase motor, and the absence of high-potential currents in the "rotor," causes breakdown to be far less frequent. The instance already referred to of armatures burning out is a case in point.

4. *Flexibility.*—The flexibility of a system is an important item, but in the case under consideration both systems seem equally suitable.

5. *Safety.*—In mining, coal mining particularly, the safety of a system must receive the first consideration. Continuous-current motors used in mines, especially "fiery mines," have to be entirely enclosed and gas-tight, and there are systems of forcing cold air and "carbon dioxide" through them to keep down the sparking and keep the motor cool. This is adding complications, and simplicity being recognised as a great advantage, adds another to the list of disadvantages of the continuous system. With the asynchronous polyphase motor and the entire absence of slip rings or any exposed parts, the motor can be left open and free to the air. For safety, therefore, polyphase working is the best, though both systems can be made quite safe.

From the above *résumé* a fair idea of the working conditions of both systems, with their respective advantages and disadvantages, can be formed. It will be seen in many ways the polyphase system has advantages over the continuous-current system, while the advantages of the latter over the former are not so marked or important. Commutators, brushes, and enclosed motors may not give much trouble in workshops and factories, but in mines, where dampness, dust, and inflammable gas are met with, they may become a matter of great importance, and this point alone might warrant the adoption of the polyphase system, apart from other considerations, as working with higher voltages, less liability of breakdown, etc.

In conclusion, there seems little doubt that polyphase working will soon become generally used as the system in mines, and however one might adhere to continuous working for general purposes, it cannot be denied that the former system has marked advantages for mines.—E. T. W.

Answer to No. 400 (*awarded* 7*s.* 6*d.*).—The uses of electricity for mining purposes are two—namely, for lighting and power, the latter use being the more important. So far as lighting is concerned there is not much to choose between them. The cost of a three-wire direct-current system and a three-phase system would be much the same, and there is not much to choose between the other items, maintenance, repairs, durability, etc., which make up the total cost. If arc lamps could be used on an extensive scale, then the advantage would be in favour of direct current, but even enclosed arcs are considered dangerous in mines, and the one or two enclosed arcs that can be used at the pithead make an inappreciable difference when considering the relative efficiencies of the two systems. We shall therefore assume that, so far as lighting is concerned, the relative advantages and disadvantages of the two systems are evenly balanced.

In the recent discussion on Mr. Ravenshaw's paper at the Institution of Electrical Engineers (*Journal*, vol. xxx., p. 856), many electricians contributed their practical experiences on the working of direct and polyphase machinery for power purposes in mines. The weight of evidence seems in favour of a polyphase system, and it will be useful to review some of the main considerations that lead to this conclusion. In discussing the relative advantages it is convenient to consider the following points separately: (1) cost; (2) regulation; (3) maintenance and repairs; (4) overload; (5) efficiency; (6) ease of working; (7) safety from explosion and shock.

1. We have not yet sufficient data to say whether the first cost of a three phase or a direct-current plant will be the greater. Still, the difference either way will be very slight, and so it will be safe to take them as equal.

2. The regulation of direct-current motors is easier than that of either synchronous or asynchronous alternating-current motors. For power main and tail-rope systems of haulage the load is very variable, owing to the steep gradients in most mines, and hence direct-current shunt motors would be best for this purpose. Still, by using an endless rope haulage system the load would be practically constant, and hence the difficulties in the way of using polyphase motors would be overcome.

3. The cost of maintenance and repairs is undoubtedly much smaller for polyphase motors. When direct-current motors are used the dust gets into the armature, and hence it has to be cleaned with a bellows two or three times a week, and the continual cleaning not only takes up a workman's time, but it is very detrimental to the insulation. If the motor is enclosed, and anything goes wrong, it is very difficult to put it right, and the electrician is apt to lose patience with it. Besides, in a mine it is practically impossible to keep dust out of the armature, and so repairs must be done sooner or later. With polyphase motors we have none of these difficulties. They also withstand the effects of vibration and moisture much better.

4. With a direct-current motor working a coal-cutter at a pressure of 500 volts, it is obvious that if the attendant is not always on the watch for the tool jamming, serious harm may be done by the overheating of the armature. With a polyphase motor, when the disc cutter jams, then there is a loud hum, but there is no excessive current to blow the fuses or cause danger by overheating.

5. So far as the mechanical efficiency is concerned, there is not much to choose between direct and polyphase motors. Mr. Eborall gives the efficiency of a 5-b.h.p. polyphase motor as 79 and of a 50-b.h.p. polyphase motor as 90 per cent. (*Journal* of the Institution of Electrical Engineers, vol. xxix., p. 813). It is possible that direct-current motors of the same size may be 1 or 2 per cent. more efficient, but it would be unsafe to assume this.

6. Polyphase motors can stand overload much better than direct-current motors, and this is a great consideration in mines, where the working of the motor has often to be left to an unskilled attendant.

7. Polyphase motors are much simpler and easier to work than direct-current motors, but, as we have mentioned above, they do not admit of such a wide range of regulation.

8. It is universally admitted that polyphase motors without slip rings on the rotor are the most suitable for fiery mines. It has been said that an explosion has never been caused by the sparking at the brushes of a direct-current motor, but one doubtless could be so caused.

In the early days, as Mr. Trotter said, someone suggested the forcing of carbonic acid gas into enclosed motors, so as to avoid the risk of explosion. There have been several fatal accidents in mines from electric shock, and so this consideration is important. A three-phase cable sheathed with lead is perfectly safe, and the live parts of three-phase motors can be put in much less exposed positions than the live parts of direct-current motors. Hence in this respect polyphase machinery has a great advantage over direct-current machinery. On the whole, therefore, we would conclude that polyphase machinery is more suitable for mines than direct-current machinery.—J. C. R.

Answer to No. 400 (*awarded* 5*s.*).—Seeing the many advantages of the polyphase system of working, it is not surprising to find so many mines and factories now adopting this system which were equipped only a few years ago with the direct current. The advantages of polyphase currents in connection with motors are many. Three-phase and two-phase motors are less bulky, and the weights lighter, than continuous-current motors for the same power and efficiency. In fiery coal mines sparkless running of motors is a matter of vital importance. The frequent sparking of

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continuous-current motors has caused them to be made entirely enclosed. This needs the motor to be larger and heavier for the same output, and also the ventilation is not nearly so good as when exposed to the atmosphere, and also the parts are not easily accessible. With the polyphase motor, especially those with a squirrel-cage rotor, there is very little chance of a spark passing except at the starting switch, which can be placed in a fireproof cover and at a safe distance from any inflammable dust or vapour. Polyphase motors, therefore, need not be enclosed in order to safeguard the surrounding materials against fire. The rotor of a polyphase motor being always at a low voltage requires very little insulating, and thus can be made more strongly and mechanically built than a continuous-current motor, which has its revolving armature, through which the full voltage has to pass, and if this be very high, the winding of the armature has to be of fine wire and very highly insulated. Thus it is much more liable to be burnt out than the rotor of a polyphase motor. Another drawback to the continuous-current motor is that brushes are needed for rubbing contact, and these need to be trimmed and readjusted, and also the commutator needs turning up if there has been any sparking, which is often the case in dusty places. The polyphase motor has no commutator, which is a further advantage in the entire avoidance of sparks. The starting switches needed for a polyphase motor are much simpler than those needed for continuous-current motors, and can be easily handled by an untechnical workman. The polyphase motor will also stand overloading for a short period as well, if not better, than a continuous-current one up to at least 40 per cent.

The transmission of energy by the polyphase system is at the present time the most satisfactory solution of long-distance transmission, and especially where there are several mines which are required to be supplied from one central station. The following are a few mines which have polyphase equipments: Elderschaht station, Germany; Mining and Metallurgical Company, Spain; Alager Mining and Chemical Company, Caucasus.—S. G. T.

Answer to No. 400 (*awarded* 5*s.*).—Coal-getting is the only branch of mining in the British Isles which uses electricity to any great extent. The principal applications in this industry have been the replacing of human and animal traction on the haulage roads at the pit bottom by means of ropes driven by motors, pumping, and lighting. Coal-cutting machines are also in use, driven either by electricity direct or by compressed air with motor compressors. Up to the present, direct current has done practically all the work, preferably at low voltages, such as 220 for lighting and 550 for power. There is not much desire among mining engineers for highly-efficient new-fangled plant unless it can be proved thoroughly reliable. The gain of a few per cent. economy is nothing compared to absolute safety and freedom from breakdown. So that although polyphase-current motors, by working at a higher voltage than direct-current machines, save initial cost of mains, the greater chance of leakage and of dangerous shocks will prevent the use of this system extending in the same ratio as it is doing where installing space is not so limited, and the matters of life and death do not hang so evenly in the balance. This is the main advantage of direct current; as regards the relative systems in detail there is little to choose. Where a mining area has to be supplied multiphase current has the advantage, but where individual collieries are concerned the superior starting torque of direct-current motors is preferable (especially for coal-cutters) also for the better self-regulating properties of these. Against this there is the absence of commutator and sparking in the multiphase motor (when worked at a lower efficiency without slip rings); but as direct-current machines are now designed there is little risk with commutators and carbon brushes. Briefly, the absence of breakdowns and facilities for repairs are the principal factors for or against machinery in mining, prime cost and working cost being subsidiary to reliableness; and in these early days of multiphase colliery plant, more will depend upon the maker and the installing engineer than upon the theoretical capabilities of any particular system.—B. C. H. J.

LEGAL INTELLIGENCE.

BRITISH ELECTRIC WORKS.

A Fraudulent Prospectus.

At the Liverpool Assizes on Thursday, the 15th inst., Mr. Justice Bucknill and a special jury concluded the hearing of the action of Glynn *v.* Atherton and others, the case having lasted just a week. The suit was one in which the plaintiff, Mr. Walter Glynn, managing director of the Leyland line of steamers, sued the promoter and directors of the British Electric Works Company, Limited, for alleged fraudulent misrepresentation and for loss and damage sustained owing to statements contained in the prospectus of the company. The facts of the case were fully reported in our last issue.

In the course of his summing-up **Mr. Justice Bucknill** said that as the case was of such importance he was sure the jury would not grudge the time that had been spent on it. He asked them to put out of their minds the non-success of the British Electric Works Company, because the success or non-success of a company had nothing to do with fraud at its inception, and fraud was the first of the three charges brought against the defendants. To establish that charge it was necessary to prove that they had made statements which they knew to be untrue, or that they had made statements without belief in their truth, or recklessly, careless whether they were true or false. In this and in every other instance the case of each director must be considered separately. The second charge was under the Directors' Liability Act, 1890, and under that Act it was enough to show that the defendants had made untrue statements without reasonable belief in their truth, and they would be liable unless they could protect themselves under the ægis of a duly qualified expert's report, such as Messrs. Fuller, Horsey, and Co.'s valuation, if the jury believed that it was fairly obtained. But it must be understood that untrue statements in a prospectus were not to be confined to active misrepresentations of the truth. There was such a thing as suppression of it. If there were material omissions from a prospectus of such a character as to alter its nature and purport, and to give it a different complexion from what it otherwise would have had, then those omissions made such a prospectus untrue, and the persons who put their names to it were liable. A prospectus must not be cunningly and cleverly contrived to convey a different meaning from its obvious meaning. On the contrary, its issuers must take good care that it should be so worded as to be unambiguous and clearly understood by ordinary men. The public had, as Lord Bramwell said, a right to be protected from company promoters. The third question that the jury would have to decide was whether the contract between Mr. J. B. Atherton and Messrs. Davidson and Cookson concerning the placing of the debentures, by which that firm were paid 10 per cent. commission, was a contract material to be known to intending investors. If it were, it would make the prospectus fraudulent as against any director knowingly issuing the same. He need not remind the jury that the Athertons were the only directors who knew of the existence of this contract. His Lordship then left 10 questions to the jury, who, after half an hour's consideration, found that the prospectus was false and fraudulent, and that the plaintiff was induced by statements contained in the same to apply for shares.

The following were the questions submitted to the jury, with their answers: (1) Was the prospectus in its general tenor untruthful?—Yes. (2) Was it false and fraudulent on the part of any, and which of the defendants?—Yes. (3) Were any of the statements on the prospectus which are complained of untrue?—Yes. (4) Was the plaintiff induced to apply for shares by such statements, or any of them?—Yes. (5) Had the defendants, or any, and which of them, reasonable ground to believe that such statements were true?—No. (6) Did the defendants, or any, and which of them, so believe up to the time of the allotment?—No. (7) What loss or damage did the plaintiff sustain by such untrue statements?—£950. (8) Did the defendants, or any, and which of them, make such untrue statements fraudulently?—Yes. (9) Did the defendants, or any, and which of them, make such untrue statements wilfully?—Yes. (10) Were the contracts in Paragraph 6 of the statement of claim contracts which it was material to disclose to intending applicants for shares?—Yes. J. B. Atherton and Jacob Atherton ought to have disclosed the contracts. The jury explained that where they answered the questions simply yes and no, they intended to include all the directors.

Judgment was accordingly entered for the plaintiff against the defendants, generally and severally, for £950 with costs.

CLAIM IN RESPECT OF ELECTRIC PUMPING PLANT.

Judgment has been given this week by Lord Pearson in the Court of Session, Edinburgh, in the action brought by Messrs. P. R. Jackson and Co., Limited, and the Salford Rolling Mills, Manchester, against the Glengarnock Iron and Steel Company, of Glasgow, for payment of £519. 10s. 3d. The facts of the case shortly are that in 1897 the defendants contracted with the plaintiffs for the supply and erection by them of an electric pumping plant at the defendants' No. 5 pit of their Auchenharvis Colliery at the contract price of £2,600. The plant was, according to the plaintiffs' case, duly supplied and erected, and there was an account for certain extra work, amounting to £169. 15s. 3d. The amount sued for is the unpaid balance of the whole account. The defendants contended that their acceptance of the contract expressly stipulated that the whole work should be in accordance with the defendants' specification of May 24, 1897, the plaintiffs' estimate of May 28, and generally as per tracings submitted by the plaintiffs, but subject to the defendants' approval of the working plans. Repeated alterations were made from time to time by the plaintiffs on the plant as originally supplied and erected by them, with a view to rendering it conform to contract; but it was not until February,

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1900, that they succeeded in putting the plant into a condition to perform the work it was intended to perform in a satisfactory or efficient manner. During the whole time from Nov. 1, 1897, to Feb. 1, 1900, it was alleged defendants were deprived of the use of the pumping plant owing to the failure of the plaintiffs to fit the same up within the contract time and to deliver the same in an efficient state and conform to contract.

His Lordship has now given judgment holding that, through the plaintiffs' undue delay in fulfilling the contract sued on, the defendants sustained loss and damage to an amount exceeding the whole claims made by the plaintiffs in the action. He therefore gave judgment for the defendants with costs.

NATIONAL TELEPHONE COMPANY.

On Monday last, in the Glasgow County Buildings, an application of the Corporation was heard for an interim injunction against the National Telephone Company opening up Argyle-street and the Trongate for the purpose of laying cables without the consent of the Corporation. It was explained, on behalf of the defendants, that the National Telephone Company got permission from a proprietor at the corner of Wellington-street and Argyle-street running westwards to erect an exchange on the roof of his building, and from the Caledonian Railway Company to lay a cable inside their tunnel running along Argyle-street. In consequence of these arrangements the company had opened up the pavement and cut a hole between the wall of the tunnel and the building in order to carry the cable to the roof. In connection with the formation of the hole, one of the workmen, acting in his own discretion, had raised the pavement of Argyle-street. The footpath, however, had been restored to its former condition. A very important legal point would be involved as to what harm the Corporation had suffered in the existence of that hole. The learned counsel submitted that there was no case in any shape or form for granting an interim injunction.

Counsel for the Corporation said the offence was committed between a Saturday night and a Sunday morning in June last. Some difficulty had been found in discovering who opened up the street. The Post Office were communicated with, and they replied that it was not done with their consent. The proprietor of the property even was not entitled to open up the footpath of that street without the permission of the Corporation.

An interim interdict was granted till next Tuesday, when the matter will be further considered.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN DISTRICT RAILWAY.

The half-yearly ordinary general meeting of the shareholders was held at the Westminster Palace Hotel on Friday, Mr. James Staats Forbes (the chairman of the Company) presiding.

The **Secretary** (Mr. W. Jones) having read the notice convening the meeting,

The **Chairman** prefaced his remarks on the motion for the adoption of the report by a short *resumé* of the position of affairs with regard to electric traction. He reminded the shareholders of the nature of the agreement under which they had secured a contract for carrying out what would electrify the railway. They knew that the people who were parties to that contract had backed their opinion by accepting it upon terms which, in comparison with other terms that they were offered, were extremely reasonable, upon a system which would be approved as being the best practicable one, although it might not be the best imaginary or possibly scientific one. Turning to the accounts, he described the results of the half-year's working as "very bad," but it was no good singing a song of lament upon a state of things which they could not control. With regard to the revision of fares and other measures to stop this wastage it was asked, "Why do you not do what is done on the Central London Railway?" The answer was, because the conditions and circumstances of the Central were entirely different from theirs. It was A B C compared with a very abstruse mathematical problem. The chairman then referred to "a very difficult question with the Metropolitan Railway as to the system upon which these railways should be electrified." Everyone had got his own idea, and the Board, under the advice of two eminent engineers—Sir William Preece and Mr. Parker, of the Metropolitan—were captivated by the apparent merits of what they called the Ganz system. They had a choice of several other systems; but that system did present elements which appeared to be sufficiently good in respect to scientific principles and otherwise to induce them to select the Ganz tender. The moment they selected the Ganz tender they were attacked on all sides by the British companies, such as the British Westinghouse system, and others, who said what fools they were, what ignoramuses they were, etc., and that it was a dead failure, and that it was impossible to adopt it. Then came this combination to electrify their railway, and they said, in the graphic language of the distinguished gentleman who was at the bottom of it, Mr. Yerkes, "I will not put a dollar into the Ganz system." That was his evidence in the House of Commons the other day. The Metropolitan were blessed with a director who was a most distinguished gentleman—Colonel Mellor—but he had the misfortune, which happily was spared him (Mr. Forbes), of knowing a little about science, and he had got a governing mind, and nothing one could do would persuade Colonel Mellor to listen to any modification of his conviction, founded upon his own electrical knowledge, that it was a good system, and he would not have any other, and that had brought them to a deadlock. It was to be applied to the electrification of the Inner Circle Railway. The District Company had four miles of it and the Metropolitan nine, and he carefully, throughout the whole negotiations from beginning to end, limited this Company's assent to any system whatever to those four miles as part of the Inner Circle, reserving to themselves the right to apply to the whole of the rest of their system any other system which turned out to be better. They had stuck to that position. Now that brought about a deadlock. Then this Act of Parliament came on, and they had to put it right, and the result of it was in a clause which left the whole matter to be settled by the Board of Trade. The Board of Trade showed no great disposition to take up this burden of determining whether the Ganz system was a good one or a bad one. They were approached in many ways to make a pronouncement, but, like wise people, they avoided cracking a nut of such a tremendous character. They determined to go to the Board of Trade forthwith. Meanwhile Mr. Yerkes, who was deeply interested in this thing as the founder and the chief shareholder in the traction company, and very largely interested in ordinary shares, had gone to Budapest with his engineers in order to satisfy himself by enquiry on the spot whether it did or did not contain elements which overcame his objection to adopt the Ganz for the whole system, and he (the chairman) should not be at all surprised, from what he knew of Mr. Yerkes, if he brought back Ganz in his pocket; but until he came back he could not say more about it. Meanwhile they must go on with this matter at the Board of Trade. It came to this: that instead of having a deadlock brought about by a conflict of opinion of two very obstinate Boards, they had an authority to settle it if they would only settle it; but it meant a tribunal, and they knew what tribunals were, particularly at this time of the year. He concluded by moving the adoption of the report and accounts.

Mr. L. H. Isaacs seconded the motion, which was carried unanimously without discussion.

The **Chairman** then proceeded to make an important statement with regard to the future constitution of the Board. Men of experience and money, he said, had come forward who believed in their views. They were going to try and rescue the Company from its present position, and make it a prosperous concern, and it was only right that they should have a fair representation on the Board. That request, continued Mr. Forbes, came at a fortunate juncture, as he, for certain reasons, had made up his mind to relinquish his post. He had had a great deal of anxiety and labour, which no one but himself could appreciate, and he felt he would not be doing justice to the shareholders if he did not encourage the introduction of younger men. What was proposed was that the knowledge he had acquired in this matter should not be thrown away, and that some such arrangement should be come to with him as was come to in a much more important fusion of two great companies, so that he might be of some service even to these younger bloods as advisory director. Therefore he should remain on the Board with all the knowledge he had, and, he trusted, judgment, and certainly with all the loyal desire that he had to further the interests of the shareholders of the Company. Mr. Perks, M.P., a gentleman whom they all knew and respected, would succeed him in the chair, and Mr. Murray Griffiths would also join the Board. Sir Charles Dalrymple and Major Isaacs would retain their positions, but the other vacancy was not yet filled. Mr. Yerkes would not join the Board—his functions were of a totally different kind.

Several shareholders spoke in eulogistic terms of the services rendered by Mr. Forbes as chairman of the Company, and, while expressing regret at his resignation from the chairmanship, hailed with pleasure his decision to remain on the directorate of the Company. The following resolution was ultimately adopted: "That having regard to the new arrangements that the Company are entering into for the electrification of the railway, and to the new interests in the proprietary, it is advisable that the Board be reconstituted, and that it be referred to the directors to consider and give effect to that resolution."

Mr. R. W. Perks, M.P., then proposed a vote of thanks to the chairman in a suitable speech.

Mr. Forbes, in reply, said he was immensely touched by the terms of the resolution, and by the renewed confidence and kindly consideration with which they were treating him upon his reluctant departure from the chairmanship of the District Company. Referring to the various schemes for constructing tube railways in London, the chairman said why in the world Parliament should have appointed a joint committee to consider whether if people could be found who would provide money to construct railways under all the main thoroughfares of London, that would be in the public interest, it seemed impossible to understand. It did not require a committee to come to the conclusion that such railways as were proposed would result in the public benefit. One of the schemes involved, for a considerable part of its distance, an expenditure of over £1,000,000 a mile for a line running immediately parallel to this Company's railway, and it did not seem very likely that when the matter was remitted, if it should be, to a committee of Parliament, there was a very great prospect of its being successful. The recommendations of the joint committee were subject to going before a committee in the ordinary way, thus affording this Company, or any other existing interest which was affected, the opportunity of exposing the fallacy and the ruinous consequences which must follow the construction of a railway at such a cost in any part of London.

The proceedings then closed.

BAKER STREET AND WATERLOO RAILWAY.

Presiding over the sixth half-yearly general meeting of this Company at the Westminster Palace Hotel on the 16th inst., **Mr. Theodore J. Hare** said the capital expenditure during the half-year amounted to £276,850, of which sum £146,203 had been spent in connection with the purchase of land. The directors regretted that the negotiations for the transfer of the contracts referred to at the last meeting, owing to totally unforeseen circumstances, had not borne fruit. The subject, however, was receiving the careful attention of the directors, and

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negotiations were still proceeding, which, it was hoped, would be successful. In the meantime the sub-contractors (Messrs. Perry and Co.) were carrying on the works, under a special arrangement with the Company. They were now engaged in boring the second tunnel, under compressed air, through the gravel-bearing strata in the river. It being of the utmost importance that this and other works should be carried on to completion, the directors considered that the available cash assets of the Company should be kept for this purpose They did not, therefore, propose that any payment of interest should be made at the present time, but that it should be kept to accrue, pending arrangements being made for raising the balance of the capital. He saw no reason for apprehending any objection to their system, when it was completed, on the score of vibration. This was the opinion of their engineers, having regard to recent improvements in electrical traction. Those gentlemen advised them that there would be no difficulty in fulfilling the conditions shadowed forth in the interim report of Lord Rayleigh's Committee, and that the railway could, and would, be worked so as to avoid any objectionable vibration.

Major-General C. S. Hutchinson having seconded the resolution, it was carried *nem. con.*

BRITISH ELECTRIC TRANSFORMER MANUFACTURING.

At the general meeting of the shareholders of the Company at Dacre House, Victoria-street, Westminster, on Wednesday, **Mr. R. Stewart Bain,** who presided, congratulated the shareholders on the satisfactory nature of the accounts, and said that during the past year the Company had been very successful in securing contracts in competition. Referring to the item of £25,404 in the balance-sheet, being the value of the patents, the chairman said the Board had granted a license to the Union Elektricitäts-Gesellschaft of Berlin. Their technical adviser was energetic in seeing that the value of the Company's patents was kept up, either by covering improvements on existing patents or taking out additional ones. During the period under review additional patents were obtained for three-phase transformers in the United Kingdom, Germany, and America, and since the date of the balance-sheet these patents had also been covered in Austria, Belgium, France, Italy, Norway and Sweden, Russia, and Switzerland. The new works at Hayes, Middlesex, now rapidly approaching completion, would put the Company in a greatly improved position for dealing with heavy work. It was expected that by the end of the year the business would have been completely transferred to these new works. The stock, as per manager's valuation taken at cost, stood at £4,271. In addition to the work in progress, amounting to £1,542, there were orders in hand to the extent of £8,312. The works were very busy, and overtime had to be worked almost continuously to keep pace with orders. The Board recommended a dividend for the second half of the year at the rate of 10 per cent. per annum, which, together with the interim dividend, was paid on the full capital, the vendors' shares now ranking with the others. Speaking of the future, he remarked that the prospects of alternating-current business were very bright. Large power distribution schemes were getting their works laid out, and large transformer orders might be confidently expected. The Company's works had hitherto consisted chiefly of transformers for lighting purposes of comparatively small size, with the exception of two large extra high-tension supply companies' works, but for power distribution, in which to a large extent their future as a Company must lie, larger units would be the rule, and the Board believed that this Company stood in as good a position as any other in the country to carry out efficiently and economically this class of work. He moved the adoption of the report and accounts.

Mr. Theodor Petersen seconded the motion, which was carried.

SCHATTNER ELECTRICITY METER.

In their report for the period from April 1, 1900, to June 30, 1901, the directors state that the Company was incorporated on June 29, 1900, but the business was taken over as a going concern as from April 1, 1900. The amount to the credit of the profit and loss for the period for sales, etc., is £7,815. 2s. 9d The manufacturing costs amount to £4,336. 18s. 4d., leaving a gross profit of £3,478. 4s. 5d. From this has to be deducted expenses of administration and amount written off for depreciation, amounting to £2,328. 7s. 4d., leaving a balance of £1,149. 17s. 1d. The Board, acting on the advice of their auditors, have dealt with the profits made before the incorporation—viz., £216. 1s. 10d.—to write off preliminary expenses and part of the alteration to works, leaving the sum of £933. 15s. 3d. now to be dealt with, which they propose should be as follows: by payment of a dividend at the rate of 6 per cent. per annum on the subscribed capital, £486. 12s. 7d.; to write off alteration to works, £100; and to carry forward, £347. 2s. 8d. The works at Norwich being inadequate for the business, the Board decided to remove to London in March last, where a suitable factory was obtained. The Board is pleased to state that the business shows a steady rate of progress. The retiring director is Mr. F. W. Harmer, who, being eligible, offers himself for re-election. The auditors, Messrs. Monkhouse, Stoneham, and Co., also retire, but offer themselves for re-election.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Derby.—The Plant and Stores Committee invite tenders for electric wiring of the stores depôt, Nottingham-road. Specifications may be obtained on application to Mr. T. P. Wilmshurst, borough electrical engineer, Sowter-road, Derby. Tenders by 27th inst.

Walthamstow.—The Urban District Council invite tenders for house wiring. Tenders by Aug. 30. Details in our advertisement columns.

Bournemouth.—The Town Council invite tenders for water cooler and travelling crane. Tenders by Aug. 31. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the wiring of their new Hylton-road electric lighting station. Tenders by 30th inst. Details in our advertisement columns.

Bournemouth.—The Town Council invite tenders for boilers, superheaters, economiser, feed pump, pipework, and accessories. Tenders by Aug. 29. Details in our advertisement columns.

Listowel.—The Urban District Council are desirous of treating with a responsible firm for the supply of electricity for street-lighting. Tenders by Sept. 30 Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of overhead construction for electric tramways. Tenders by Sept. 13. Details in our advertisement columns.

Aston Manor.—The Urban District Council invite tenders for pipework, fitters' shop, and cables for their proposed electric power station. Tenders by Sept. 4. Details in our advertisement columns.

Torquay.—The Electric Lighting Committee invite tenders for the supply and delivery of arc lamp carbons for a period of 12 months from Oct. 1, 1901. Tenders by Sept. 13. Details in our advertisement columns.

Ilford.—The Urban District Council invite tenders for the construction of about 11 miles of tramways. Specification, etc., may be obtained of Mr. John W. Benton, clerk, Council Offices, Ilford. Tenders by Aug. 31.

Doncaster.—The Corporation invite tenders for the supply, delivery, and fixing of a tramway switchboard at the Corporation electricity works, Doncaster. Tenders by 31st inst. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the electric lighting installation, etc., of the second portion of the Colinton Mains fever hospital, the number of lighting points being about 800. Tenders by Sept. 9. Details in our advertisement columns.

Farnham.—The Urban District Council are desirous of contracting with a responsible firm for the supply of electricity under the requirements of their Electric Lighting Order, 1900, in their area. Proposals by Aug. 27. Details in our advertisement columns.

London, S.W.—The Guardians of St. George's Union invite tenders for electric lighting of the chapel at the Fulham-road Workhouse. Particulars can be obtained on application to Mr. Edwin T. Hall, F.R.I.B.A., architect, 54, Bedford-square, W.C. Tenders by 28th inst.

Aston Manor.—The Urban District Council invite tenders for water-tube boilers, stokers, and economiser, two 500-kw. steam dynamos, one 200-kw. steam dynamo, motor balancer, switchboard and testing-room, travelling crane, and arc lamps for their proposed electric power station. Tenders by Sept. 4.

Glasgow.—The Corporation invite tenders for the supply, delivery, and erection complete of the overhead trolley constructional work required for the extension of the tramways system. Specification, etc., can be had on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by Aug. 30.

Mansfield.—The Electric Lighting Committee invite tenders for refuse destructors (to deal with the whole of the refuse of the borough) by Sept. 5. Specification, etc., may be inspected at the offices of Mr. Robert Hammond, M.I.C.E., the consulting engineer to the Corporation, 64, Victoria-street, Westminster, London, S.W.

Croydon.—The Lunacy Visiting Committee invite tenders for the execution of the wiring for the electric installation, including ring main and feeders, sub-mains, lamp circuits, switchboards, distribution boards, fittings, etc. Specification, etc., can be inspected at the Borough Engineer's Office, Town Hall, Croydon. Tenders by Aug. 26.

Warlingham (Surrey).—The Croydon Town Council invite tenders for wiring, including ring main and feeders, sub-mains, lamp circuits, switchboards, distribution boards, fittings, etc., at the lunatic asylum, Warlingham, Surrey. Specifications, etc., can be obtained at the Borough Engineer's Offices, Town Hall, Croydon. Tenders by Aug. 26.

Lowestoft.—The Corporation invite tenders for the supply and erection of one 500-kw. steam dynamo (vertical enclosed engine), with pipework connections complete, and switchboard panel with cable connections to dynamo. Specifications, etc., may be obtained at the office of Mr. R. Beattie Nicholson, town clerk, 115, High-street, Lowestoft. Tenders by Sept. 9.

Middlesbrough.—The Electric Lighting Committee invite tenders for the supply and erection of mechanical coal-handling plant in connection with the municipal electricity works. Specification, etc., may be inspected at the offices of Mr. Robert Hammond, M.I.C.E., consulting engineer to the Council, 64, Victoria-street, Westminster, London, S.W. Tenders by Sept. 3.

Oldham.—The Electricity Committee invite tenders for the supply, delivery, and erection of two electric overhead travelling cranes. Specification, etc., can be obtained from Mr. Arthur Andrew, Gas and Water Offices, Oldham. The specifications and drawings can be seen at, but not obtained from, the offices of Dr. Alex. B. W. Kennedy, 17, Victoria-street, Westminster, S.W. Tenders by Sept. 10.

Batley.—The Corporation invite tenders for the supply, delivery, and laying in the borough of Batley of steel rails, points, crossings bonds, and accessories, granite setts, stone setts, wood blocks, concrete, and all excavation work, and laying of the permanent way for tramway (approximately 3½ miles). Specifications, etc., may be obtained from the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by Sept. 14.

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London County Council.—The County Council invite tenders for track rails and fastenings, slot rails and fastenings, tiebars, and conductor tees, and roadwork and platelaying required for the reconstruction on the conduit system of the tramway routes between Westminster Bridge, Blackfriars Bridge, and Waterloo Station respectively, and Tooting. Specifications and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

Worcester.—The Corporation invite tenders for the supply and erection of water-tube boilers, economisers, steam and feed pipes, and pumps; steam dynamos, motor-alternator, and booster; Korting condensers, electric pumps, cast-iron suction, delivery, and exhaust pipes, and tank; switchboard; overhead travelling crane; and accumulators, the whole bound up in one specification, for the new electricity works. Specifications, etc., may be obtained from Mr. C. J. Sutherland, city electrical engineer, Guildhall, Worcester. Tenders by 23rd inst.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a continuous-current 1,500-kw. dynamo working at from 550 to 625 volts, and the erection of these sets in the generating station of the South London Electric Supply Corporation, near Loughborough Junction. Also for three auxiliary 250-i.h.p. vertical high-speed enclosed steam-engines, each coupled direct to a continuous-current dynamo working at from 200 to 225 volts, and for the erection of these sets in the Council's generating station at Greenwich. Specifications and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a three-phase 1,500-kw. generator working at from 6,500 volts between conductors, each with an exciter, and for one 750-kw. reversible synchronous motor-generator, with exciter, designed so that either the low-tension or the high-tension side of the set will act as generator, and for the erection of these sets in the Council's generating station at Greenwich; also for nine 300-kw. synchronous motor-generators, working at from 550 to 600 volts on the low-tension side, each with an exciter, and for three 50-kw. induction motor-generators, working at from 200 to 225 volts on the low-tension side, and the erection of these sets in sub-stations provided by the Council. Full particulars may be had at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

RESULTS OF TENDERS.

Ashton.—The Corporation have accepted the tender of Messrs. W. T. Glover and Co. for four feeder pillars.

Keighley.—The tender of Messrs. Grace and Sutcliffe, Keighley, for the installation of electric light at the parish church, has been accepted.

Taunton.—The Corporation have accepted the tender of the Electrical and Gas Shade Company for wiring and payment on the instalment system.

West Ham.—The Lighting and Tramways Committee have decided to accept the tender of Messrs. Babcock and Wilcox for the supply of 11 water-tube boilers at £14,720.

Bradford.—In connection with the supply and erection of a switchboard at the electricity works, Valley-road, Bradford, the Corporation have accepted the tender of Verity's, Limited, Manchester.

Liverpool.—With regard to the supply of four steam dynamos for use at the Charters-street refuse destructor, the City Council have accepted the tender of Messrs. Willans and Robinson, Rugby, at about £5,000.

Rochdale.—The General Purposes Committee have accepted the tender of G. L. Adamson, Ohm Works, Rochdale, for the supply and fixing of about 10 ventilating fans to be driven by electric power for certain offices and rooms in the town hall.

Rochdale.—The Corporation have accepted the tender of Messrs. Macartney, McElroy, and Co., Limited, 53, Victoria-street, Westminster, London, S.W., for the supply, delivery, and erection of steel poles, bases, section boxes, overhead line, and accessories for the equipment of approximately five miles of tramways; and also for the supply, delivery, and laying of feeder cables and pilots.

Grays Thurrock.—The School Board have received the following tenders for electric lighting to three schools at Grays Thurrock, Essex:—

Prism Globe Company	£463	10	6
Eben, Ryan, and Co.	405	1	10
Gardener and Blandfort	371	5	0
Mayfield and Co.	320	10	0
G. W. Clarke	234	16	0
Dennis and Co. (accepted)	230	10	6

Gravesend.—The following tenders have been received for plant in connection with the electric lighting scheme:—

Section A.—Boilers.

Hornsby	£2,640
Babcock and Wilcox*	2,862
Stirling Boiler Company	3,134
Manlove	3,525
Renshaw	3,789
Meldrum	3,938

Section B.—Steam-pipes.

H. Maxim	1,729
Aiton	2,000
J. Spencer	2,231
Babcock*	2,226
Manlove	2,495

Section C.—Engines only.

Vauxhall Ironworks	2,040
Electric Construction Company	2,290
J. Pullar Phibbs (Belgian)	2,361
International Company (Alley)	2,590
Sunderland Forge Company (Alley)	2,635
Johnson-Lundell Company (Alley)	2,647
Johnson and Phillips (Alley)	2,650
Bergtheil and Young (Alley)	2,691
Lancashire Dynamo Company (Alley)*	2,693
De Grelle (Alley)	2,700
Westminster Engineering Company (Alley)	2,700
British Thomson-Houston Company (Alley)	2,713
F. Suter (Alley)	2,721
Davey-Paxman (Peache)	3,200
W. H. Allen and Co. (Allen)	3,235
Crompton and Co. (Allen)	3,228
Lahmeyer (Allen)	3,245
Electric Construction Company (Peache)	3,254
Galloways (Peache)	3,265
Johnson and Phillips (Allen)	3,275
Crompton and Co. (Peache)	3,281
Johnson-Lundell (Allen)	3,288
Lancashire Dynamo Company (Allen)	3,330
Manlove-Alliott	3,525
Electric Construction Company (Reavell)	3,736
Reavell (Reavell)	3,744
Johnson-Lundell	3,744
Johnson and Phillips (Reavell)	3,745
Johnson-Lundell (Clayton)	3,761
Browett-Lindley	3,835
International Company (Willans)	3,850
Siemens (Willans)	3,886
Sunderland Forge Company (Browett)	3,910
Willans (Willans)	3,914
Royce (Browett)	3,920
Crompton and Co. (Browett)	3,929
Johnson and Phillips (Browett)	3,932
Electric Construction Company (Willans)	3,944
Mather and Platt (Browett)	3,945
Johnson-Lundell (Allen)	3,960
W. H. Allen and Co. (Allen)	3,960
Crompton and Co. (Allen)	3,961
Lahmeyer (Allen)	3,980
Sunderland Forge Company (Browett)	3,980
Royce (Willans)	3,990
De Grelle (Willans)	3,994
Mather and Platt (Willans)	4,000
Johnson and Phillips (Allen)	4,008
Crompton and Co. (Willans)	4,009
Johnson-Lundell (Willans)	4,011
De Grelle (Browett)	4,030
Allgemeine Elektricitats-Gesellschaft	4,031
Lancashire Dynamo Company (Willans)	4,075
Brush Company (Willans)	4,082
De Grelle (Willans)	4,086
Electric Construction Company (Belliss)	4,219
Crompton and Co. (Belliss)	4,291
Sunderland Forge Company (Belliss)	4,292
Johnson-Lundell (belliss)	4,293
International Company (Belliss)	4,350
Mather and Platt (Belliss)	4,370
De Grelle (Belliss)	4,399
Westminster Company (Belliss)	4,399
Royce (Belliss)	4,490

Engines and dynamos.

Thames Ironworks (Alley)	5,845
Thames Ironworks (Allen)	6,727
Thames Ironworks (Allen)	7,437
Parsons (Parsons)	7,287

Section D.—Dynamos.

International Electric Company	2,351
Westminster Engineering Company	2,800
A.E.G.	2,983
F. Suter (Helios)	3,013
Westminster Engineering Company	3,088
Veritys	3,116
Bergtheil and Young	3,357
T. Parker	3,396
De Grelle-Houdret	3,424
T. Parker	3,514
Davey-Paxman (Schuckert)	3,531
Lancashire Dynamo Company*	3,552
Royce	3,679
Greenwood and Batley	3,686
Crompton	3,722
High-Speed Engine Company	3,743
British Thomson-Houston Company	3,767
Lahmeyer	3,772
Electric Construction Company	3,812
Electric Construction Company	3,882
Crompton	3,884
Rosling, Appleby, and Fynn	3,892
Lahmeyer	3,894
Sunderland Forge	3,930
Electric Construction Company	4,026
Mather and Platt	4,045
Johnson-Lundell	4,061
Mather and Platt	4,155
Siemens	4,203
Brush Company	4,400
Bruce Peebles	4,624
Johnson and Phillips	4,646

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Section E.—Switchboard.

Broeke, Hirst, and Co.*	830
Johnson and Phillips	848
Crompton and Co.	868
Dorman and Smith	978
Johnson-Lundell	991
Clayton and Co.	997
Spagnoletti	1,026
Veritys	1,035
Electric Transmission Company	1,043
Fryer	1,063
General Electric Company	1,065
Westminster Engineering Company	1,082
B. Thomas	1,109
A.E.G.	1,138
Williamson and Joseph	1,150
Mechan	1,186
Heaton and Smith	1,215
Statter	1,226
J. White	1,330
British Thomson-Houston Company	1,435
Siemens	1,729

Section F.—Cables and underground work.

Western Electric Company*	7,220
Johnson and Phillips	7,727
Henley's†	8,060
Glover†	8,389
Callender‡	8,390
Callender (alternative)†	8,614
British Insulated Wire Company	8,634
British Insulated Wire Company (alternative)	8,914
St. Helens Cable Company	8,990
J. Pullar Phibbs	9,131

† Plus 1 per cent. per annum. ‡ Plus 1½ per cent.

Section G.—Accumulators.

		Maintenance.
Ashmore-Benson	£1,199	£80
Veritys-Pritchett (add for cable, £100)*	1,577	80
Hart Battery Company	1,748	110
Johnson and Phillips (Hart)	1,795	115
D.P. Battery Company	1,896	85
Lithanode Company	1,893	87
E. P. Storage Company	2,230	154
Tudor Company	2,270	144
Chloride Company	2,299	110

Section H.—Meters.

Bastian, £1. 15s., £2. 5s., £2. 5s.

Schattner, £2. 7s. 6d., £2. 10s., £2. 15s., £2. 17s., £3. 7s. 6d., £3. 10s., £4.

Reason, £2. 15s., £2. 15s., £2. 15s., £4. 5s., £5, £5. 10s., £6.

Ferranti, £2. 15s., £2. 16s., £3, £3. 3s., £3. 5s., £3. 10s., £3. 10s.

Electrical Company, Charing Cross, £3, £3, £3, £4. 1s., £4. 19s., £4. 19s., £6. 1s. 6d.

Geipel, £3. 4s., £3. 8s., £3. 18s., £4. 17s., £5. 5s., £5. 7s. 6d., £5. 12s. 6d.

A.E.G., £3. 6s., £3. 6s., £3. 6s., £5. 2s. 6d., £5. 18s., £2, £2. 13s.

General Electric Company, £3. 10s., £3. 10s., £4. 5s., £5. 2s. 6d., £5. 7s. 6d., £5. 10s., £5. 10s.

Section I.—Crane.

J. Carrick	219
Chatteris	220
Johnson and Phillips	227
Carrick and Ritchie	238
J. Carrick	244
A.E.G.	246
J. Spencer	250
Bedford Engineering Company	275
Broadbent	375
J. Booth	395

Section J.—Dust destructor.

Manlove-Alliott	1,286
Hughes and Stirling*	1,550
Meldrum	1,955
Horsfall	2,131
Heenan and Froude	3,450

Section K.—Well.

Isler*	310
New Calyx	327
Murray	334
Blake and Knowles	342

* Accepted subject to sanction by the Local Government Board.

BUSINESS NOTES.

TRACTION.

Dunstable.—The Corporation have a proposal before them for an electric tramway to Luton.

Manchester.—On all routes last week the Corporation tramways carried 564,468 passengers, the receipts amounting to £2,199.

Torquay.—One of the arguments, it is said, against electric trams for Torquay is that they would ruin the trade of Union-street.

Southend.—It is said that the electric trams carry on an average about 11,000 passengers a day, the average daily takings being £43.

Private Bills.—The City and Brixton Railway Bill and the Watford and District Tramways Bill have been read a third time in the House of Commons.

Weston-super Mare.—The Urban District Council have referred all matters in connection with the proposed tramways to the Baths and Lighting Committee.

Warwick.—We understand that the construction of the proposed electric tramways between Warwick and Leamington will be commenced some time this autumn.

Brighton.—In answer to memorialists, the Tramways Committee have refused to recommend the Town Council to alter their decision, which is in favour of a Sunday car service.

Cheltenham.—Colonel von Donop, R.E., Board of Trade inspector, has made his official inspection of the Cheltenham to Cleeve Hill light railway, and the cars commenced running last Saturday.

Sandgate.—The light railway company have informed the District Council that they have withdrawn their application for powers to construct a light railway in Folkestone, Sandgate, and Cheriton.

Skene and Echt.—The promoters of the Skene and Echt light railway have decided that the cost (£120,000) for electric traction is prohibitive. It is probable that steam traction will be adopted.

Bath.—At a special meeting of the Urban Sanitary Authority on Tuesday a motion was down on the agenda in favour of serving notice of compulsory purchase by the Corporation of the Bath Road Car and Tramways Company.

Aberdeen.—It has been remitted to the Tramways Committee to consider and report as to the advisability of applying for authority in the next session of Parliament to connect the existing tramway system with the district of Torry.

Sunderland.—The weekly takings of the electric trams at present average about £1,300, and it is pointed out in the local Press that this means that the trams carry something like two and a half times the population of the borough over the service every week.

Greenock.—Everything is now ready at the Corporation electricity station for supplying the tramways with electricity. Mr. Nelson, the engineer, has prepared an important report, in which he suggests that new machinery would require to be provided in the near future.

Nantwich.—The support of the Rural District Council to the action of the British Electric Traction Company, who intend laying down tramways in Crewe and the neighbourhood, has been obtained. The Crewe Town Council, however, are opposing it, as they have a scheme of their own.

District Railway.—The traffic receipts of the Metropolitan District Railway for the seven weeks ended 19th inst. were £42,016, a decrease of £4,512 on the receipts for the corresponding period last year. Last week's receipts amounted to £5,332, a decrease of £33 over the corresponding week of 1900.

Huddersfield.—The Town Council have decided not to pay their tramway employés more than ordinary wages for Sunday labour. The borough engineer (Mr. K. T. Campbell) is preparing plans and specifications for the conversion of the remaining portion of the steam tramways to electric haulage.

Padiham.—A sub-committee has been appointed to inspect the paving of the tramline, and the clerk and surveyor have received instructions to draw up the conditions upon which the District Council would consent to the fixing of centre poles between the tramlines and for the lighting of Burnley-road.

Plymouth.—The Borough Council have resolved to apply to the Board of Trade for authority to borrow the sum of £12,540 for the purpose of constructing the Hyde Park-road section of the tramways; also a sum of £1,270 for the construction of a circular turn-out at the Octagon, and that the work be done forthwith.

Railway Motor Cycles.—A message comes from South Africa to the effect that General French has permitted the use of railway bicycles, which run along the rails, sometimes attaining a speed of 30 miles an hour, and also of a motor railway cycle, which is being built, and which will be capable of doing 40 miles an hour.

Forres-Findhorn Light Railway.—At a largely attended meeting of supporters of the scheme for a light railway to Findhorn on Tuesday it was explained that it is proposed to run for two miles on the Highland line, and to branch off at West Grange Farm, the estimated cost being £15,000. A committee was appointed to carry out the necessary preliminary arrangements.

Hobart Electric Tramway Co.—The directors' report shows that the revenue for 1900 amounted to £14,769, as against £13,624 for 1899, being an increase of £1,145, while the running expenses amounted in 1900 to £10,714, as against £10,152 for the previous year, leaving a net increase of £583. The revenue for the current year continues to show a steady increase.

Pemberton.—The Wigan Corporation have accepted the offer of the Pemberton Urban District Council of £7,750 for the portion of the tramway undertaking situate within the district of Pemberton, subject to the payment also by the District Council of the parliamentary costs, amounting, with the purchase money, to a total of £8,217. The Pemberton Council, however, have decided not to entertain the claim for costs.

Broadstairs.—The Urban District Council have received a copy of regulations which the Board of Trade propose to put into force with respect to electric traction by the overhead trolley system on the Isle of Thanet light railways. The matter has been referred to a committee to offer any observations that might be thought fit. The Council have expressed their satisfaction that the Board of Trade are dealing with the subject

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Taunton.—The official inspection of the new tramway system at Taunton took place last Friday. The Electric Lighting Committee report that the Newton Electrical Company have delivered at the works the generator and Belliss engine (parts of their contract for tramways plant), and they have also erected the tramway switchboard, so that the committee are prepared to supply energy for the trams as soon as they commence running.

Govan.—An arrangement has been come to between the Govan Town Council and the promoters of the Glasgow Corporation tramways order to the effect that the portion of tramway now to be constructed from the present terminus of the tramways to the western boundary of the burgh, as extended, shall, when considered by the Corporation, belong to the burgh of Govan, and be deemed to be part of the tramways leased by the burgh to the Corporation.

Walsall.—At the last Town Council meeting communications were read from one of the branches of the Amalgamated Society of Railway Servants and other local institutions urging the Council to municipalise the tramways rather than grant a further lease, as had been recommended. The communications were referred to the Tramways Committee. Plans and reports of the borough surveyor and the electrical engineer for the extension of the tramlines are under consideration.

Strikes Abroad.—The tramway strike at Rome has died a natural death. In view of the concessions made by the tramway company, and its statement that it would continue as far as possible to improve the condition of its men, work has been resumed. The tram-men at Leghorn have now come out on strike; and the strike at Milan still continues. The tramway strike at Malaga is becoming more serious, the strikers maintaining a determined and offensive attitude. A number of arrests have been made.

Light Railways.—The Board of Trade has confirmed the Wales and Laughton Light Railway Order, 1901; the Bridlington and North Frodingham Light Railway (extension of time) Order, 1901; the Lizard Light Railway (extension of time) Order, 1901; and the Tickhill Light Railway Order, 1901. The Light Railway Commissioners have submitted the following to the Board of Trade for confirmation: the East Sussex Light Railway, the Mitcham (Surrey) Light Railway, and the Lyndhurst Light Railway Orders.

Portsmouth.—The Board of Trade have notified the Corporation that they have appointed Colonel von Donop, R.E., and Mr. Trotter as inspectors to proceed to Portsmouth, the former to examine the permanent way, and the latter the overhead trolley system. Up to the present, however, no date has been fixed for the visit. The Portsmouth tramway drivers and conductors are now being practised in the handling of the electric cars, and every morning practice runs are being made along the North End-Cosham line.

Warrington.—Mr. Behr's proposal for an electric express railway between Manchester and Liverpool is at least regarded in some quarters with every satisfaction. At the last meeting of the Warrington Rural District Council the Clerk said it was satisfactory to report that the Electric Express Railway Bill, to pass through several of the Council's parishes, and the South Lancashire Tramways Bill, to pass over the Newton and Winwick roads, were now Acts of Parliament, and that their construction would shortly commence.

Birkenhead.—The new sections of the Corporation tramways just opened must be doing an enormous traffic, according to all accounts. The average receipts per mile on the three new sections have turned out to be 1s. 3d. Figures show that, particularly at Higher Tranmere, the innovation has been thoroughly appreciated by the residents, as the receipts on that route average over 2s. per mile travelled. At New Ferry the receipts continue high, and during last week 58,780 passengers were carried, the fares totalling £932. 6s., equivalent to just over 1s. per mile.

A Saddleworth Scheme.—It is reported that the joint committee elected by the District Councils of Lees, Saddleworth, and Springhead are promoting a scheme to connect their districts by a system of electric tramways. It is expected to cost between £80,000 and £100,000. Messrs. Hewitt and Rhodes, engineers, have offered to construct and work the tramways, the local authorities to have the option of purchasing the lines at the expiration of a term of years, 14 years being suggested. Their offer has not yet been accepted or declined. Meanwhile, another firm of engineers have made a similar offer.

Woodford.—From the first day of its proposal the residents in the Woodford district had offered the most strenuous objection to an electric tramway being built to connect the Epping Forest district with the City. Probably it is a result of this opposition that the Metropolitan Tramway Company, the promoters of the scheme, have decided to abandon that portion of the proposed line relating to Woodford and Wanstead. The company, it is understood, have now decided to proceed with their line as soon as they have received powers for construction in the districts of Tottenham and Walthamstow, and so to approach the Forest through Buckhurst Hill.

Stockport.—The first section of the electric tramways being constructed by the Corporation of Stockport is to be inspected by the Board of Trade official on Saturday. This route is from the tramway depot, Mersey-square, in the centre of the town, through Portwood, Bredbury, and Woodley Village to the Hyde side of Woodley station. The formal opening of the system is arranged for Monday next, and the public service will probably begin on this route the same afternoon. The Corporation of Hyde will construct a continuation line from Woodley to Hyde, and form a junction with the lines of the company now running cars between Hyde, Denton, and Ashton.

Scarborough.—The Corporation having decided to let a private company construct the proposed electric tramways in the town, a settlement was arrived at between the two bodies on Tuesday as to the line of route to be adopted. It is proposed to complete a circle of the main streets, and to tap all the wards save the South Cliff, which is left entirely alone. These lines the company have agreed to construct as soon as parliamentary power has been obtained. They have also consented to include in the Bill, and construct before a certain date to be fixed, a section starting from the top of Prospect-road, and continuing along Manor-road and Scalby-road to the main line.

Singapore.—This place is apparently going in for electric trams. We note that on the 15th inst. a company called "Singapore Tramways, Limited," was registered at Somerset House with a capital of £2,000. The objects of the company are described thus: to establish, maintain, and work by electricity, steam, horse, or other power, rail and tram roads in the Straits Settlements, to carry on the business of generators, accumulators, and distributors of electric energy for the purposes of light, heat, or power, and to construct for the purposes of the company or otherwise any machinery, plant, lamps, transformers, accumulators, dynamos, generators, motors, lines, wires, cables, etc.

Halifax.—It has been rumoured that the proposed tramway to Wheatley has been abandoned. This, however, is a mistake. The tram poles have been erected, and the rails are placed at the roadside ready to be laid, and the work is now at a standstill. But the tramway has not in a sense been abandoned. The Halifax borough engineer is awaiting instructions to complete the line, but in the present condition of the tramway finances the committee, it is stated, do not intend to issue those instructions for some time. It is a question whether the line would pay its way, and it is felt that the committee should be wary of hastily proceeding with routes of this nature.

Tanat Valley Light Railway.—Presiding at the third yearly meeting of the shareholders in the Tanat Valley Light Railway Company, the Chairman said they had unfortunately met with considerable difficulty from unexpected quarters, but these had now been overcome, and the work of constructing the line was now rapidly proceeding. Terms had been arranged with all the landowners, with the exception of two small owners at Penybontfawr and Llangynog, and their claims had been referred to the Board of Trade for arbitration. The total authorised capital, exclusive of borrowing powers to the extent of £5,000, was £71,750, and the whole of this money has been raised, with the exception of 4,084 £1 shares.

Leeds.—As a result of the recent extensions of the Corporation electric tramway system, it has been decided to prepare specifications for 50 new cars, and to order two boilers for the new generating station. Specifications will also be prepared for some additional feeders for the Roundhay-road and Street-lane extension, and tenders invited for materials for the overhead line in Street-lane. When that extension is carried out there will be another circular route in the city, as Roundhay will be connected with Chapeltown by way of Street-lane. It is probable that before long a by-law will be introduced against smoking outside the Corporation tramcars. The matter is now engaging the attention of a committee.

Bohemian Enterprise.—A consular report on Bohemia states: "During the year 1900 the Corporation completed its network of electric trams, and provided the public with an excellent and cheap means of transit, admirably managed. The trams run through all the principal streets to the suburbs, and the old horse tram has nearly disappeared. The overhead trolley system is that used, and has, I understand, been found to work satisfactorily. Several prominent towns are now running electric trams. Electric lighting is being largely used in Prague, both in the streets and houses. A central station to supply the city has been erected, and commenced work last year. There are already in Bohemia 16 towns lit by electricity."

The Future of the London General Omnibus Co.—At the half-yearly meeting of the London General Omnibus Company, the deputy-chairman said he did not despair of the future, and added that the directors were looking forward to some change in the methods of locomotion by steam, electricity, or motorcars, but though they had examined many proposals, they had as yet found no system so cheap as that now in vogue. At a low estimate he calculated that the laying down of the Government telephone and the electric light mains had lost the company on an average two passengers per omnibus per journey, and this represented £21,000 in the half-year. If the roads had not been disturbed, they would in all probability have paid the usual dividend without any trouble.

Hope (Derbyshire).—We hear that a company of private gentlemen have formulated a proposal to construct an electric tramway from Hope Station to Bradwell and Castleton. Leaving the station yard at Hope, it is proposed that the Bradwell line shall run across the Hallsteads, keeping on or near the Roman road until near the entrance to Bradwell, where it terminates with a station in the centre of the village. The line to Castleton is to follow the River Noe through Hope, terminating with a station under the shadow of Peveril Castle. Plans of the scheme have been prepared, and it is expected a Bill will be introduced in the next session of Parliament. In addition to being of enormous service for passenger traffic, the new lines are regarded as the best means of greatly developing the mineral resources of the district.

Bradford.—We note that the work in connection with the laying of the line of electric tramways from Bradford to Idle is rapidly nearing completion, and cars will probably be running between the two places in about a month. The Tramways Committee have under consideration the question of constructing a tramway from Forster-square up Church-bank, one of the steepest gradients in the city, but which, it has been suggested, could be successfully engineered. The proposal is, by taking off the "hump" at the top of the incline, and raising the level of the road where the ascent commences, to reduce the gradient to 1 in 9, and thus bring the scheme within practical possibility. A deputation from the Corporation paid a visit to Glasgow on Saturday, and inspected the tramway system there, including the Pinkston power station.

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Glamorganshire Light Railways.—The Parliamentary Committee of the County Council have decided that notice to the Light Railways Commissioners be given in respect of the undermentioned lines, with the view to the passing of special resolutions to make applications for orders for such of them as may be decided on by the Council: (1) a line from Aberdare by Mardy, Porth, Tonyrefail, Blackmill, and Tondu to Bridgend; (2) a line from the boundary of the county borough of Swansea, or the end of the authorised Swansea light railway, to Ystalyfera by Clydach and Pontardawe; (3) a line from the county borough of Swansea, or the end of the authorised Swansea light railway, to Loughor; (4) a line from the authorised Swansea light railway at Morriston to the end of the existing tramway at Neath Abbey; (5) a line from the termination of the Neath Corporation tramway at Briton Ferry to Taibach. And, if found desirable, to make such applications jointly with the Swansea Borough Council or the district councils of the districts wherein any part of such light railways may be situate, and to make working or other arrangements with such councils, both as to the proposed and authorised light railways and the existing and authorised tramways, and also, if thought fit, to advance money to a light railway company promoting any of the above-mentioned light railways.

Central London Railway Trials.—As was stated by the chairman at the recent meeting of the Central London Railway Company, a new locomotive has been under trial for some time past with a view to diminishing vibration. The new engine is fitted with powerful springs and with lighter armatures, which are said to work at thrice the rate of the old ones, and are geared down to the ordinary speed. The weight of the new motor is 31 tons, or 11 tons less than the old one. The combination of lightness with extra springs has given every satisfaction to the experts of the Board of Trade, the vibration being reduced almost to vanishing point. According to the *Daily Mail*, the company are now giving the multiple-unit system a thorough trial. They have fitted a train consisting of two ordinary coaches, with a motor coach at each end, the motor coaches carrying the usual number of passengers. A motor coach weighs six tons more than a trailing coach. A multiple-unit train, consisting of two motor coaches and two trailers, was run from Shepherd's Bush to the Bank and back with great success on Tuesday night, both from the speed and vibratory point of view. To-night probably another trailing coach will be added, and if this is successful a trial will be made with four trailers. Should this prove satisfactory the multiple-unit system will most probably be adopted. Apart from the question of vibration, weight will probably be the decisive test of the two systems. The new light locomotive and six carriages weigh 115 tons. Two motor coaches and four trailers weigh 96 tons, or 30 tons less than the present heavy motor and six carriages.

One Hundred Pounds Reward.—The "dispute" between the Bristol Tramways Company and their late employés, who claimed the right to "combine" and were dismissed for joining the union, is by no means "over," in the true meaning of the word, as was reported at the end of last week. Protests, mass meetings, processions, and like demonstrations having failed to move the company from the high position they have taken up, the men have adopted a course which, to say the least, cannot possibly help their cause, and can only be prompted by the lust for revenge. The serious pitch to which matters have come may be judged from the following strongly-worded notice which has appeared this week in the local Press: "Whereas there is evidently an organised conspiracy on the part of certain dastardly scoundrels to injure the company, utterly regardless of the lives and safety of the public of Bristol, and in order to encompass their vile purpose, they have maliciously designed and are still perpetrating a plan of placing obstructions, such as iron bolts and rivets, pieces of rod iron, stones, etc., on the rails of the tramways. Now, therefore, we, the Bristol Tramways and Carriage Company, Limited, do hereby invite all law-abiding citizens to co-operate with us in the discovery of offenders, and we hereby give public notice that we will pay a reward of £100 to any person or persons who shall give such information as leads to the conviction and imprisonment of the persons guilty of the above-mentioned offences or of any similar outrage which may be committed after the publication of this notice." The company have adopted a novel method of rewarding their employés who remained loyal to them throughout the recent strike. The company have announced that silver medals will be presented to these men, and they will also receive gratuities at the rate of 2s. for foremen and inspectors, 1s. for drivers, and 6d. for conductors. The directors are giving their year's emoluments, totalling £2,200, to the loyal men.

LIGHTING AND GENERAL.

Hindley.—The Royal assent has been given to the Hindley Electric Light Bill.

Tonbridge.—The Guardians are about to become subscribers to the municipal telephone system.

The Pacific Cable.—In the House of Lords the Pacific Cable Bill has been read a third time and passed.

Royton.—The Royal assent has been given to the Bills confirming the Royton tramway and electricity provisional orders.

Govan.—A recommendation of the Electricity Committee for the appointment of an assistant electrical engineer has been approved.

Kingston.—The Guardians are considering the advisability of installing an electric lift at the house at an estimated cost of £292.

Stafford.—The output of electricity for the past month shows a decrease of 1·54 per cent., but for the quarter there is an increase of ·48 per cent.

Kinning Park.—It has been decided to instal the electric light in the burgh—six arc lamps in Paisley-road West and nine in West Scotland-street.

Bredbury and Romiley.—Mr. C. L. Turner, of Manchester, has been commissioned by the Urban District Council to prepare a combined lighting and tramway scheme.

Llanelly.—Mr. Stewart, the engineer to the Llanelly Harbour Commissioners, has been instructed to prepare a full report on the question of lighting the new dock by electricity.

London Exhibitions, Limited.—Mr. Ernest W. Dunton, A.M.I.E.E., A.M.I.M.E., informs us that he has been appointed chief electrical engineer to the above company.

Charing Cross and Strand Electricity Supply Co.—The warrants for the dividend on the preference and ordinary shares of this corporation have been posted to the shareholders.

Blaenau Festiniog.—An agreement is nearly concluded between the Urban District Council and the Yale Electric Power Supply Company for the supply of electricity in the town.

Newcastle.—At a meeting of the Public Clocks Committee on Friday, it was reported that the clock for the town hall was ready. It was decided to have the clock electrically controlled under the new system.

Leamington.—The General Purposes Committee having considered the question of the desirability of the Council laying down their own electric light installation, have referred it to the Electric Light Sub-Committee.

Stock Exchange.—The Stock Exchange Committee has appointed Wednesday, Sept. 4, as a special settling day for the British Electric Traction Company's further issue of £250,000 5 per cent. perpetual debenture stock.

Berwick.—At a meeting of the sanitary authority last week, the clerk reported that they had been advised by Mr. Campbell Swinton that the town was too small to make an electric lighting undertaking a paying concern.

Halifax Telephones.—In accordance with the resolution of the local chamber of commerce, the secretary has issued a circular to telephone subscribers requesting their views as to the desirability of a municipal telephone.

Kingstown (Ireland).—After considerable discussion the Urban District Council have decided to invite the British Schuckert Company to state the terms on which they would be prepared to carry out the electric lighting of the town.

Caversham.—A scheme drawn up by Mr. A. T. Cooper for supplying electric energy in the district has been submitted to the Council. Further consideration of the proposal has been postponed in order to obtain the views of the Goring Rural District Council on the subject.

Wireless Telegraphy.—The Dover Chamber of Commerce have decided to again petition the Trinity House authorities to replace on the Goodwin Lightship the wireless telegraph apparatus, which was removed about a year ago. The installation proved to be of enormous value when vessels got on the Sands.

Barnstaple.—At the last meeting of the Town Council the Electric Lighting Committee reported having received a letter from Messrs. Carrington and Scotter, of London, expressing a desire to carry out the electric lighting scheme for the Council. The Council decided they were unable to comply with the request; they were already committed to a scheme.

Greenock.—In the five weeks ended Aug. 2 (according to the latest accounts), 17,469 units of electricity were generated and 11,567 sold, being 5,114 more than for the same period last year. The applications for supply to date number 226, which is an increase over last year of 103; and the connections made number 216, which is equivalent to 16,971 8-c.p. lamps.

Whitehaven.—The Corporation's charges for electricity to private consumers have been fixed as follows from Oct. 1: £12 per annum, and 2d. per unit by meter, or 6d. per unit by meter. The sanction of the Board of Trade to the Council doubling the pressure on the mains from 210 to 420 volts has been received. Mr. T. Bell has been appointed assistant electrician to the Corporation.

High Wycombe.—A committee of the Corporation has been appointed to consider the advisability of establishing a system of municipal telephones. The reason given for this action is the inadequacy of the system of the National Telephone Company, many people being unable to obtain the telephonic facilities which they desire. Considerable feeling exists in the town on the subject, and it is thought the new system will be heartily supported.

Share Market.—British Westinghouse prefs. rose ⅛, to 4⅞-5⅛, at the latter end of last week after remaining quiet for some time. A few electric shares were inclined to harden, and all debentures continued in favour. Tractions were steady without change. On Monday all electric shares were quietly good, with an improving tendency, the dividend deducted on account day having, in most cases, been recovered. Westminster and St. James's Electric shares were a shade harder, and South Londons were weaker at 2⅜-3. With the middle of the week electrics generally were in demand, with the exception of South Londons, which closed 5s. lower at 2¼-2⅜.

Huddersfield.—General satisfaction was expressed at Wednesday's meeting of the Corporation at the passage of the Yorkshire Electric Power Bill. The Corporation had, it was stated, obtained a clause to the effect that no body would be able to supply electric power in the immediate district without the consent of the Corporation, which would have power to settle disputes. Other city councils would have to refer disputes to the Board of Trade. Another advantage to Huddersfield would be that the electric power company would not have a right to break up the streets, and they would be responsible for any damage to Corporation property if caused by their laying mains in the borough.

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Portsmouth Telephones.—It is announced that the County Council have given their sanction to the proposed municipal telephone undertaking, so far as it affects their administrative area. Everything is now clear for the Board of Trade enquiry.

Hoylake and West Kirby.—Sanction has been obtained by the District Council to the borrowing of £13,500 for electric lighting purposes. The work of converting the public lamps to electric light will probably be commenced in about a month.

Swadlincote.—The U.D.C. have received notice that the Provincial Electric Supply and Traction Company intend to apply to the Board of Trade for a provisional order to empower them to supply electricity for public and private purposes in the district.

Epsom.—The clerk has been instructed to consider a notice from the Leatherhead and District Electricity Company and to report generally upon the position of the Rural District Council in the matter and as to the probable cost of procuring a provisional order.

Personal.—We understand that Mr. James Paxman (of the firm of Messrs. Davey, Paxman, and Co.) is visiting the United States of America. He sails on the Cunard ss. "Campania" to-morrow (Saturday), and is accompanied by his London manager (Mr. T. H. Harrison).

Lower Bobington.—It was announced at the last meeting of the District Council that a report had been received from the Liverpool firm the Council had engaged to consider the question of electric lighting for the district. The report was referred to the Parliamentary Committee to consider.

A French Scheme.—We hear that at Krugero, in France, a company, with a capital of £35,000, has been formed to develop the water power in the district. About 1,000 h.p. will be available. Electric light will be provided, and power, it is said, will be supplied at from £2. 15s. to £3. 18s. a year.

Cable Laying.—The Eastern Extension, Australasia, and China Telegraph Company announce that the ss. "Scotia" left the Thames last Saturday morning with the necessary cable to lay the Cocos-Perth section, which is expected to be completed and the line opened for traffic before the end of October next.

Harrogate.—In view of the fact that the Corporation are considering the advisability of applying for a license to work a municipal telephone exchange in the borough, it has been resolved to ask the National Telephone Company if they are prepared to make a deduction in their present charges, and to make one uniform charge for the borough.

Henley's Telegraph Works.—The directors of W. T. Henley's Telegraph Works Company, Limited, have declared an interim dividend for the first six months of the current year at the rate of 4½ per cent. per annum upon the preference shares, and at the rate of 10 per cent. per annum on the ordinary shares, both payable on Sept. 2, 1901.

Appointments.—Mr. S. D. Penning, of the technical department of the day college for men, has been selected, out of 97 candidates, for the post of assistant engineer in the borough of Woolwich. We hear that Mr. H. Brewin-Noble, of Shepherd's Bush, has been appointed by Hastings Corporation to fill the position of mains superintendent.

Pemberton.—In answer to an application of the District Council to borrow money for the purpose of wiring the premises of private consumers of electric light, the Local Government Board have replied to the effect that they do not propose in future to entertain applications for sanction to loans for the execution of works beyond the consumers' terminals, or the meter in houses to which electricity is to be supplied.

Dunstable.—Mr. Snell, the engineer responsible for the scheme of electric lighting for Luton, has visited Dunstable and conferred with the Town Council as to the possibilities of carrying out an electrical undertaking for the borough. It is estimated that an electric lighting scheme for the town could be carried out for about £10,000, but Mr. Snell will report on the subject in due course. He has, however, recommended the Council to obtain a provisional order.

Rochdale Telephones.—A deputation was received at the last meeting of the General Purposes Committee from the Rochdale association for securing a municipal telephone service. The deputation presented a petition signed by over 200 persons who have promised to become subscribers if a municipal service were established. The matter was referred to the Telephone Sub-Committee, who have decided to write to various corporations to obtain additional information.

Dinner.—On Saturday evening Messrs. Buchanan and Curwen, electrical engineers, of Westminster, Beckenham, and Bristol, entertained their employés, numbering nearly 40, at dinner at Howard's Assembly Rooms, Beckenham. The company also included a number of visitors. Afterwards a thoroughly enjoyable musical programme was carried out. Messrs. Buchanan and Curwen are the contractors for the Beckenham Urban District Council's free wiring scheme.

Radcliffe.—So long back as 1895 the District Council obtained an electric lighting order, but up to now nothing has been done to carry it out. The patience of the Board of Trade was at last exhausted, and they have been threatening to revoke the order. The Board, however, have now written to the effect that they are not disposed to revoke the order if within a reasonable time definite steps are taken by the Council to exercise the powers conferred upon them by the order.

Truro.—In reply to questions at the quarterly meeting of the City Council, it was stated that the Electric Lighting Committee had been reappointed, not with the expectation of being able to make a formal report, but to keep in touch with the development of a new gas. The Bill was before Parliament, and there were prospects of economy in the production of electric lighting in the future. It would be useless to formulate a report which they could ask the Council to adopt at present.

Aberaychan.—At the monthly meeting of the Urban District Council it was stated that the Council could obtain a provisional electric lighting order at a cost of £150. The following Councils intended applying for an order next session: Abertillery, Tredegar, Mountain Ash, Ebbw Vale, and Abercarn. By obtaining a provisional order they would be able to prevent any company coming into the district. After some discussion it was decided that the order should not be applied for this year.

Elstree and Boreham Wood.—This district is about ripe for an electric light plant. The consumers of the district are dissatisfied with the quality of the gas and the price, 5s. 6d. per 1,000 cubic feet. Two consumers in the district have already installed their own electric lighting plant. From the local Herts papers it would appear that the Parish Council of Elstree are not entirely satisfied with the cost of public lighting. There is a brickworks at the railway station that might be customers for power.

A Motor Plough.—News comes from St. Louis that Dr. Gatling, the inventor of the gun of that name, has devised a motor plough, which he asserts will accomplish as great a revolution on the farm as his gun did on the field of battle. The inventor makes the claim that his plough, under the guidance of one man, will break the surface of a 30-acre field in a single day. For the present no details are to be made public, but a company has been organised, with £500,000 capital, and will erect a large factory in this city. It is said that besides the motor plough there are other farm implements to which Dr. Gatling is giving his attention.

Plymouth.—The electrical engineer has submitted a statement of the estimated and actual cost of the first year's working of the electricity undertaking, which will shortly be made public. It was pointed out at the last meeting of the Corporation that originally Mr. Rider estimated the working expenses at £3,815, and the capital charges at £2,497, a total of £6,312. But from a return of the borough treasurer he found the working expenses last year were £5,642, and capital charges £3,097, a total of £8,739, or an excess over the estimate of £2,427. On the other hand, the revenue had exceeded the estimate, but only by £500, so there was a deficiency of £1,900.

Woking.—A remarkable case is reported from Woking in Surrey. For some years the streets of Woking have been lit with electricity, but it is said the Council have decided to revert to gas. They omitted, however, to give the electric light company the necessary notice to terminate their contract, and the company claimed to do the lighting for another year. The Council, however, had accepted a contract from the gas company. At length the electric company have waived their claim, but the mistake has caused a great deal of inconvenience, and has postponed the adaptation of the electric standards to gas, so that the streets are still in inky darkness each evening.

Penzance.—The Corporation still contemplate adopting the electric light for public lighting, and at the last meeting of the Town Council the Electric Lighting Committee reported that the deputation appointed to visit electric light stations at Plymouth and Torquay were received at these places with the greatest courtesy, and all possible information and help afforded them. Subsequently they went on to Bristol and inspected the stations there. At each place there was absolute unanimity as to the importance of the Corporation keeping the matter of electric lighting in their own hands, and everywhere they went they were told that the electric lighting was successful, financially and otherwise.

Aberdeen.—An unfortunate breakdown occurred in the Corporation electrical supply on Friday. It was found after the city's supply had been cut off that a fault in the feeder cable in George-street and Loch-street caused a short-circuit. The failure only applied to the electric lighting supply, and as the tramways receive their motive power from another plant, there was no suspension in the car traffic. Before evening the defect had been remedied, and no further inconvenience was felt. The Telephone Committee are considering the question of the Corporation obtaining the control of the local telephone system. The manager of the National Telephone Company has been requested to put his proposals in writing, when the committee will meet again to consider them.

Padiham.—Councillor Jackson has been appointed chairman of the new Electricity Committee, which is considering the question of the motive power to be employed for the proposed dust destructor. The Power Gas Corporation, Limited, have been asked for information as to where the system is at work, and of any place making the gas from the refuse or other materials of the town; also, whether the Mond process is at all applicable and if it can be adapted in connection with the destructor process. In respect to electricity, the surveyor has prepared a plan of the district for an electric lighting area with the works at the destructor works. It has been decided to get information as the cost of obtaining an electric lighting order from Brierfield and Great Harwood.

The "Asco" Insulator.—Messrs. Atkinson, Schmahl, and Co., of Manchester and Newcastle-on-Tyne, inform us that they have recently brought out a new type of insulator, which goes by the above name. This insulator is made, in two parts, of hard fire porcelain. A galvanised metal clip, which receives the wire or cable, is firmly held in position by the upper part of the insulator, which fits into the lower part of same, and an ordinary wood or coach screw then serves to clamp the whole together, this screw at the same time serving to fasten the insulator in position. The chief advantage which is claimed for the "Asco" insulator over other types is that it entirely dispenses with binding wire, and there is no chance of the insulation of the cable or wire being damaged or cut.

Ashton.—It was reported at last week's meeting of the Town Council that the Board of Trade had made an order granting permission to the Corporation to alter the standard pressure at which electrical energy may be supplied to consumers from 200 to 240 volts, the Corporation to pay the consumers the reasonable cost of or

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incidental to the change of pressure of the supply to their premises, including compensation for any loss or damage incurred by the consumer in consequence of the change. Recommendations that application be made to the Board of Trade to borrow £30,000 for extensions, alterations, etc., to the electricity works, and that the laying of the main along Manchester-road be proceeded with, were referred to the General Purposes Committee.

Manchester Telephones.—Continued efforts are being made to eestablish a municipal telephone system in Manchester. Conferences of representatives of the Manchester, Salford, and Eccles Corporations, and of urban councils in the district, have been held, and the outcome of these is a scheme which was approved by the Manchester Corporation Telephone Committee on Friday. This scheme, which will have to be presented to the City Council for confirmation or rejection, provides for the subscription of capital, Manchester to pay two-thirds and Salford the other third. The proposal further is that profits not exceeding 5 per cent. per annum on the capital expenditure shall be divided in the same proportion. When the undertaking shows a profit exceeding 5 per cent., after payment of working expenses, interest, and sinking fund, such profit shall go in reduction of telephone charges.

Wakefield.—The following unenlightened statement was made by the chairman at the half-yearly meeting of the gas lighting company last week: "The Corporation are now busy erecting electric arc lamps in all the main streets of the city, and they are evidently preparing for the extension of lighting. This is undoubtedly a step to be regretted, as electric arc lighting has been tried and condemnod by several of the leading cities of the world. The Corporation have lately lighted Southgate by means of incandescent electric lamps, but it is a well-known fact that as much light can be obtained for 1d. from incandescent gas burners as for 10d. from incandescent electric burners. Having regard to the alarming manner in which the rates have gone up recently, and as one of the largest ratepaying concerns in the city, they strongly protested against the further expenditure of the ratepayers' money on electric lighting."

Mansfield.—The Board of Trade have approved the system of the supply of electrical energy for the purposes of the Mansfield Electrical Lighting Order, 1899. At the last meeting of the Town Council, the engineer, Mr. Hammond, attended, and tenders to the approximate amount of £26,000 were entered into with a number of firms. General approval was given to the sketch plans of the buildings submitted, and the engineer was instructed to get out quantities and advertise for tenders. The town clerk reported that the Corporation Bill had received the Royal assent, and it was decided to take steps to raise £50,000 capital for purposes of electrical undertaking and refuse destructor. For the supply of electricity, the following scale of charges was adopted: For quarterly payments, for the first 100 hours' use per quarter of the maximum demand, private lighting only, per unit, 6d.; motive power only, 4d.; for the remainder, 2d. and 1d. respectively. For monthly payments, for the first 30 hours' use per month of the maximum demand, per unit, 6d.; motive power, 4d.; and for the remainder, 2d. and 1d.

King's Lynn.—During the past month applications have been received for 65 additional lamps of 8 c.p., making a total of 8,801 from private consumers. The Engineer reported at the Town Council's last meeting that the appointment of assistant electrical engineer had been given to Mr. Claud H. Klyne, of the Morley Corporation electricity works. The following arrangement has been come to with regard to the supply of current for motorcar charging: Until such time as there is a day load to warrant running an engine all day, the current to be supplied for motorcar charging by arrangement with the engineer. If taken at a time when the plant is running, and power can be spared, the price to be 1½d. per unit; at all other times, 5d. per unit. The following charges have been fixed to ordinary power users: When the maximum demand for current is not taken on the average more than one hour per day, the price to be 3d. per unit, and for all current used afterwards, 1½d. per unit. If a maximum current of not less than 50 h.p. is taken by any one consumer at his terminals, the price per unit to be for the first hour per day 2d. per unit, and afterwards 1½d.

British Submarines.—The *Daily Telegraph* learns that the torpedo gunboat "Hazard" has been commissioned to carry out experiments in home waters with the first five submarine boats of the Holland type building by Vickers, Son, and Maxim, of Barrow-in-Furness, for the British Admiralty. Of these five boats one or two will be launched in a week or two. The motive power is a four-cylinder vertical gasoline engine. This motor will be able to vary its speed from 200 to 360 revolutions a minute, and its maximum brake horse-power will be 190, with a consumption of one pint of gasoline per horse-power per hour. The storage capacity to be provided will enable the boat to travel 400 sea miles at nine knots on the surface. The maximum speed will be about 10 knots, and under water between seven and eight. When the boat is submerged the propeller will be run by electric motors, taking current from accumulators, and these will enable the vessel to keep under the water for some hours, but she may come to the surface so that the gasoline motor may work a dynamo to recharge the batteries. The boat is to be 63ft. 4in. long over all, 11ft. 9in. beam, and 120 tons displacement, and will carry a crew of seven officers and men.

Walsall.—A memorial from the residents of Highgate has been received by the Corporation with reference to a supply of electric light for the district. The matter is receiving the attention of the Electric Lighting Committee. The last report of the committee shows that the total number of consumers supplied on July 31 last was 196. During the past month the total units generated at the station was 22,407. The Board of Trade have made additional regulations for ensuring a proper and sufficient supply of electrical energy to consumers requiring the same. The Local Government Board have sanctioned the borrowing of the further sum of £3,000 for the purposes of the electric lighting undertaking. The Board have also given their approval to the appropriation of the land required for the Freer-street sub-station. The electric lighting mains are to be extended from Bescot-road to Slaney-road at an estimated cost of £90, and also to the Pleck Gas-works at a cost of £82. The various charges made for electric current supplied by the Corporation are: for lighting, 6d. per unit for 1½ hours' maximum consumption; 2d. per unit for all additional units. From the above charge a discount of 10 per cent. is allowed to consumers of upwards of 10,000 units a year, and to consumers of upwards of 15,000 units a year 12½ per cent. For motive power, 2½d. per unit for four hours' maximum consumption; 1d. per unit for all additional units.

Leeds.—The latest report of the Electric Lighting Committee shows that during the year ending March 25 last the consumers of electric light in Leeds have increased from 1,393 to 1,820, equivalent to 31·3 per cent., and the lamps and other consuming devices installed from 106,263 to 132,283, equivalent to 24·5 per cent. The use of electricity as a motive power, though still very limited, is extending, the number of motors connected to the mains at March 25 last being 86, with an aggregate of 205 h.p., an increase of more than 100 per cent. during the 12 months. The units sold were 2,520,414, compared with 2,005,840 in the previous year, an increase of 514,574 units (25·6 per cent.). The average price obtained was 4·03d. per unit, compared with 4·09d. per unit in the preceding year, and the average consumption per 35-watt lamp was 20·8 units, yielding a revenue of 6s. 11·8d. The capacity of the plant installed at the works has been increased from 3,040 kw. to 4,020 kw. (6,700 i.h.p.), and contracts have been entered into for additional plant with an aggregate output of 4,720 kw., making a total of 8,740 kw. Contracts have been entered into for the erection of buildings in extension of the works on the site formerly occupied by Britannia Mills. The abnormally high price of coal, the committee point out, has largely increased the cost of production, which was 1·31d. per unit, as compared with 1·19d. in 1900. The capital expenditure during the year was £60,575. 10s. 6d. The total receipts on revenue account were £43,669. 2s. 2d. The working expenses were £13,770. 3s., leaving a gross profit of £29,898. 19s. 2d. After deducting interest and sinking fund a surplus remained of £6,881. 10s. 8d. Of this sum £6,000 became available for the relief of the rates.

Hexham.—At the request of the Urban District Council, Messrs. Lacey, Clirehugh, and Sillar, of Westminster, have prepared a report upon the question of the introduction of the electric light into Hexham, together with a special note as to the desirability of utilising a fall on the River Tyne for motive power. Though Hexham has only a population of 7,000, the firm believe that it is commercially possible to establish electric works on a remunerative basis in Hexham. As to the probable demand, the opinion is expressed that the equivalent of 6,000 8-c.p. lamps will be taken up in the very near future, and that, therefore, plant should be installed to meet this demand. Comparing the cost of the electric light with gas, the report says: "Gas is sold in Hexham at 3s. 4d. per 1,000 cubic feet, and the electric light, if sold at 6d. per unit, would be slightly more expensive. We feel sure, however, that this would not act as a deterrent to shopkeepers and others to whom electric lighting must be a great advantage and business attraction. The price of 6d. per unit would only be necessary when the output was very small. So soon as the first 6,000 lamps were taken up, the price could be reduced, and we anticipate the Council would in the not distant future be able to sell electricity at 4d. per unit, which is about the average price it is being sold by various local authorities to-day. At such a price it presents attractions even to those who do not require it for business purposes, simply on the score of cheapness. Upon the question of revenue, the calculations are based on the assumption that each lamp will consume 15 units per annum, making a total consumption of 90,000 units annually. This at 6d. per unit, will produce £2,250 per annum." A list of the consumption in different towns is given to show that 15 units per lamp per annum is a reasonable estimate, the consumption in the towns quoted varying from 15·4 units in Barrow to 23·4 in Whitehaven. The estimate of the working expenses gives the total cost of producing a unit of electricity at 2·51d., but to this amount must be added 6½ per cent. on the capital expenditure to provide for interest and sinking fund, as the Local Government Board will only sanction loans for a period of 25 years. This brings up the actual cost to 4·82d., and, assuming the charge for current is 6d., leaves a net profit of £442 per annum. Steam, and not water, is recommended as the motive power. The Works Committee are now considering this report.

Boston.—The full text of Mr. A. Collins's report on electric lighting combined with dust destruction for the borough, referred to in our last issue, has now been made public. As already stated, he advises the Corporation to adopt a continuous-current supply with a pressure of 220 volts at consumers' terminals. In combination with the electric lighting scheme, Mr. Collins has estimated for a dust destructor capable of dealing with 12 tons of refuse per day and fitted with a Lancashire boiler. In addition to the dust destructor and boiler, he recommends that boilers of the Economic type be employed, each having an evaporative duty of 8,000lb. of water, with a working pressure of 160lb. to the square inch. He also advises the adoption of high-speed three-crank enclosed compound engines on account of the small space they occupy, their economical steam consumption, and their suitability for coupling direct to dynamos with a moderate speed. Dynamos of multipolar type would be coupled direct to the engines, and these would be three in number, each with an output of 120 kw. at 400 to 480 volts. There would also be a balancing set, and a pair of booster dynamos for charging the battery. In his scheme Mr. Collins has provided for arc lamps for public lighting and posts, upon which would also be placed two incandescent lamps for use after a certain hour at night. The annual cost of the arc lamps would be £12. 10s., and they would replace

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124 gas lamps. For the present Mr. Collins recommends a uniform rate of 6d. per unit for lighting, and a general charge of 3d. per unit for motor purposes. He estimates the capital expenditure at £28,500, and that at the end of the second year's working the revenue from all sources will amount to £3,097. 7s. 8d. After providing for interest on loans and on sinking fund and for working expenses, he estimates a clear profit of £63. 6s. 8d. When, however, the works were fully loaded, a profit of £2,153. 18s. might be expected. In conclusion, Mr. Collins makes a proposition for relieving the Corporation of the first two years' working—namely: "That the contractor should pay all the expenses connected with the running of the electrical light station for two years, and this also to include the payments which have to be made during this period to the sinking fund and interest. The arrangement also to be that if there were any profits made during the two years, half of these to go to the contractor and the other half to the Corporation, and if a loss be made, then the contractor be repaid the amount of the loss out of the first profits made." This arrangement, Mr. Collins understands, has been entered into by two or three corporations which were not only practically relieved of any risk in the matter, for in the third year all electrical undertakings have been found to arrive at a self-supporting point, but in one case over £250 was handed to the Corporation at the end of the second year. This report is shortly to be considered by the Town Council.

NEW COMPANIES.

The following new companies have been registered since our last issue:

Union Electric Company, Limited.—Capital, £25,300. Objects: to carry on the business of manufacturers, sellers and suppliers of electric lamps, electric light contractors, electricians, electrical, mechanical, metallurgical, and general engineers, contractors for the supply of electrical or other force, agency, or energy for the purposes of light, heat, power, traction, or otherwise, etc.

Liverpool Electric Cable Company, Limited.—Capital, £10,000. Objects: to adopt an agreement with R. Taylor, and to carry on the business of manufacturers of and dealers in wires, cables, and lines of all kinds, electricians, mechanical engineers, and manufacturers of and dealers in all apparatus and things required for or capable of being used in connection with the generation, distribution, supply, accumulation, and employment of electricity.

Gearings, Limited.—Capital, £3,000. Objects: to adopt an agreement with F. W. Dunlop, and to carry on the business of engineers, electricians, dealers in and manufacturers of cycles, motors, mechanically-propelled carriages, etc.

Gordon Syndicate, Limited.—Capital, £1,000. Objects: to manufacture, repair, sell, let on hire, exhibit, and otherwise deal in and with automatic, electric, and other mechanical machines and contrivances, etc.

Singapore Tramways, Limited.—Capital, £2,000. Objects: to establish, maintain, and work by electricity, steam, horse, or other power rail and tram roads in the Straits Settlements, etc.

PROVISIONAL PATENTS, 1901.

AUG. 10.

16076. Improvements in trolleys for electric cars. Walter Clayton, 6, Bank-street, Manchester.

16115. Improvements relating to electric transformers. Robert Grisson, 45, Southampton-buildings, Chancery-lane, London.

16121. Improvements in electricity meters. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

16122. Working zinc and substances containing silicic acid in electric furnaces. Alfred Dorsemagen, 78, Fleet-street, London.

16123. An automatic "end connection" for electric cable conductors to provide for continuation conductors. Thomas Jacob, 12, Pond-street, Hampstead, London.

16128. Improvements in electric accumulator batteries. Albert Tribelhorn, 18, Buckingham-street, Strand, London. (Complete specification.)

AUG. 12.

16150. An arc lamp safety winch. J. Lawrence, 163, Kingston-road, Oxford.

16175. An improved escapement for electromagnetically-controlled clocks and like mechanism. Hubert Henry Grenfell, 11, Southampton-buildings, Chancery-lane, London.

16182. Improvements in connecting boards for use in junction boxes and the like for multiple electric cables. George Gatton Melhuish Hardingham, Clun House, Surrey-street, Strand, London. (Edward Waskowsky, Germany.)

AUG. 13.

16227. Electric engine. Hans von Kramer, 25, Avondale-road, Lower Weston, Bath.

16235. Improvements in electric plugs and sockets. Albert Hedley, 83, Addison-street, Heaton, Newcastle-on-Tyne.

16250. Improvements in or relating to automatic circuit breakers. Leonard Lord Elden, 55, Chancery-lane, London. (Complete specification.)

16271. Improvements relating to electric cables. John David Peachey and William Jackson Rice, 45, Southampton-buildings, Chancery-lane, London.

16276. Improvements in electric automobile motors. Charles Richter and Richard Theodore Eschler, 53, Chancery-lane, London.

16277. Improvements in electric traction motors. Charles Richter and Richard Theodore Eschler, 53, Chancery-lane, London.

16283. Improvements in or connected with arc lamps. William James Davy, 40, Chancery-lane, London.

AUG. 14.

16303. Improvements in connecting overhead trolley and other bare wires. Edwin Hopper, 6, Bank-street, Manchester.

16319. Application of the law according to which the electromotive force produced in a conductor moving in a magnetic field is varying with its speed, to indicate the number of revolutions per unit of time made by a turning body. Giovanni Scialpi, nor *vid* Montesano, Genoa, Italy.

16330. Improved electrically-illuminated portable travelling case for holding and illuminating watches or similar articles. Major Alfred Roswell, 53, Jerningham-road, New Cross, London.

16340. Improvements in means for electrically operating railway switches. Frederick Noyes Riggs, Fife House, Kingston-on-Thames.

16351. Improvements in submarine boats. George Gatton Melhuish Hardingham, Clun House, Surrey-street, Strand, London. (The Electric Boat Company, United States.) (Complete specification.)

AUG. 15.

16395. Improvements in the electrolytic production of bleaching solutions and in apparatus therefor. Edgar Leslie Thorp, 139, Queen Victoria-street, London.

16419. Improvements in frogs or points and crossings to be used in connection with overhead conductors of electric tramways or railways. Hugh Godfrey Nicholson, 47, Lincoln's-inn-fields, London.

16428. Improvements relating to scale-changing devices for electricity meters and means for operating them. Wilhelm Mathiesen, 18, Buckingham-street, Strand, London. (Complete specification.)

AUG. 16.

16450. A new or improved insulated guard for electric tramway vehicles. Edward Jones Rowland and Thomas Row Fowler, 9, Warwick-drive, Liscard, Cheshire.

16460. Improvements in electric alternating-current transformers and accessories thereto. George Wilkinson, Kirkside, Bilton, near Harrogate.

16477. An apparatus for electrically controlling the operation of railway points and signals. Arthur Henry Johnson, Winfrith, The Avenue, Bickley, Kent.

AUG. 17.

16527. Improvements in or relating to magneto-electric and other ignition devices. William McNeill and John Ridley, 61, Clifton-road, Prestwich, near Manchester.

16566. Improvements in storage battery plates. Albert Thomas Davies, 23, Coleman-street, London. (Complete specification.)

16596. Improvements in telephonic apparatus. Pierre Germain 45, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 7.

1900.

14426. Combined electric meters and demand indicators. Wright.

14794. Apparatus for use in wireless telegraphy. Bowlker.

15095. Electrical demand indicators. Wright and Reason Manufacturing Company, Limited.

16226. Machinery or apparatus for covering electric cables, wires, and other cores. Berridge and Kerr.

16541. Electric switching and metering apparatus. Lorrain. (Macdonald.)

17722. Electric light fittings. Stead and Scott.

18184. Shades of electric incandescent lamps. Spiral Globe, Limited, and Livet.

18434. Feeding mechanism of arc lamps. Oliver.

1901.

690. Electric controllers. Johnson. (Electric Controller and Supply Company.)

3416. Construction of electrodes containing zinc for use in electric batteries, and method of producing and employing the same. Erny.

3417. Galvanic batteries. Erny.

7118. Electric motor. De Mare.

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10565. Storage batteries. Edison.

10961. Electric striking clock. Möller.

10974. Electrodes for electrolytic cells. Justice. (Castner Electrolytic Alkali Company.)

11408. Electric railways on a sectional conductor or like system. British Thomson-Houston Company, Limited. (Stewart.)

13956. Circuit breakers and brakes on electric railway and tramway vehicles. British Thomson-Houston Company, Limited. (Potter and Clark.)

14404. Electric switches. Lake. (Pinckard.)

14490. Electric lamp hangers. Harrison.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Aug. 17	936	876	+ 60	—	—
Birmingham Tramways	,, 17	4,489	4,472	+ 17	145,757	— *b*
Blackburn Corporation	—	—	—	—	—	— *b*
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 17	1,720	1,973	- 253	9,403	9,760
Bolton Corporation	,, 18	1,593	1,612	- 19	47,313	37,745*b*
Bradford Corporation	,, 18	1,243	515	+ 727	26,225	14,453*b*
Bristol Tramways Company	,, 16	3,646	3,605	+ 41	—	—
Carlisle Tramways Company	—	—	—	—	— *b*	—
Central London Railway	,, 17	5,304	4,580	+ 724	41,206	—
City and South London Railway	,, 18	1,863	1,534	+ 329	12,911	10,535
Cork E. T. and L. Company	,, 15	549	576	- 27	15,128	13,238*b*
Darwen Corporation	—	—	—	—	—	—
Dover Corporation	,, 17	328	354	- 25	6,935	6,510*b*
Dublin & Lucan Electric Railway	,, 18	158	149	+ 9	1,050	858
Dublin U. T., electric cars	,, 16	4,030	4,320	- 290	—	—
Dublin S. District, Electric	,, 16	1,068	1,361	- 293	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 17	12,516	9,788	+ 2,728	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 17	1,706	1,357	+ 349	12,398	9,433
Liverpool Corporation	—	—	—	—	—	— *b*
Liverpool Overhead Railway	,, 18	1,734	1,818	- 84	12,306	12,193
Oldham-Ashton-Hyde Tramways	—	—	—	—	—	— *b*
Portsmouth Corporation	,, 17	1,140	—	+ 305	—	—
Potteries Tramways	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 18	3,746	—	—	—	—
Southampton Corporation	,, 15	1,024	827	+ 197	—	—
Southport Corporation	—	—	—	—	— *d*	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. *b* From Jan. 1. *d* From April 1. 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £356 decrease.
Barcelona Ensanche y Gracia, £37 decrease. Barcelona, £299 increase.
Brisbane, £280 increase.
Buenos Ayres and Belgrano Electric, £526 increase.
Calcutta, £134 increase.
Cape Town (month of July), receipts, £13,440; expenditure, £6,832.
Mexico Electric (month of July), receipts, £17,600; expenditure, £10,800.
Perth Electric, £237 increase.
Port Elizabeth (month of June), receipts, £2,983; expenditure, £1,800.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅛-¼ xd
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-¼
—— Ordinary, 1-125,000	1 ..	⅛-¼
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	6-6½
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4¾-5½
British Electrical Engineering, Ordinary	2 ..	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2½
—— 4½ per cent. Debenture Stock	100 ..	103-108
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	108-112
—— Ordinary	5 ..	14½-15½
—— 5 per cent. Pref.	5 ..	5¾-6½
Crompton and Co.	3 ..	3½-3¾
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	0-¼
—— 5 per cent. Debentures	5 ..	1½-2½
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	85-90
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1½-2
—— 7 per cent. Cumulative Pref.	2 ..	2¼-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10½
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	101-104
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10¼-11½
—— 5 per cent. Cum. Pref.	5 ..	5¾-6¼
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¾-7¼
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	95-100
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9½-10¼ xd
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	7½-8 xd
—— 7 per cent. Preference	5 ..	8½-8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7½-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	9-10 xd
—— 4½ per cent. Cum. Pref.	5 ..	5½-5¾ xd
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105
Chelsea Electricity Supply	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	107-110
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	11½-12½
—— 5 per cent. Debenture Stock	100 ..	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	99-101
County of London and Brush Provincial, Ordinary	10 ..	8-9 xd
—— 6 per cent. Cum. Pref.	10 ..	12-13 xd
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	103-106
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¾-6¼
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10½
London Electric, Ordinary	3 ..	1¼-1¾
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13-14 xd
—— ,, 85,001-98,769	5 ..	13-14 xd
——4½ per cent. First Mortgage Debenture Stock	100 ..	109-112
——3½ per cent. Mortgage Debenture, Red.	100 ..	94-97
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7¼-7⅜
—— £4½ Shares, New	4½ ..	6¼-6⅜
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5¼-6½
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	101-103
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15¼
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	12-13 xd
Electric Railways.—		
Central London, Ordinary	100 ..	99-102 xd
—— 4 per cent. Pref.	100 ..	102-105 xd
—— ,, ,, deferred	100 ..	98-101
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	52-54
—— Ordinary	10 ..	5¼-5¾
—— 4 per cent. Debenture Stock	100 ..	112-117
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	92-95
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4-4⅛
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-129
Blackpool and Fleetwood Tramroad	10 ..	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	102-104
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6-6½ xd
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¾-14¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11¾-12¼ xd
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅛-1¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5¾
—— 5 per cent. Deb. Stock, Red.	100 ..	102-105
—— Prov. Cert., all paid	100 ..	96-99
Cape Electric Tramways, Nos. 1-400,000	1 ..	1¾-2
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5¼-5¾
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	98-102
Imperial Tramways, Ordinary	all ..	22-22¼
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	105-107
New General Traction, Ordinary	5 ..	3-3¼
—— 6 per cent. Cum. Pref.	10 ..	4¼-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	12-13
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9½-10¼ xd
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	6s. ..	5/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	30 p.c. ..	30 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	3¾-4¼
—— 6 per cent. Cum. First Pref.	10 ..	11-13
—— 6 per cent. Cum. Second Pref.	10 ..	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¾-5
—— 4 per cent. Deb. Stock, Red.	100 ..	91-94
—— 3½ per cent. Deb. Stock, Red.	100 ..	95-98
Oriental Telephone and Electric Company	1 ..	⅛-1

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NOTES.

Long-Distance Transmission.—We understand that the Californian Power Company is securing the water rights in the Kern Canyon, some 18 miles from Bakersfield. The company proposes to use the water power obtained to generate electricity, which will be transmitted to Los Angeles at 140 miles away. Three separate power stations are likely to be erected, each containing plant of from 15,000 h.p. to 20,000 h.p.

Electrolytic Transmission of Sulphur.—With respect to our note on the successful electrolytic transmission of sulphur through the skin by Dr. F. W. Smith, which appeared in our issue a fortnight ago, we now see that the priority of Dr. Smith is disputed. A correspondent in last week's *Lancet* states that the electrolytic transmission of sulphur and other medicinal agents through the skin has been known and practised by E. Savary de Rovigo for more than 10 years in London.

The A. A. A. S.—The time-honoured joke about the "British Asses" pales before such initials as the above. The initials, however, remind us that the jubilee meeting of the American Association for the Advancement of Science is holding its meeting this week at Denver. We understand that a fairly good programme has been arranged, and that an attempt is being made to put the association in good order. Owing to the want of organisation in the past, it has earned the name of "The American Association for the Suppression of Science" in certain quarters.

New Cell for Military Telegraphy.—A German firm have recently introduced a new cell for military telegraphy which is said to be giving satisfactory results. The electrolyte is a strong caustic alkaline lye, the anode is of zinc and the cathode of carbon, the latter having a resistance which is diminished by embedding it in a thin cruciform perforated sheet of copper. Thus the resistance is brought down to one-hundredth of an ohm. The E.M.F. of the cell is from 1·2 to 1·5 volts, and when short-circuited it will give a current of 25 amperes. The elements are enclosed in an enamelled iron vessel.

Electrically-Lighted Shunting Pole.—Some months ago we referred to the invention of a Glasgow gentleman, having for its object the facilitating of shunting operations at night. It consisted of the addition of a small electric lamp fixed on the pole. and lighted by means of a small battery in the handle. The circuit would be closed by means of a spring switch at the other end of the pole, so that the light would only be on when the shunter required it. In consequence of this a small battery, weighing only 1lb., was proposed to be used. We understand that the pole in question is to be tried in Glasgow shortly before representatives of the large railway companies.

Engineers and Shipbuilders.—The two latest issues of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders, covering the months of March, April, and May, have just reached us. The first of these contains the discussions on Mr. Edwin Griffith's paper on "Water-Tube Boilers;" Mr. F. W. Jennings's reply to the discussion of his paper on "The Ventilation and Heating of Ships;" and the discussion on Mr. G. M. Brown's paper on "Some Attempts to Increase the Efficiency of Marine Boilers." The second book gives Mr. Brown's reply to the discussion on this paper, and continues the discussion on Mr. Griffith's paper mentioned above. It also contains an account of the closing general meeting of the session.

The Institution Journal. — The Institution of Electrical Engineers has just issued its last *Journal* for the 1900-1901 session, containing the proceedings in May. The first paper given is that by Mr. J. S. Highfield on "Storage Batteries in Electric Power Stations, Controlled by Reversible Boosters," which, it will be remembered, gave rise to an exceptionally instructive discussion at the last ordinary meeting of the session. This issue also embodies Mr. G. A. Grindle's paper before the Manchester Local Section on "The Use of Storage Batteries in Connection with Electric Tramways," together with the discussion thereon. An abstract of a paper by Mr. H. Broadbent before the Newcastle Local Section, entitled "Notes on Wiring Rules," an original communication on "The Rise of Temperature in the Field Coils of Dynamos," by Mr. E. Brown, and another from Mr. C. Basil Nixon on "The Application of Electric Power to Machine Tools," also appear in this issue of the *Journal*. A full account of the proceedings at the twenty-ninth annual general meeting of the Institution on May 30, together with the Council's annual report, are given at the end of the volume, and also the report of the Cape Town Local Section on the work of the last session.

Municipal Ownership.—It is interesting to read the comments of the engineering Press in the States on the question of municipal ownership. In view, however, of the great difference in the laws of the two countries respecting the election of town councillors and officials, and the control of municipal matters, the remarks made by the Press in the one country are not applicable in the other. Still, large company promoters in this country who depend for their livelihood—or, shall we say, their champagne?—on concessions obtained with the consent of local authorities, will be pleased with the following quotation from the *Electrical Review* of New York: "People are beginning to learn by experience—that costly but excellent teacher—that municipal ownership is a snare and a delusion of the first water." The instance quoted as a proof of the above is the breakdown of some girders on the Brooklyn Bridge. Our contemporary says it is scandalous that it should have been left to policemen and ordinary citizens to discover what was very nearly resulting in the total breakdown of the bridge in question. Our contemporary adds that "this is the sort of thing that municipal ownership has always resulted in, and probably will always result in—in this country (America) at any rate."

Electrical Fire-Damp Detector.—A novel fire-damp indicator has been devised by Mr. G. Léon. It will be remembered that Mr Liveing, of this country, has an electric indicator based on the difference in redness of two platinum wires heated by the same current, one in pure and the other in contaminated air. This method will show about ½ per cent. In the present method Mr. Léon uses instead the difference of electric resistance of two platinum wires heated to about 1,000deg. C. by the same current. One of the wires is stretched in a sealed glass tube, and the other (for the fire-damp) placed in a wire-gauze case. The two wires form the two branches of a Wheatstone bridge, the other two branches being formed of suitable resistance wires, in this case of 1·3 ohms each. The galvanometer of the bridge was a Chauvin and Arnoux instrument, giving a deflection of 100 divisions for 50 milliamperes. The resistances are adjusted till the needle remains at zero when both wires are in pure air. Thus when the air contains fire damp the galvanometer was found to be deflected two divisions for one-thousandth part of fire-damp. These deflections were about proportional to the quantity of gas. With this indicator the proportion of fire-damp in a mine may be determined at any instant, and that it will even be possible to establish fire-damp observing stations, and thus contribute greatly to the scientific study of the subject.

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The Central London Railway.—A new locomotive is now being tried on this line which will, it is hoped, greatly reduce the vibration at present complained of by certain householders near the line of route. The effect of the gearing in reducing vibration is two-fold; the first and most important advantage is that with a geared motor the major portion of the weight of the same can be suspended on springs. This is not the case with the present type of motor, in which the armature is built up directly on the shafts, while the field magnets have to be rigidly secured in a position concentric to the shaft. The result is that with the older type of locomotive in use on the Central London Railway the major portion of the weight is not spring borne. At any inequality of the lines, such as occurs at every rail joint, this directly borne weight has to be quickly accelerated in a vertical direction, with a resultant heavy blow on the track. This blow will be largely reduced in the new locomotive with its geared motors. The other advantage of the new locomotive is its lighter weight, which is a direct outcome of the use of gearing. The motors run at higher speeds, and hence are very considerably lighter. It is well to place on record, as we have done once previously, the fact that the contractors who supplied the plant for this important line advocated a locomotive with geared motors in the first instance.

The American Streets.—We have received a copy of a South Wales paper, in which a short article by Mr. C. D. Phillips, of Newport, on the "Harnessing of Niagara" is given. What interests us most, however, in the article is the remarks of the author on the streets of the towns in Canada and in the States. Thus he says of Quebec: "The streets of Quebec are somewhat old-fashioned still—in fact, the worst I ever saw. All the sidewalks are laid with planks, and a drive around town in a spring calash gives one plenty of exercise. But the electric light and trams are excellent. We had a taste of the method in which everything is brought under the influence of machinery one day when, with Mr. Adam Brown, we drove to the mountainside at Hamilton. All the party—horses, carriage, and persons—were driven right into an elevator, and taken to the top of the hill. After a sojourn there we came down again by the same means of descent. Nothing that machinery can be applied to is done by hand, and the popularity of electricity for lighting and for power is almost astonishing." It is this fact, that the streets are not well laid down, nor are the roads and footways properly made up, that has made electric tramways such a great success on that side of the Atlantic. With the road unmade it is cheaper to put down two iron rails than to put down the depth of foundation and macadam required to make the road really serviceable.

The Bremer Arc Lamp.—It has been exceptionally difficult to obtain any technical information about the Bremer arc lamp, which was boomed in connection with the Paris Exhibition last year. We remember that as long ago as the meeting of the Municipal Electrical Engineers in Bradford last year we met a gentleman who wished to dispose of the patent in this country, who would not give any technical information, and conveniently ignored appointments he had made with that object. We now gather that the electrodes in connection with these arc lamps form the major portion of the invention. It seems that the carbon out of which these electrodes are made is mixed with a metallic salt, and also with another substance, which is not disclosed. The inventor claims that this other substance prevents the trouble which has arisen from the use of metallic salt previously, as it forms a flux with the scoria of the salts, which causes the same to flow off the end of the electrode. In order to produce a yellow tint, one part of fluorine with two parts of calcium salts are mixed with the carbon. In order to get a white light magnesium is added. As regards the lamp itself, two or more inclined carbons are used for both the positive and negative electrodes. This arrangement necessitates a reflector, and from the description before us we gather that the lamps will not be so simple in construction as is to be desired. A few figures as to the actual advantage of the use of the carbons in question would be of service at the present time.

Tunbridge Wells Telephones.—The competition between the new municipal telephone exchange in Tunbridge Wells and the local exchange of the National Telephone Company is exceedingly keen. This is shown not only by the great reduction made by the company in its scale of charges, but also by the correspondence in the daily Press. It is curious to note that whereas the supporters of the municipal exchange sign their letters, the supporters of the National Telephone Company hide their identity behind a *nom de plume*. In the issue of one of the Tunbridge Wells papers now before us, one supporter of the National Telephone Company requires a column and a quarter to express his views, while the other gentleman who supports the company manages to relieve his feelings with only four lines over the column. The two letters written by advocates of the municipal exchange are comparatively short in length. We can remember that when the town first took up an agitation against the National Telephone Company, the advocates of competition used to write the long letters to which exceedingly short replies, if any, were given by the National Telephone Company. As the letters before us are much too long to digest, we can only conclude that the party having the hardest case writes the longest letters, and that the supporters of the National Telephone Company in Tunbridge Wells are trying to cover up the defeat they feel to be coming by means of long letters. In a fight of this kind it is actions rather than correspondence which decide the issue, and we think that in the present case the municipal exchange has the better results to show.

The British Association.—With the near approach of the annual meeting of the British Association in Glasgow we are able to give more particulars of the programme of the meeting. This year the first provisional list of papers we have received is of those to be read in Section A. The titles we give may not be exactly the same as will appear in the final programme, but they indicate the subject on which the authors have based their communication. The following are the papers: "Sur les Effets Magnétique de la Convection Electrique," by Dr. V. Crémien; "On the Absence of Induced Currents on Starting a Convection Current," by Prof. A. Gray; "On the Zero Magnetic Field due to the Motion of a Charged Condenser," by Dr. F. T Tronton; "On the Laws of Electrolysis of Alkali Salt Solutions," by Dr. H. A. Wilson; "The Surface Tension of Mercury in Contact with Salt Solutions," by Mr. J. A. Crow; "Æpinus Atomised," by Lord Kelvin; "On Electrical Conduction through Mercury Vapour," by Prof. A. Schuster; "On New Instruments for Magnetic Work on Board Ship," by Captain Creak; "Stress and Magnetisation of Nickel and Cobalt," by Messrs. Stewart and Peek; "On a Simple Method of Observing and Comparing Hysteresis in Iron," by Dr. F. T. Tronton; "The Influence of a Magnetic Field on the Viscosity of Magnetisable Liquids," and "The Influence of a Magnetic Field on the Viscosity of Magnetisable Solids," by Prof. A. Gray. In addition to the above, the various committees of Section A will report on the work they have done during the past year.

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Storage Batteries in Central Stations.—Mr. R. F. Schuchardt contributes to the *Electrical World* a short article explaining how valuable accumulators were to the Chicago Edison Company at the end of June last. An accident involved the shutting down of the station at Harrison-street for about 40 minutes. The accident occurred at 12.25 p.m., and 15 minutes later the whole of the plant of the station was shut down. Two batteries of accumulators in sub-stations then had to take the bulk of the roads, supplying together 21,000 amperes on the average and 23,000 amperes at the maximum. This load was only required from them for 40 minutes, after which the station was again taking up the load. The batteries had been connected with the system without doing any work since they were charged the night before. Each of the batteries had a capacity of 11,200 amperes for one hour, so that they were not exhausted at the end of the discharge. The accident above shows how useful accumulators were, but it must be remembered that the accident occurred at mid-day, whereas if it had happened at night an interruption for the same length of time would have completely exhausted the accumulators. We doubt very much whether it would pay any central station to instal sufficiently heavy accumulators to serve as a stand-by in the event of a complete breakdown of the plant at night. The more reasonable safeguard is to divide the plant in the station up into independent sections, any one of which can be interrupted without causing any irregularity in the running of the remaining sections With large central stations this becomes almost an essential.

The Margate Accident.—The Board of Trade enquiry in connection with the recent tramway accident at Margate has been the cause of considerable excitement on the Margate Town Council. We gather that the Board of Trade appointed Major J. W. Pringle, R.E., to hold the enquiry, and that the inspector in question wrote to the Corporation as follows: "I propose to hold my enquiry into the recent tramcar accident in Margate on Friday and Saturday in next week, and will inform you later of the time and place, on which subject I have written to the tramway company. I do not propose to admit the general public to this enquiry, but shall have, so far as I can judge at present, no objection to representatives of the Corporation and of the Press being present, and shall be glad to take any evidence which the Corporation may be able to obtain for me from eye-witnesses of the accident." This letter raised a storm in the Council, who, one would presume, intended to advertise the enquiry as one of the attractions of the Margate season. There was even evidence in some of the speeches that the aldermen and councillors objected to Major Pringle deciding in any way how the enquiry was to be conducted. We fail to see what good the presence of the general public in the room while the enquiry was going on would do, but there is every reason why the Corporation should be represented, and all eye-witnesses to be present. We are quite sure that the Press can be relied upon to give the general public all the information they require. In fact, it is difficult, in face of the above letter, to understand what really the Town Council had to complain of.

Accidents in Mines.—The report of the Government inspectors of mines and quarries in the United Kingdom for 1900 has just been issued. The statistics given in this report are both interesting and valuable. The figures, for instance, show that the large number of deaths which occur annually in coal and metal mining are smaller in proportion to the number engaged than was the case 50 years ago. Thus in the early fifties what may be termed the underground death-rate was rather more than five out of every 1,000 people employed. The average death-rate for 1900 of the same class of work is 1·445 per 1,000. There are also signs that, due to the more careful supervision, the average death-rate is still on the decrease. Of the accidents in coalmines for the past year a large number of the fatal ones were caused by the use of naked lights where safety lamps should have been employed, or from defects in safety lamps. In one case, in which eight people lost their lives, an electric lamp was being used to illuminate a shaft in course of excavation. Instead of adding incandescent lamps when more light was required, the miners used naked candles. The result was that when gas burst up from a thin coal seam it was fired by the candles. The report urges a more strict discipline amongst the men employed, and points out that in certain districts this is particularly needed. It is curious to learn from this report that there is now actually a higher death rate from the working of open quarries than from underground workings, and it is hinted that unless the quarry owners reform their system of management, much more stringent powers will have to be given to the inspectors to enforce that discipline which is necessary.

Electric Signalling and Point Shifting.—We believe that on the Continent Messrs. Siemens and Halske have done some good work in connection with the use of electricity for shifting the points and signals on railways. The system so devised has stood the test of practical work on several lines, and is being rapidly extended. We also notice that in the *Western Electrician* of Chicago of Aug. 10 there is a good illustrated description of an electrical plant recently installed at the crossing of the St. Charles Air line and the Chicago, Madison, and Northern Railway with the Chicago Rock Island and Pacific and the Lake Shore and Michigan Southern Railways. Besides some 850 main-line trains which pass these crossings each day, there is a considerable suburban traffic both morning and evening. Most complete interlocking devices were accordingly required, and this has been secured by means of electrical apparatus designed by the Taylor Signal Company, of Buffalo. In the ordinary way some 160 working levers would be required to do the work mechanically, and these would occupy a space 70ft. long, and would require from three to four men to work them. With the electrical apparatus only 26ft. length of space is required, and it can be worked by one man, except when the rush of suburban traffic is on in the morning and evening. We gather from the description of the apparatus that a ¼-h.p. motor is used to work each semaphore, whereas for each of the points a 1-h.p. motor is required. The apparatus is worked at 100 volts from accumulators in the basement. The accumulators are of sufficient capacity to work for a number of days without recharging. The details of the system are worthy of careful study by all railway engineers.

An Electric Foe.—With the requisition of electricity, military manœuvres never approached so close to actual warfare as they did at Aldershot last week. The old and decidedly tame method of fixed-target shooting gave place on this occasion to a far more exciting and up-to-date system, which is calculated to give the troops a much better opportunity of displaying their markmanship. The "enemy" consisted of dummies which were kept in motion by means of electricity, and only appeared at unknown distances, the main object being to practice company and section commanders in directing the fire of their men at small targets at unknown ranges, and to train at such targets as would be presented on active service. The scene, in fact, was an excellent reproduction of South African conditions under present circumstances. There

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was the armoured train (built of lath and canvas) running along a valley, drawing on it as it ran its course between the hills showers of bullets, and in its rear a cavalry patrol kept it close company to blow up the line after it had passed Despite the leaden showers which rained upon them, the cavalry succeeded in fulfilling their task, an explosion, electrically managed, denoting the uprooting of the rails. Then the scene changed to a farmhouse, where the "slim Boers" charged with electricity offered but poor targets for the fire of the British. Sufficient heads, arms, and legs were shown, however, to enable good practice to be made. Another feature of the fight was the exploding of bombs by electricity to represent the firing of the dummy artillery. This was a novel experience for the men, the whole scheme being carried out by electric wires laid under the turf and controlled by an engineer in a butt. The trials proved highly successful, and after it was all over it was proved by the riddled state of the "enemy" that the "live" troops had had an excellent day's practice.

Cable Tariffs.—Mr. F. E. Hesse, the manager of the Eastern Telegraph Company, writes to the *Times* in answer to certain statements made by Mr. Henniker Heaton in the debate in the House of Commons on the second reading of the Pacific Cable Bill. In the course of this communication Mr. Hesse gives some interesting information with regard to the rates charged by the company for communication with Australia. The original cable to Australia, he says, was laid without the company receiving any Government subsidy or other privilege, and at a time when cable enterprise was considered very risky, and the prospect of a remunerative tariff was most remote. The first tariff for messages between London and Australia was £9. 9s. for 20 words, that being the system in vogue over all international lines until a word rate was adopted by the International Telegraph Conference held at St. Petersburg in 1875. The tariff was then divided by 20, which worked out at about 9s. 6d., and this was rounded up to 10s. 6d. per word. "Consequently," he continues, "Mr. Heaton's assertion that the rate, 'on pressure being brought to bear, was reduced to 10s. 6d. a word,' is entirely fallacious—as is also the statement that 'only by the Australian Government promising a large subsidy was the rate reduced to 4s. a word.' The Eastern Extension Company has never received a subsidy for reduction of tariff, the reduction to 4s. having been effected by guarantee arrangement, under which my company under took to bear one-half of the loss resulting from such reduction, and the Governments concerned bearing the other half. The tariff is now 3s. 6d. per word, and if the 'standard revenue' arranged between my company and certain of the Australian States is maintained, it will be further reduced on Jan. 1 next to 3s., and on Jan. 1, 1903 to 2s. 6d. per word. The existing rate (3s. 6d.), however is one of the lowest in the world, and works out at ·29 of a penny per 100 miles of transmission, against ·34 charged between London and New York, where an enormous traffic is transmitted, and the keenest competition prevails."

Portable Wireless Telegraphy Installation.—As an outcome of experience gained in the use of wireless telegraphy for military purposes in South Africa, Mr Marconi has designed a portable outfit especially adapted to requirements in wartime. The inconvenience caused by the absence of the poles which are essential in his system led Mr Marconi to devise a portable installation, and for some time past he has been experimenting with huge cylinders to act as receivers in lieu of the high wire. These cylinders are said to have proved to be more efficacious for the transmission of messages over short distances than the ordinary apparatus. When the electric currents are excited the waves at first oscillate very rapidly and violently, but in a few moments the vibrations die down, or become damped, in much the same way as the wire of a piano decreases its vibrations after a note has been struck. It is imperative that these vibrations should be sustained as much as possible, in order to travel over a long distance, and to ensure this end there must be a great capacity in the sending instruments. The effect of the cylinder is to render greater capacity than the ordinary aerial wire, and consequently more sustained vibration is obtained. The rear part of the automobile, which is of the Thornycroft steam motor type, is fitted up as an operating-room, containing instruments and electric batteries. Upon the roof of the car the long cylinder is placed, and the arrangements are such that, when not required, the cylinder may be laid down flat upon the roof, out of the way. The cylinder is about 25ft. in height. It is constructed of metal and thoroughly insulated, and can be raised or lowered instantaneously. The car, owing to the strength of stability of its construction, is a typical vehicle for military work where rough roads are encountered, and makes a speed of from 12 to 14 miles an hour. One special recommendation of this novel installation is that communication can be maintained while the vehicle is travelling. The maximum distance over which messages can be dispatched and received by means of it is 20 miles at present, which is taken to be generally sufficient for military purposes. The inventor, however, is still continuing his experiments with a view to increasing this distance. The cylinder performs exactly the same functions as the aerial wire, even in connection with the tuned or synchronised messages.

Electric Rock Drills.—The rivalry between compressed air and electricity as the means of driving rock drills in mines is keen. We fear that in some cases the electric drills have suffered because they have not been made sufficiently strong for the work they have to do. In an article in the *Electrical World*, Mr. G. H. Waltman takes up the question on the relative expenditure of power on the two systems. In view of the large steam plant required to drive compressed-air drills equipments, he tried to ascertain the energy actually used by driving the air compressor by means of an electric motor. The test was made in one of the large mines in Butte, Mont., where they were operating a three-drill compressor from a Thomson-Houston motor. The style of drill was one of a prominent make, size 3in., corresponding to a weight of drill of about 340lb., unmounted, the drills being practically new. The distance from the surface to one drill was 200ft., and of the other 450ft. Standard Weston measuring instruments were used. During a test of half an hour's duration with two drills in operation the air gauge showed 60lb. per square inch, the ammeter a mean average of 70 amperes, and the voltmeter 440 volts, corresponding to 30,800 watts, or 41 e.h.p., or 20·5 h.p. for each drill. The conditions under which this test was made were ideal for the drills, for the reason that one drill was only 200ft. distant and the other 450ft., which is a comparatively short air transmission line. The author adds that, besides large power consumption, steam and electric drills have the objection that it is difficult to lead the pipes round the various corners in a mine without losing pressure. The author goes on in his article to describe a special type of electric drill in which an electric motor is used as the prime mover. We regret that he does not give the power actually required by the same, as ascertained on test in the same class of rock. A statement that from 1 h.p. to 2 h.p.

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is necessary is exceedingly vague, and is not just to compressed-air systems when placed alongside of the exact figures given above. We are sure, however, that with the electric system there is a great saving in energy, and in spite of the cheap fuel which abounds in coal pits, this must have an effect. In other class of rock mining the saving will be enormous, especially where fuel is dear, as on the Rand. It is a *sine qua non*, however, that the electric drill should be substantially made and easy to keep in repair.

Electromagnets for Heavy Lifting.—In a recent paper on this subject Mr. George E. Walsh adduces some strong points in favour of the adoption of electrically-energised lifting magnets on cranes and conveyors. Although it cannot be said that their use at the present day is at all extensive, powerful electric magnets are undoubtedly of the greatest use and economy in works and mills where heavy magnetic material is constantly being handled. In steel mills, boiler-shops, rolling mills, etc., the modern and most economical procedure is to carry the plates or other material required to be moved by means of overhead conveyors equipped with these electromagnets. The magnets are simply lowered to the surface of the plates and the electric current is switched on. According to the figures supplied by the mills using electromagnets for lifting purposes, there is a distinct saving in cost of operating as well as in time. It is estimated that in speed there is a saving of from 20 to 30 per cent., and as regards labour, one man is able to operate a huge conveyor supplied with electromagnets picking up, carrying, and stacking heavy plates in much less time than several men could do the same work in the old way. Many of the objections to using electromagnets for this purpose have been removed in recent years, and it is quite possible to-day to make the magnets so powerful as to dispel all fear concerning their carrying capacity. The success of the electromagnets, however, depends upon the cost of the power supplied by the current and upon the design of the magnets. The former is not great, and the current consumption depends both upon the design of the magnet and upon the winding of the coils. The power of the magnet is always much in excess of the ordinary work required of it. Thus a magnet with a capacity of 3,000lb. should be operated on 1,000 watts, but the full power of it under favourable circumstances may be increased to 10,000lb. with the same power consumption. The designing of electromagnets is, perhaps, the most important part of the work. As a general rule the following lines should be followed: In the first place the designer must enquire how often the magnet is to be used, and what character of material is to lift. If the magnet is to be employed only occasionally, the density of the current should run high to save the cost in copper; but where the power is to be employed almost continually for heavy lifting, the current density should be lower and the initial cost in copper made heavy to save losses in the end. This is a pretty safe rule for a designer to follow for ordinary cases. In plate lifting to-day the magnet is usually constructed so that it will present a straight line to the bend of the long, thin plate, and to accomplish this groups of rectangular poles are distributed variously at points where considered the best. The best distribution of these magnets is not yet a matter of absolute certainty. It is well known by designers that much depends upon their distribution and proper arrangement. The success or failure of the magnet is often decided by their arrangement. It would appear from the latter part of Mr. Walsh's paper that the problem at the present stage of development is to be able to regulate the strength of the magnet for different kinds of work. This is a very important point, it being highly desirable in picking up a number of plates or other articles to get the maximum safety load each time, but to accomplish this the operator must be deft in shutting off and putting on the power until the plates are piled in the most serviceable manner for carrying. A skilled operator who understands his work will do twice the amount of work that a clumsy one could perform in the same time. Sometimes the strength of the magnet is regulated by means of a rheostat in series with the winding. This, however, generally increases the danger of dropping the load.

Ozone in Railway Carriages.—Our esteemed contemporary, the *Lancet*, takes up in last week's issue the question of purifying air in railway carriages. It says: "The air of a railway carriage is seldom without an objectionable characteristic; indeed, it has a peculiar smell of its own. The atmosphere may be tainted by the much-used upholstery or by varnish or oil, or the grime deposited by the engine on the seats and hat rails and in the various crevices, of which plenty are usually available for the process. Of course, the windows may be flung wide open to get as much change of air as possible, but then dust, smut, and draughts invade the compartment. It is, in fact, difficult to keep the air of a railway carriage in a satisfactory state, and how bad it gets sometimes may easily be ascertained by entering a crowded compartment at the end of a journey. Railway headache is without doubt largely to be attributed to the impure and rebreathed air of the carriage. Many contrivances exist for the ventilation of railway carriages, but the majority of them act with limited success. Nothing sweetens or freshens stale air better than ozone, and now that most of the railway companies have successfully adopted a system by which each carriage on its journey develops by means of a dynamo attached to the axle-trees its own current of electricity for lighting purposes, there is no reason why the same current should not be utilised at the same time to ozonise the air of the compartment. The quantity of ozone required is small. The result would certainly be good, since ozone has a remarkably destructive action on aerial impurities and unpleasant smells, and gives the air a degree of freshness similar to that of the sea-breeze. It rapidly overcomes the smell of stale tobacco smoke, which so persistently lingers in smoking compartments or in rooms where the upholstery is heavy or where cumbersome curtain hangings are the custom. It is reasonable to believe that if this expedient could be adopted, much of the distress and fatigue of a railway journey would disappear. It is too much to hope that the same means of maintaining air in a fresh and pure state could be adopted in omnibuses, for even the problem of satisfactorily lighting these vehicles has not yet been solved. Again, the speed of the omnibus, we imagine, would never be high enough to generate a current sufficient for lighting purposes. The Underground Railway or 'The Tube' might adopt automatic ozonisers in their trains with advantage; the suggestion might even appeal to the directors and shareholders of the former company as an alternate scheme to electric traction." The last part of our contemporary's leaderette is not well expressed. It is not the speed of the omnibus which is against the electric lighting of the same by means of a dynamo, as any necessary speed could be obtained from the wheels by means of gearing. It is rather a question of the first cost, the cost of upkeep, and the extra work entailed on the horses. We shall be much surprised if the introduction of ozone into the Metropolitan District trains would have a sufficient effect to restore the financial position of the company.

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THE ELECTRIC LIGHT AND POWER INSTALLATION AT THE LANCASHIRE COUNTY ASYLUM, PRESTWICH.

The rapidity with which the various asylums throughout the country are installing electric light and power is instructive, as showing an interest on the part of the various asylums committees, and their appreciation of the value of the use of electricity for lighting and power as conducive to the health of the patients, and also tending to greater economy in the working of these establishments. A scheme for lighting the Prestwich Asylum on a limited scale was first drawn up about 10 years ago by Mr. Charles Hopkinson, M.I.C.E., now of the firm of Hopkinsons and Talbot, Manchester and London, but for various reasons was not then proceeded with. After a lapse of six years it was again brought forward, owing to the necessity of either improving the gas illumination or superseding it by the electric light. An entirely fresh and more complete scheme was prepared by Mr. Hopkinson and approved by the Committee of Visitors, Mr. Hopkinson being appointed consulting engineer to carry it through. Application was forthwith made to the Local Government Board for a grant of £22,000, and their sanction being obtained, specifications for plant, etc., were issued, contracts let, and work started in 1899. Rapid development of the use of electricity necessitated a further grant of £5,500, being obtained in for additional generating plant, lighting, and motors.

The asylum, which is the largest in the kingdom, consists of three portions (Fig. 1). First, the main building with the usual administrative offices, superintendent's house, doctors' quarters, stores, laboratories, laundries, various workshops, eleven female and eight male wards, reception wards for both sexes—these cover an area of over 11 acres; secondly, the annexe, separated from the main by a distance of three-quarters of a mile, and covering an area of 6¾ acres, forming a smaller edition of the main, and having its own workshops and laundries; and lastly, the farm and gasworks, which, together with the church and attendants' cottages, are situated an approximately equal distance from the other two places.

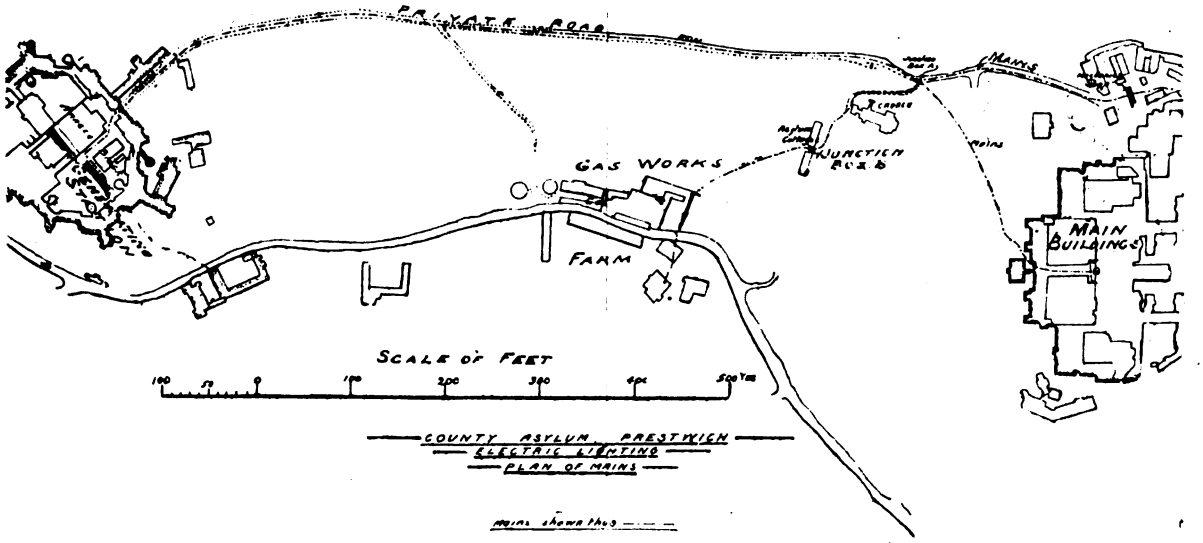

FIG. 1.—Map of Asylum.

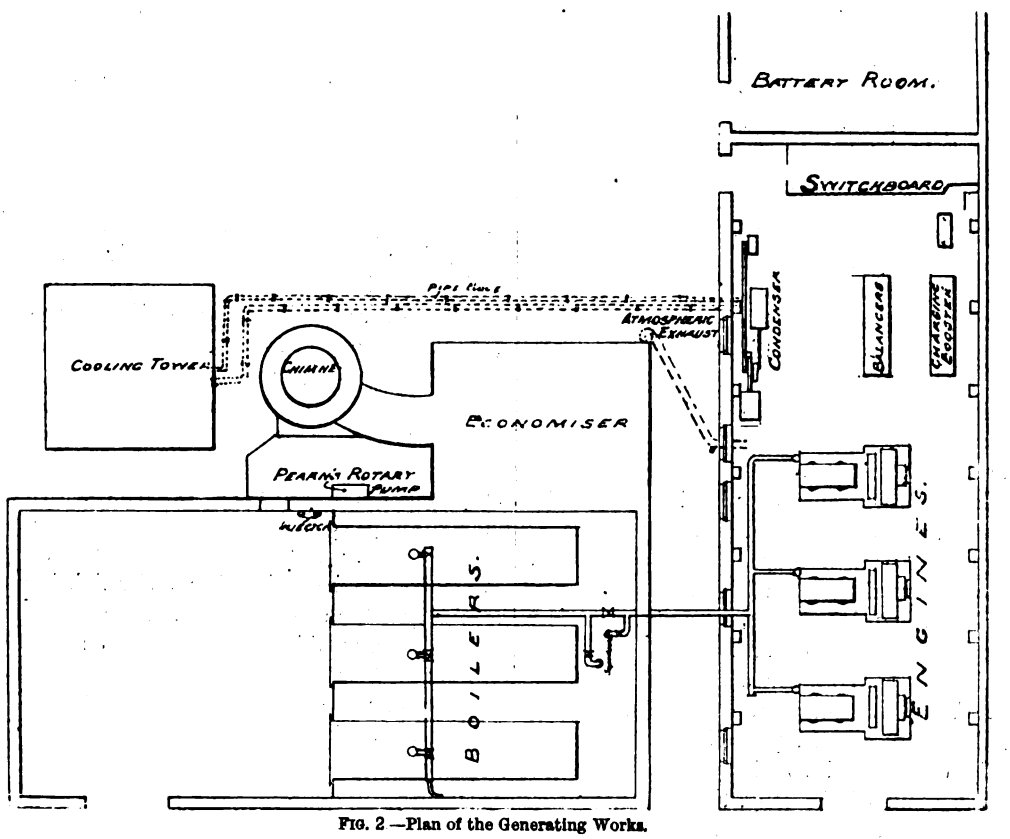

FIG. 2.—Plan of the Generating Works.

The generating buildings are situated at the annexe, which, though not the most suitable centre for distributing, was decided upon by the committee, as they had recently

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put down a new boiler plant for steam heating and laundry work, and deemed it advisable to lessen capital costs on

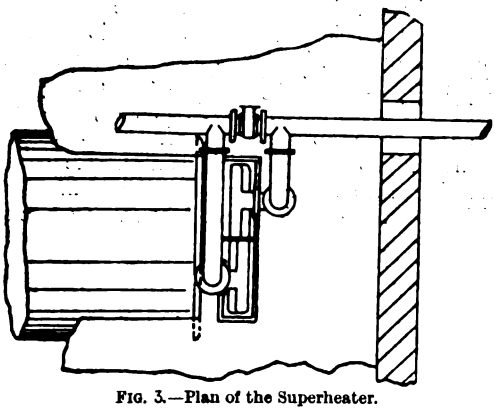

FIG. 3.—Plan of the Superheater.

the electrical installation by working their generators from that boiler plant. The general arrangement of these build-

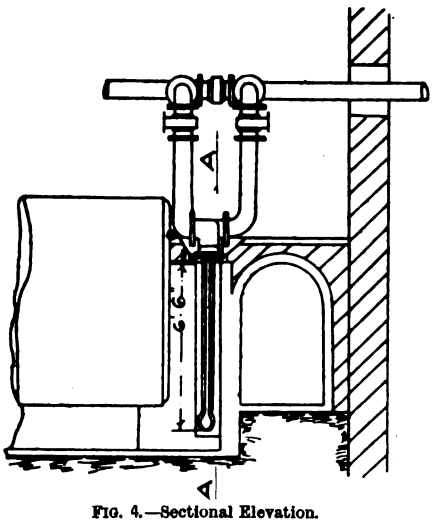

FIG. 4.—Sectional Elevation.

ings is clearly shown by the plan (Fig. 2), and consist of a boiler-house, pumproom, economiser-house, engine and accumulator house. The boiler-house is of ample size, 100ft. by 35ft., well lighted from the roof, contains three Lancashire boilers, each 30ft. by 8ft., provided with dead-weight safety valves and all necessary fittings. The working pressure is 80lb., which for laundry and heating purposes is reduced to 40lb. by a reducing valve on the branch pipe serving to those places. They are hand-fired with natural draught, the fuel used being best slack. Each boiler is connected through its stop valve to a common 9in. steam range, a branch of the same size being taken off and carried through to the main range in the engine-house. A "Musgrave" superheater (Figs. 3, 4, and 5) superheating up to 100deg. F. is placed in the back flue of the centre boiler and forms a by-pass to the above main; the arrangements of the valves on this enable all the steam to be passed through or the superheater to be cut off altogether for inspection. A thermometer pocket is placed on the outlet side, and by altering the inlet, outlet, and by-pass valves the superheat of steam passing to the engines can be varied from 0deg. to 100deg. F. with the greatest facility. The feed-water arrangement consists of two injectors, each capable of supplying any two boilers, and in the pumproom adjoining a "Pearn" pump with a "Royle" feed-water heater is used as a stand-by; they are connected to a ring main, so that interference with the boiler feed is reduced to a minimum. The injectors and pump can be supplied either from the mains of Manchester or Bury, the discharge from the condenser, or the cooling-tower tank. Adjacent to the boiler-house is the economiser

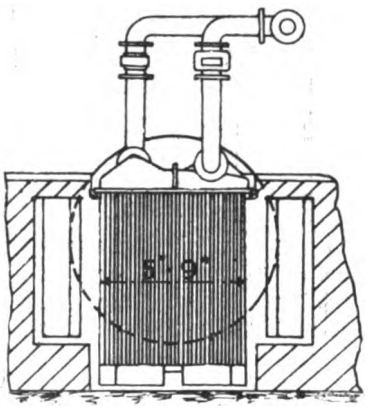

FIG. 5.—Section showing Superheater.

house containing a Green's economiser of 174 tubes, the scrapers and gear being driven by a small steam-engine and

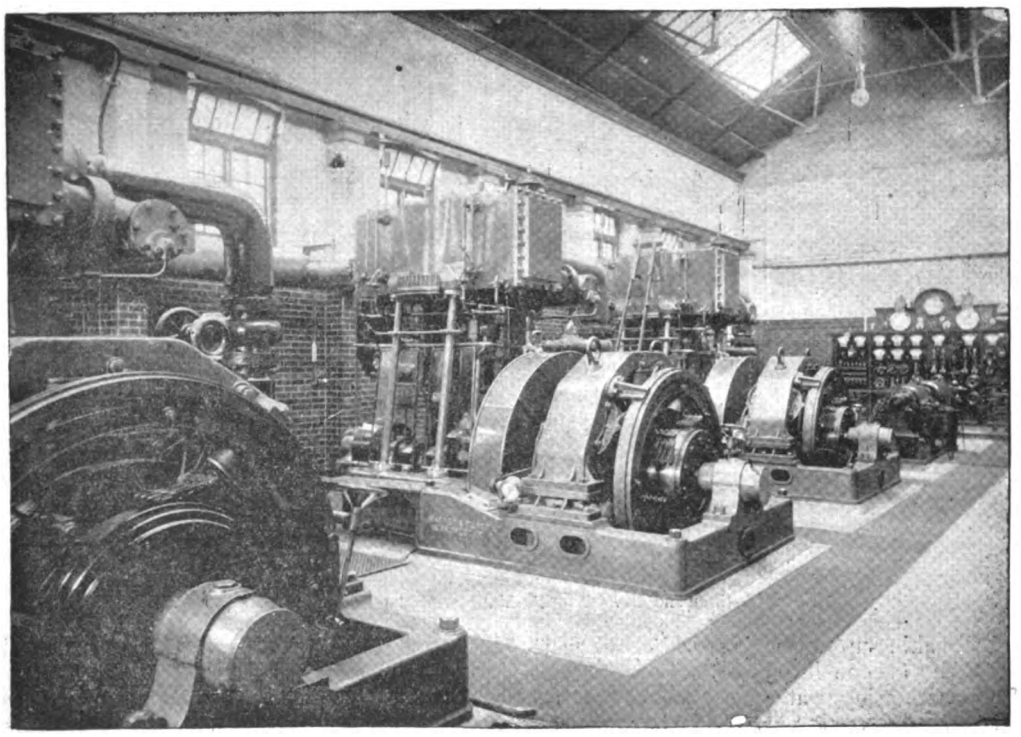

FIG. 6. View of the Engine Room.

belting. A by-pass for the flue gases is constructed, so that the economiser can be shut off at any time for inspection or cleaning. Outside, at the end of the economiser-house, is the chimney, 150ft. high, built of red brick, circular in shape, and very well proportioned; opposite to this is the natural-

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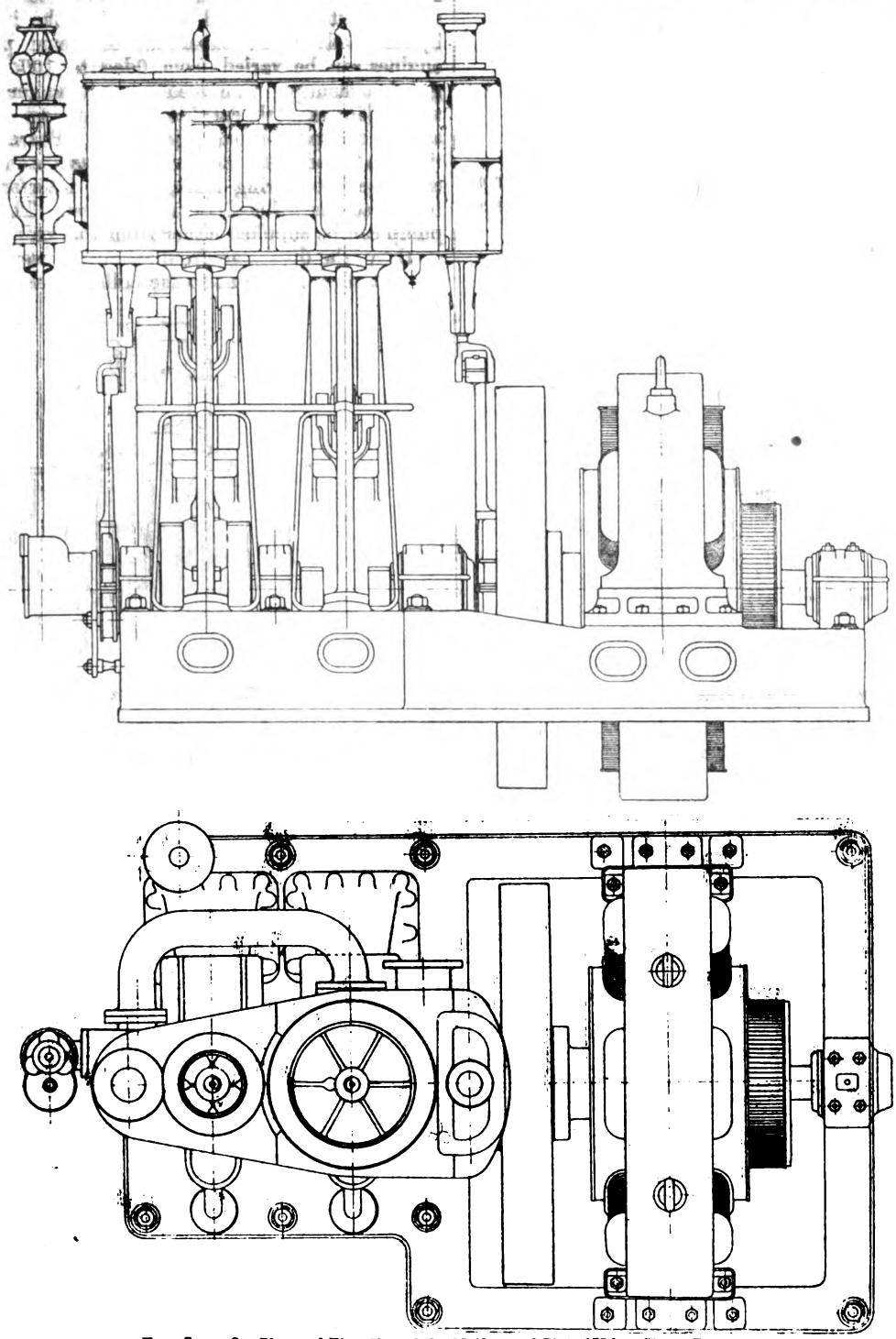
draught cooling tower, which was manufactured by the Klein Engineering Company. There are no moving parts, the condensed steam and water being lifted to a height of 27ft., and then allowed to fall through layers of wood slats, which constantly change its direction, impeding its descent, and so allowing a longer time to cool without obstructing the draught. The water falls into a tank built at the base of the tower, and having a capacity of 20,000 gallons; a branch from the main water supplies is brought into this and fitted with a ballcock, so that when the boilers are being fed from the condenser discharge pipe, all evaporation and making-up water is supplied automatically and the tank kept at one level, besides lowering the temperature of the circulating water and thus improving the vacuum. With all due respect to a certain committee who wandered round vainly looking for a cooling tower that was not a nuisance, this one, though flanked on two sides by dormitories, etc., has not caused the slightest complaint nor any excessive wear and tear of umbrellas.

The engine and accumulator house is built at right angles to the boiler-house, an open passage 8ft. in width separating the two, the 9in. steam main from the boilers to the steam range in the engine-house being carried across it. The engine-room is 80ft. by 35ft. wide, lofty and exceptionally well lighted from the roof. The walls are lined with white glazed brick, relieved by a dado of brown and chocolate to about 9ft. from the floor level and an ornamental frieze of blue brick just below the tie-rods. The floor is laid with tessellated mosaic marble, giving a very handsome appearance to the place. Large double doors are fitted at one end, so that material from outside can be delivered and picked up off the lurries by the crane and placed into position with the minimum of labour. The crane, built and supplied by Messrs. Higginbottom and Mannock, is worked by hand. It is capable of lifting a load of five tons, and travels the whole length of the room. The steam range is suspended from brackets on the boiler-house side of the engine-house, and consists of 8in. and 6in. cast-iron pipes, into which the main from the boilers is brought, and from which 4in. branches are taken and connected to the engines (Fig. 6) through large copper bends.



FIGS. 7 AND 8.—Plan and Elevation of the Mather and Platt 132-kw. Steam Dynamos.

The generating sets, three in number, were built and supplied by Messrs. Mather and Platt, Limited, and have a capacity of 132 kw. each. The engines (Figs. 7 and 8) are their

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well-known vertical marine, open-type, compound condensing, to work with superheated steam. The speed is moderate (190 revolutions per minute), and when running at that speed with steam at 80lb. they develop 220 i.h.p. They are fitted with Pickering governors, steam and vacuum gauges, and have a hand regulating cut-off gear, so that the cut-off can be adjusted to the load whilst running. All drains are run into the exhaust pipes and subjected to the same vacuum as the engine. The dynamos are of the multipolar type, rated at 132 kw., the maximum current being 280 amperes, voltage 470. The yokes are of cast steel, separate from the bed-plate, which is of the open type, and carries the engine on its extension. The armature core is carried on a spider, allowing of ample internal ventilation. The armature is wound with two layers of copper bars of ample area laid in deep slots. The winding is of the drum type. The brush-holders are carried on two complete rings bolted together, but insulated from each other and supported by lugs bolted to the magnet frame. These rings are rotated by means of a screw feed. The brushes are of carbon, and give great freedom from sparking and wear. The outer bearing is provided with ring lubrication. The exhaust pipes from each engine are provided with valves taken down under the floor to the main exhaust trench, and there jointed on a 12in. main exhaust. This is branched at one end and provided with two valves—one opening to the atmospheric exhaust, which is brought up outside the economiser-house; the other opens to the condenser through the oil separator (Fig. 9). The oil separator consists of a rectangular steel tank elevated on a brick pier and provided internally with fluted baffle plates, causing the passing steam to constantly change its direction, and so throw off the oil and water, which drop to the bottom of the tank, and on reaching a certain level (shown by a gauge mounted on the side of the separator) is drained off into a subsidiary tank situated at a lower level and under the same vacuum as the separator. The small tank is then cut off from the separator and opened to the atmosphere, when the oil and water flow away by gravity to the drains. The separator is thus kept clear at all times without impairing the vacuum. The steam on leaving the separator is condensed by a jet condenser capable of dealing with 9,000lb. of steam per hour. The air and circulating pump is driven by a 20-h.p. motor, connected to it by means of a belt and helical toothed spur reduction gear. With this arrangement a vacuum of 24in. to 26in. is easily maintained. The motor has its starting gear fixed on a small switchboard close by, on which is mounted an ammeter, double-pole switch, and maximum and minimum cut-out starting switch. The condensing water is supplied from the tank of the cooling tower, the injection chamber being fitted with an automatic vacuum-breaking valve, so that on any stoppage, if the water backs towards the engine cylinder, the vacuum is broken. The steam consumption on test of one of the main engines worked out at 31·58lb. per kilowatt-hour at full load, the cut-off being ·8 of the high-pressure cylinder, and after providing power for driving the air and circulating pumps of condenser. To deal with the steam from two engines, the condenser pumps requires to be driven faster, taking 17 units per hour instead of 13·5. The steam consumption is therefore relatively less when two sets are run at full load simultaneously.

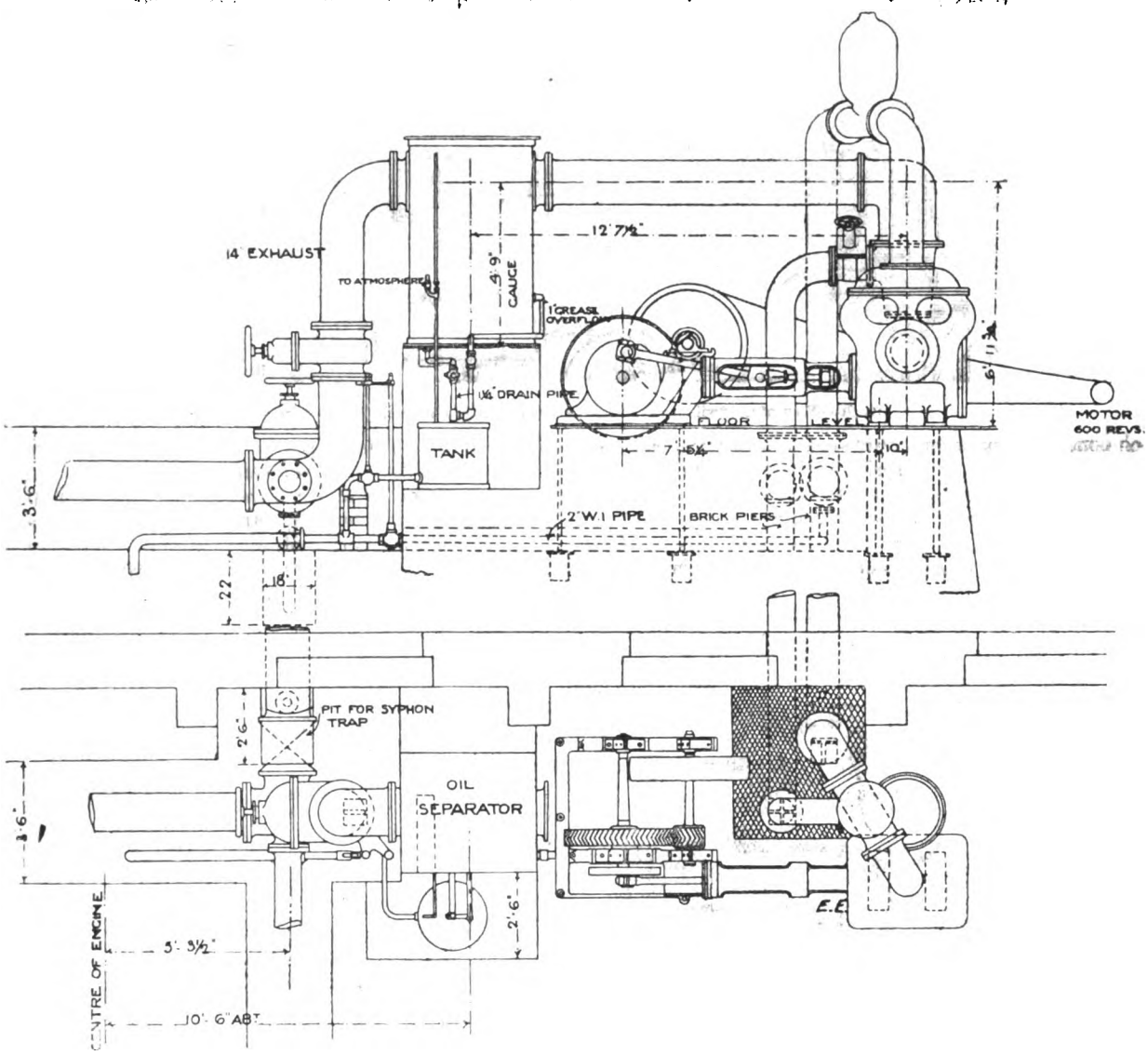

FIG. 9.—Plan and Elevation showing the Air Pump and Connection to Condenser.

The combined balancer and double boosters, together with the motor-generator for charging, are an interesting and prominent feature of the engine-room, and are well shown in the illustration (Fig. 10). They were built and supplied by the Electric Construction Company, Limited, and are of their well-known type. The balancer consists of a double-wound armature with two identical commutators in series with one another, the centre wire being taken off

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the common point of connection. This double armature revolves in a common field separately excited across the outers; each end is capable of dealing with an out-of-balance current of 200 amperes. The balancer is rigidly connected to and forms the motive power of the booster, which consists of another double-ended armature, each end of which is connected in series with the winding on one limb of the field magnets, and with one outer of the main asylum lighting mains. When driven at a speed of about 900 revolutions there is a boost on each side of from 0 to 30 volts, regulating automatically with the current on circuit, the maximum output being 400 amperes on each outer. This voltage can also be varied on regulating the speed of the balancer by inserting resistance in its field circuit. The motor-generator for charging consists of a separately-excited motor at 460 volts coupled to a separately-excited generator mounted on one bed-plate, giving an E.M.F. of 200 volts in open circuit and 150 volts with 150 amperes. The voltage is regulated by regulating the speed and the fields of both motor and generator. Nearer the switchboard is placed a small milking booster, consisting of a 2-h.p. enclosed "Lundell" motor coupled to a "Lundell" generator capable of giving an E.M.F. of six volts and 200 amperes. This is used for charging up and bringing to a normal condition any sick cells in the battery.

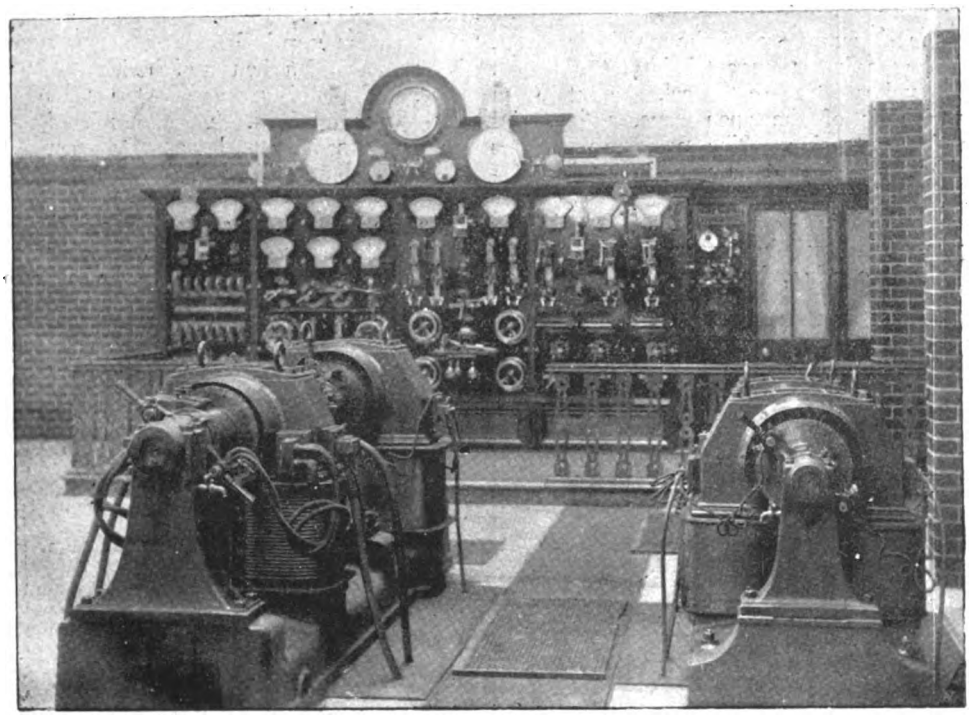

FIG. 10.—View of the Switchboard, with the Balancers and Boosters in the Foreground.

The next item of interest, and one of the most important, is the switchboard, built by Mr. Bertram Thomas, of Cornbrook Telegraph Works, Manchester. The board, which is well shown in the photograph, is of handsome appearance, and its only fault is that it is, if anything, too compact, which, however, is not a disadvantage in a station where the staff is limited, and it is important that in emergencies the necessary switching arrangements can be readily got at and made in the minimum of time. It consists of five slate panels erected on an iron framework mounted in teak, and surmounted by a pediment containing the clock, two large

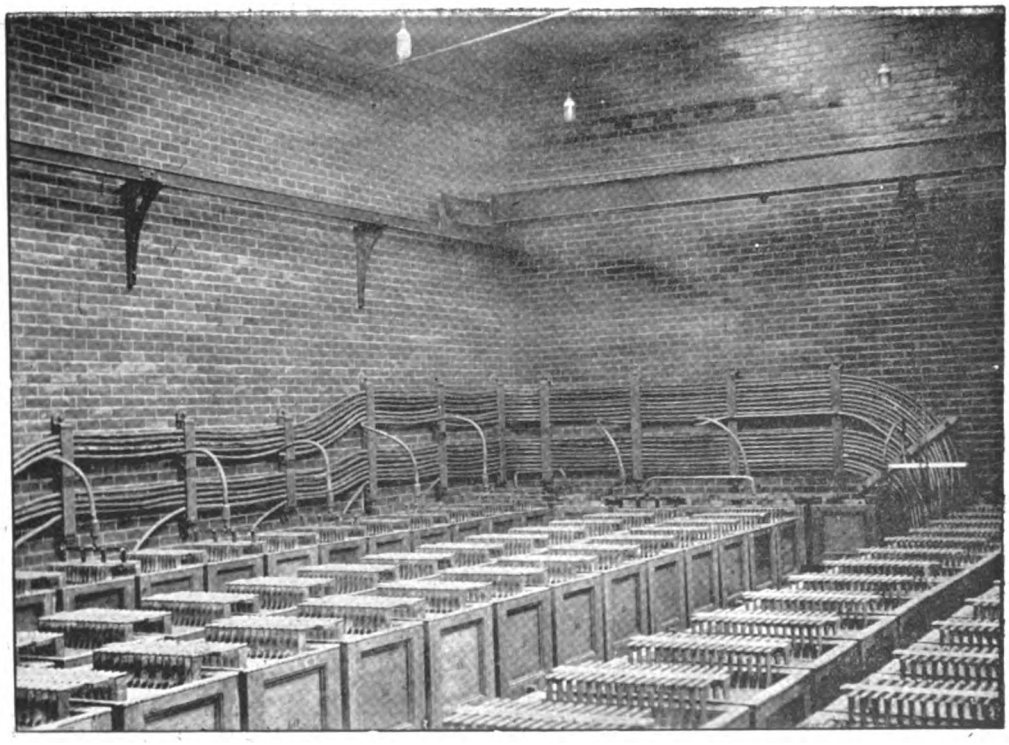

FIG. 11.—The Accumulators.

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18in. dial "Kelvin" voltmeters reading the 'bus-bar voltage on each side of the system, two smaller voltmeters—one reading to 50 volts for boosting purposes, the other reading to 200—the additional voltage for charging. There are also three two-light and one single-light brackets for lighting the board; the centre one of these is a pilot circuit, and can be switched on to any generator, this giving an approximate idea of its voltage before paralleling: the others are wired partly off the battery and partly off the 'bus bars. By this means no breakdown can put the board in darkness at a time when light is most needed. The first panels on the right facing the board belong to the generators, and contain ammeters for each machine, a "Kelvin" electrostatic voltmeter reading to 500, and multiple switch key to put it on any machine, three maximum and minimum cut-outs and switches combined, three shunt regulating switches, three shunt exciting switches with carbon breaks interlocked, with quick double-break switches on the negative lead. The next panel is for the battery, and on it are two ammeters reading to 600 amperes, a "Kelvin" electrostatic voltmeter reading to 700 volts, four maximum cut-out switches (two being for paralleling battery on 'bus bars, and two for booster discharge from

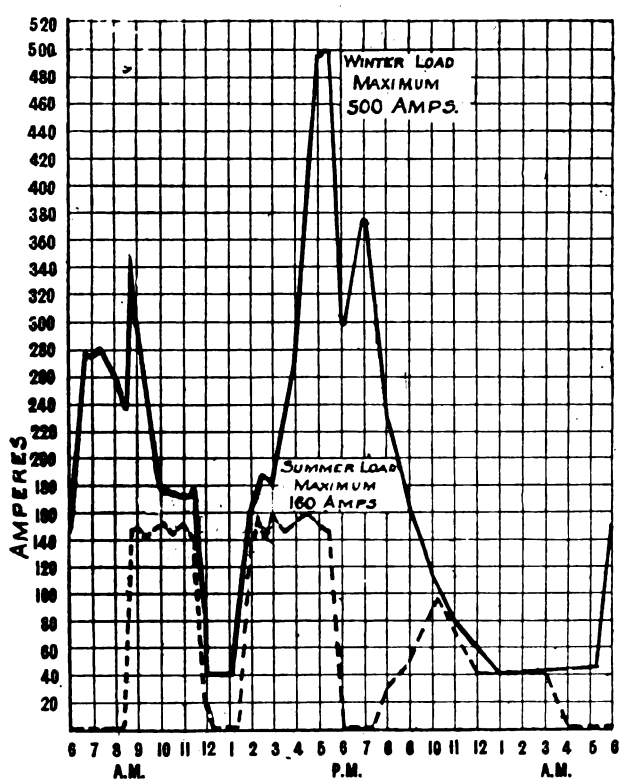

FIG. 12.—Typical Load Curves taken at the Prestwich Asylum.

battery to main asylum), a quick-break single-pole switch belonging to the charging generator and interlocked with one of the former switches, an automatic cut in and out switching in the charging generator when its voltage exceeds that of the battery and cutting it out if from any means it falls below. There are also four hand-wheels and indicators operating the regulating switches, mounted on separate panels behind the board. The top pair regulate the battery to the 'bus-bar voltage, and the lower pair add extra cells for the boost to the main asylum. The fourth panel, controlling the balancer and boosters, has two ammeters to indicate the current boosted from 'bus bars to the main asylum; one centre-wire ammeter reading to 300 amperes on outer side of zero; one ammeter reading starting current of charging motor, an earthing ammeter reading to 10 amperes either way in series with a removable earthing plug and fuse, which last is in parallel with a 16-c.p. lamp. The circular switch on the right is a combined starting, shunt exciting and regulating for the motor of charging generator, a similar one on the left being for the balancer. Immediately above these are the centre-wire switches of the balancer and battery respectively, this latter being interlocked with the starting switch of the motor-generator, necessitating the breaking of the battery centre before starting to charge. Two maximum cut-out switches couple the positive outers of the balancer and charging motor to the bays, a British Thomson-Houston magnetic cut-out being also in circuit on the negative side of the balancer. The double-pole, single-break, three-way change-over switch in the centre controls the main asylum load, and when over to the right that load is on the 'bus bars, in the middle position on boosted battery, and over to the left in circuit with the main boosters. The two main detachable fuses are in series with the last named and serve as a quick means of disconnecting the load from them, which, if left on, and the balancer broke down, would cause the boosters to immediately reverse and to run till they burst if not disconnected. The small shunt regulating switch in this panel regulates the field of the charging generator. The last panel is used for distributing feeders only, the two ammeters on it being for the annexe lighting. The three horizontal bars immediately below being for the same purpose, the fuses are of the switch type, and act as such on the outers only. The "Kelvin" electrostatic voltmeter is a pilot, and reads the voltage at the main asylum feeding point. The vertical 'bus bars below are the boosted mains, and have a spare circuit on them for any extension that may be required. All parts of different polarity are carefully screened from each other by polished slate partitions. The small panel near the telephone apparatus is used for controlling the "milker" and its motor, there being on it an ampere-meter reading to 200 amperes, a single-pole quick-break switch, and a throw-over switch for putting the motor on either side of the system for balancing purposes; below this is a Cutler-Hammer starting and regulating switch. A small eight-volt pilot lamp mounted on above gives an indication of the generator voltage. By the side of this board is also mounted a plug board for three circuits and a light-reducing switch. This controls a pilot lamp fixed opposite each engine, the dimming of which conveys to the driver the variation of the cut-off required, or serves as an approximate guide for starting or stopping. Ample space is allowed behind the board, and here are mounted the British Thomson-Houston two-wire wattmeters for each machine, two Kelvin recording ammeters on charge and discharge of battery, two British Thomson-Houston three-wire wattmeters on the annexe and main lighting circuits respectively. The regulating switches of the battery are fixed on slate panels mounted on an iron framework, and are connected to the front of the board by steel tubes, which allow for any slight variation out of centre. The cables from all machines, etc., are carried under the floor in a cable trench covered with chequered steel plates, and are brought up behind the board, the floor plates being movable in sections to allow free access to any part of the cables.

Before leaving the engine-room, some of the minor features may be mentioned. Polished and pitch-pine cupboards are provided for workmen's clothes, light stores, and sundries; oil storage tanks with pumps attached and having each a float showing quantity of oil therein, and with automatic seal—these are made by the Richter Manufacturing Company; the oil-filter, of 40 gallons capacity, is of Boult Bros'. well-known type, with steam circulation. The ventilation of the engine-room is improved by a 24in. fan with enclosed motor, made by Messrs. John Gibbs and Son, of Liverpool, situated in the gable end of the roof and extracting hot air. A portable hand-vice and bench is provided for small repairs, etc. The artificial lighting is by means of four "Stewart" enclosed arcs, plugs and portable lamps being provided at necessary points. Telephonic communication is provided to all parts of the asylum.

The battery-room (Fig. 11) is a continuation of the main building, but separated from the engine-room by a 9in. party wall; it is of the same height and width, but only 50ft. long. It is finished off in the same style as the engine-house, except that the floor is laid with acid-proof cement, and all ironwork painted with anti-sulphuric paint. The cells (250 in number) were manufactured and supplied by the Chloride Electrical Storage Syndicate, and have a capacity of 1,300 ampere-hours. They are carried in two tiers on a pitch-pine framework erected on York stone

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These are of the R. L. type, in lead-lined wood boxes, the sections of adjoining cells being burnt together. The regulating leads are ·5in. section lead-covered cables carried on brackets, bolted to the walls, and go through the party wall to the regulating switches in Doulton casing, this being sealed up with bitumen to prevent the egress of acid vapour. A water supply is laid on for filling up and facilitating cleaning. There is a light travelling crane, capable of lifting one ton, which is a great convenience. The artificial lighting is by means of 15 32-c.p. lamps in special acid-proof fittings, two plugs and hand lamps being provided for closer inspection of any cell. The leads from the milker consist of two flexible copper strips, ·2in. in section, braided and compounded, brass jaws or grips being sweated on to the ends of these so that they can be readily fixed to cells in any part of the battery.

The lighting generally is carried out on the distributing board system. For the annexe, six three-wire lead-covered and armoured cables are run underground to various feeding points, from which interior mains are run to the different wards. The power at present installed at the annexe is as follows: one 15-h.p. enclosed motor for driving laundry machinery, a small combined three-throw pump and motor lifting the condensed water from the heating and drying apparatus for use in the laundry again (this is controlled automatically by means of a ball and float connected by the quantity of water to be lifted). Two 42in. electric fans for removing steam and hot air from the washing-houses have been erected, and a combined motor and hydro extractor with safety doors specially designed is on order, and will shortly be installed. The supply to the main asylum is by ·49, ·25, ·49 cables laid in bitumen and run for half a mile to a main four-way cast-iron feeder box sunk in the ground. Here it is sub-divided through connecting bars, a ·32, ·15, ·32 being run to a main board situated in the administrative block; a ·12, ·06, ·12 to a main board at the workshops; and a ·06, ·028, ·06 to a smaller three-way main box from which is fed the church, the attendants' cottages, the farm, and gasworks. All these mains and boxes were supplied and laid by Messrs. Callender and Co. on their solid system. The main board at the administrative block is in a fairly central position for feeding, and consists of three slate panels mounted in teak, the various circuits being taken off through detachable duplex fuses. A Weston voltmeter reading on either side and ammeter are provided, the latter being used by inserting connecting leads in the place of the fuse on any circuit. The wiring is carried out on three-wire principles throughout, so that no ward can be left in total darkness by failure of one side of the system. Pilot circuits for the all-night lighting are run where necessary. The dining-hall, recreation hall, and sewing-room are lit by means of enclosed arcs, 14 of these being used for this purpose. Various small electric fans are being installed in the wards where supplementary ventilation is needed.

The distributing board at the workshops is of a type similar to the one before described, but with eight circuits only, and is used for feeding the mechanics', joiners', brewery, laundries, and other shops with their light and power. A 15-h.p. motor is fixed in the mechanics' shop, driving the line shafting. In the brewery a 5-h.p. for the malt mill and a 3½ h.p. for the hoist are used. The joiners' have two 5-h.p. driving line shafting and circular saw respectively, a 3½-h.p. on the planing machine and a small blower feeding the blacksmith fires and ventilating the shop by having its intake inside. The laundry machinery is driven by a 15-h.p. motor geared down by spur gearing to a line shaft running underground, and to which all the machines are belted. An electrically-driven hydro similar to the one before referred to is also on order for this department. In the end wall is fixed a 42in. fan extracting steam, etc. In the female laundry a 3½-h.p. motor is used for driving the mangles, and another 42in. fan drives hot air in for vaporising the steam at the washing-tubs. Electric irons are on trial in the ironing-room, and if satisfactory their use will be extended. The mortar mill is driven by a 15-h.p. enclosed motor, reduced by belting to a speed of 60 revolutions. The motors in operation at the farm consist of a 15-h.p., driving the bone-crushing and corn-grinding machines, a 3½-h.p. at the dairy, driving the butter-making and milk-separator machinery. In the shippons a 2-h.p. is used for chaff-cutting, and a ½-h.p., fitted with a reversible switch, for either turnip slicing or fingering. All these motors are of the enclosed type, the 15-h.p. being supplied by Messrs. Mather and Platt, Limited, the 5-h.p. and 3½-h.p. by the British Westinghouse Company. They are provided with maximum and minimum cut-outs and starters.

The whole of the lighting amounts to an equivalent of 14,000 8-c.p. lamps, and the motors take another 140 h.p. The main asylum, farm, church, etc., was wired by the Alliance Electrical Company and the annexe by Messrs. Drake and Gorham, Limited. A new hospital which is being built will require another 500 to 600 lamps. The wiring for these and the installation of motors, etc., is being carried out by the asylum staff, who have also designed and erected the buildings in connection with the installation. Two load curves obtained at the above works are given in Fig. 12.

The work throughout has been personally supervised by Mr. H. A. Wood, A.M.I.E.E., who has acted as assistant to Mr. C. Hopkinson, and clerk of works for the Committee of Visitors.

THE CENTRAL-STATION SUPERINTENDENT.

BY J. H. VAIL.

The following is the prize-winning paper in the competition on the subject organised by the *Electrical Review* of New York:

Coincident with the remarkable industrial development of electric lighting has grown the demand for men well versed in the art, men who have the necessary practical skill and technical knowledge, combined with the other attributes that make them competent to fill the more advanced positions. The kind of skill and knowledge necessary requires a broader familiarity with the several branches of engineering than is usually requisite to fit one for a similar position in other manufacturing lines. The superintendent of an electric lighting system has the oversight of so varied an assortment of modern appliances and operating methods that it is manifest that he should be unusually well acquainted with the characteristics and modes of operation of the improved types of steam and electrical equipments, and also have a thorough knowledge of underground and overhead systems of distribution. With the rapid growth of electric lighting there has been a corresponding advance in all the types of apparatus that are combined in a central-station plant of the first class, while the increasing uses of current for lighting and motive power have so broadened the field as to involve the production and distribution of current of different characteristics, necessitating a very thorough acquaintance with the exact value of each type or system. Unless one is personally acquainted with the many duties required of the superintendent, it is difficult to appreciate the numerous qualifications of a high order required. The intensity of application and the strenuous work frequently required from the superintendent are only rarely understood by the business management; the man's ability is judged according to the results he produces, and it is seldom that time is given to analyse the details whereby the results are obtained. It is expected that the man selected for so important a position will be of good moral character and strict integrity, therefore we will not dwell upon these points. Executive ability should be the first requirement of a superintendent, for the reason that if he has practical experience and technical knowledge without capacity for organisation and management, he cannot successfully regulate the duties of the operating or constructing force. His value to his company depends not alone on his personal knowledge of the various branches of his profession, any of which he may be personally competent to handle himself, but he must be capable of selecting and surrounding himself with a corps of competent subordinates and of so supervising and directing their labours that he obtains from them superior results with the least expenditure of his own vital energy. Many who have technical knowledge and practical experience yet lack executive ability, and are, therefore,

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incapable of supervising or directing the work of others. His own practical experience, his knowledge of human nature, and a keen determination of the abilities of individual workmen will quickly enable him to measure the capacity of each subordinate and to decide to what limit each man can be depended upon. He thus proves his ability to perfect a working organisation and system of operation that will, in a large degree, leave him free from anxiety about details. In such an organisation each man knows when and in what manner his duties are to be performed, and emergencies are met and overcome with the least difficulty. Favouritism and political influence are responsible for placing many incompetent men in advanced positions. The writer has personal knowledge of a man being placed as superintendent of an important station through favouritism. This man had no executive capacity, only a superficial theoretical knowledge, no technical education, and absolutely no practical experience. His instructions to subordinates were a constant subject of ridicule. His mistakes cost thousands of dollars, and yet, because of favouritism, he was for a long time retained while competent and faithful subordinates were discharged on his recommendation. It cannot be a subject for wonder that under such maladministration a well-equipped station is not successful.

Practical experience should be the second essential requirement of the superintendent. He should be a man of proved capacity in this direction; which qualification is best obtained by actual labour in the ranks, or by long familiarity with accurate observation of methods of manipulation. An apprenticeship served in a good general machine works will be time well spent by the man who hopes to advance in this branch of electric lighting. He should, primarily, have a genius for mechanical pursuits, and in the course of a reasonable term of service as a private he learns how properly to apply his technical training. He perceives how to analyse his theoretical knowledge and correctly apply it to practical work. He thus combines theory and technical training with practical experience, and becomes a master workman in the true sense. This kind of training develops quick perception, and in emergencies affords self-reliance and resourcefulness to decide promptly between methods and select wisely the best means. The superintendent is recognised by both his superiors and subordinates as a master workman in his profession. Having attained this standard, he has established a confidence in his ability that is not easily disturbed. It is possible to become well trained in technical knowledge even while in daily association with working conditions, and by many it is believed that technical training is thus more readily acquired, as practice and study are simultaneous. An experience of no little value is that to be obtained through the students' courses arranged by many of the large electrical manufacturing companies. This work is of a practical character, and, when diligently followed by an observant man, affords him a most excellent knowledge of the various types of generators and appurtenances and their characteristics. This course of training cannot fail to be highly appreciated in after years by those who have been so fortunate as to obtain it. It is but one of the many stepping stones that assist in equipping a man for his chosen work, and it is here mentioned as a help, but not of vital importance.

Technical knowledge should be the third requirement of the superintendent. He should have the training of a mechanical and electrical engineer. The increasing complexity of the several mechanisms that are combined in the equipment of a large central lighting station, and the diversity of the systems of transmission, distribution, and methods of utilisation of electric energy, all require for their proper supervision a well-trained, active, and energetic mind. A thorough technical education provides the superintendent with a ground-work upon which he builds his career of usefulness. The superintendent must be well read in the technical literature relating to the several branches of his work. He requires to be well informed and up-to-date on all matters pertaining not only to improvements in the several types of apparatus or mechanism, but also in the best methods of securing results. The valuable reviews of current technical literature afford opportunities for keeping pace with the most advanced methods, as well as indicating salient points worthy of careful analysis.

The superintendent should be a thinker, as the work frequently demanded of him will require all his skill and resourcefulness to meet and control the difficulties. How often do we find that the real difficulties to be overcome are those which are brought by the introduction of combination of conditions which the ordinary rules have not anticipated? And very often the actual working conditions are difficult of precise determination. There has been a marked advance in recent years in technical engineering education, and there is yet much to be desired in the direction of bringing the educational courses into closer conformity with actual working conditions. It is believed that the time is not far distant when the student will, during his educational course, obtain his theoretical and technical instruction combined with actual working conditions. He will then be prepared to start out upon his business career at a higher level, and will add from three to five years' time to his earning career.

It cannot be expected that the superintendent will be learned in much of the law, yet it is quite important that he should have a fair knowledge of the laws governing the employment of labour; the rights of his company under its charter and of the city ordinances; the liability of his company, as a common carrier, to serve the public; the liability of his company because of accidents to employés or to the public. He should be well informed in the preparation of contracts and specifications. With a fair knowledge of the salient points he will the better understand how to avoid legal entanglements pertaining to his department of the business.

The superintendent should possess a thorough knowledge of human nature and the peculiarities of men, that he may wisely select his subordinates with a view to the particular ability of each individual, and he should always have men ready in the line of promotion. The superintendent who has laboured in the ranks as a private has obtained a valuable knowledge of the characteristics and environment of the workman. He not only knows the worth of each class of labour, but he has the prestige of having such a thorough practical knowledge of the details of the business that his superiority is readily recognised by his subordinates. He will readily concede that the most humble subordinate may offer a valuable suggestion, and he will appreciate that the work done by the intelligent individual quickens his observation. Therefore consultation with subordinates who are in daily contact with the several features of operation will give the superintendent the benefit of others personal experience, and will encourage the employé to study more closely the particular features of his own work. It is not a difficult matter to select a force of men which is not only competent, but, if treated with proper consideration, can be relied upon to co operate with the superintendent in attaining his standard of excellence The superintendent cannot afford to retain incompetent, discontented, or disloyal men, or those of bad character. Favouritism should not exist, and an employé with a political pull will sooner or later cause trouble. It will be of advantage to the superintendent to come in frequent personal contact with every employé of his department. The happy faculty of knowing each employé personally not only gives the superintendent a knowledge of the personal character of his subordinates, but it tends to the establishment of a higher *esprit de corps* than can otherwise be attained. Strict integrity, justice, and square dealing should be firmly established between the superintendent and his subordinates. The efficiency of the operating force can be vastly improved by using reasonable efforts to elevate the character and improve the conditions of employés.

The rules necessary for the regulation of the business should be stated in plain language, to the end that exactly what is required of him will be conveyed to the employé, and the orders must be so definitely expressed that execution is not difficult. No business of the magnitude of a large lighting station can be conducted without careful attention to the discipline of the

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force; where proper thought precedes the establishment of regulations strict attention should be given to their enforcement. Regular employés should not be dismissed or suspended except for sufficient cause, and, in any event, the delinquent should be given a hearing and allowed a fair opportunity to state his side of the case. Where leniency is allowable, it will, if applied with discrimination, no doubt instil in the man a higher sense of duty. When vacancies occur, or when new positions are created, then it is that promotions should be made as a recognition of loyalty and faithful service. This affords one of the best opportunities of proving the appreciation of faithful service. When promotions are not possible a kindly word of appreciation will be highly treasured by the recipient.

METHODS OF SAFETY FOR THE OVERHEAD ELECTRIC TROLLEY SYSTEM.*

BY EDWARD MANVILLE.

The rapid growth in this country of late years of tramway systems operated electrically on the overhead trolley system has drawn public attention to its merits and disadvantages, and the Corporation of Leicester having recently determined to instal this system for the Leicester tramways, makes this occasion a peculiarly appropriate one for the consideration of such a subject by the association. The limits of this paper will not permit of a consideration of the whole of this somewhat extensive subject, and the author therefore proposes to confine himself to the methods which may be adopted for ensuring safety to the public when using the tramways or the streets in which they are laid. For the convenient consideration of this paper it is divided into two parts: (1) precautions to be taken to ensure solid construction; (2) methods of ensuring safety should a breakdown occur.

Precautions to be Taken to Ensure Solid Construction.

Obviously it is most important that the overhead trolley system, when installed, should be of such solid construction and excellence of design that with a comparatively limited amount of inspection there shall be the smallest possible liability to breakage of the "live" conductors, or of parts carrying these, and of the entanglement of the trolley wheel with the "live" conductor, the guard wires, and their fittings. In the first installations made on this system abroad both the trolley wire and the fittings supporting it were very light, and liable to fracture when subjected to comparatively small extra strains. It was originally the custom to use 1/0 B. & S. trolley wire of hard copper or phosphor bronze, having usually a tensile strength of about 24 tons per square inch section; consequently a trolley wire of the size mentioned would part when subjected to a strain of 4,560lb. The numerous accidents occurring from the use of so small a wire, and the fittings proportionate to its size, gradually caused the introduction of larger sizes of trolley wire, 1/0 wire being replaced by 2/0, having a breaking strain of about 5,230lb., and this size being itself superseded in the most modern installations by 3/0 wire, having a breaking strength of 6,580lb. As the wire used was increased in section, so the fittings supporting it were increased in size and strength, until the 3/0 wire, as installed to-day, has become an exceedingly strong and substantial structure. No doubt the length of time that has elapsed in the adoption of the heavier wires, having regard to the accidents that undoubtedly occurred with the lighter ones, has been due to the fact that, especially in this country, it was believed that the heavier wires and fittings would be more perceptible to the eye than those of lighter character, but the actual installations of those that exist show conclusively that at the height above the road level which they occupy small differences in size are quite imperceptible, and certainly do not, so far as that reason is concerned, warrant the sacrifice of anything in the shape of the extra safety secured. The provision of the heavier trolley wire does not necessarily mean a perceptible increase in the cost of the tramway system, since the extra copper thus put into the trolley wire effects a material saving in the cost of the insulated distributing wires laid underground. On the table are samples of the earlier type of fittings with single 0 trolley wire, as originally used, and a sample of 3/0 trolley wire with one of the most modern type of fittings used for supporting it. In addition to making the trolley wire and the fittings directly supporting it of ample strength, it is, of course, equally necessary that the further fittings required to attach these to the bracket arms or the cross suspension wires—if used—should be of equally substantial design, and the brackets themselves should be proportioned to have an ample margin of strength to withstand strains that may be thrown upon them through the trolley wire.

In the gradual growth from the 1/0 to the 3/0 construction there has been a tendency, whilst adapting the heavier trolley wire and fittings, to consider that the minor details used in the lighter construction were sufficiently strong for the heavier construction. For instance, ⅝in. bolts, which were universally used for the light insulating ears, are quite unsuitable for the heavier ears, and it is to be particularly noted that for this purpose no bolts less than ¾in. in diameter, and of mild steel, should be used. In the same way the fittings on the steel street standards themselves, where used for the attachment of cross suspension wires, or for the securing of the bracket arms to the poles, should be made of no less reliable material than malleable iron castings; although one sees in a good many instances cast-iron fittings of this description used for the purpose, as formerly. To ensure effective insulation of the trolley wire, the insulation should be double throughout. In the case of cross suspensions, the insulated bolt carrying the ear to which the trolley wire is attached is the first insulation; the second insulation forming a portion of the straining apparatus used to take up the sag from the cross span. In the case of bracket-arm suspension, the first insulation, as before, should be the insulated bolt supporting the ear, and the second a layer of insulating material between the clamp to which the hanger is attached and the bracket arm itself; but where flexible suspension is used in connection with a bracket arm in place of the rigid suspension, the same arrangement of double insulation should be used, as in the case of the span-wire construction.

Next only in importance to the strength of construction of the trolley wire arrangements are the methods which should be adopted to ensure as far as possible the absence of contacts between falling telephone or telegraph wires and the trolley wire. This is usually

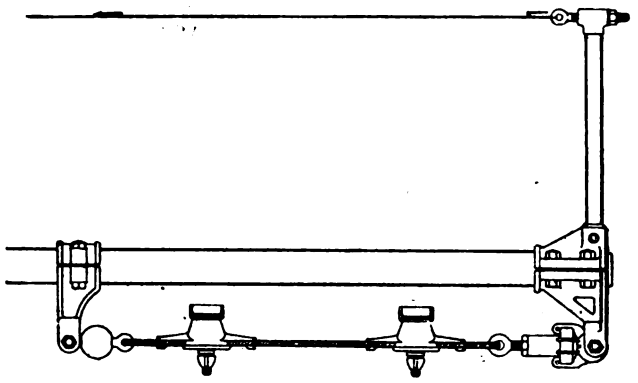

Fig. 1.

effected by placing guard wires parallel to and above the trolley wire, so arranged that there may be but little chance of falling telephone or telegraph wires evading the guard wires, and thus coming into contact with the trolley wire. The guard wire should be proportionately quite as substantially supported as the trolley wire, and should be of such section that the accidental contact of a falling wire simultaneously with the guard wire and the trolley wire will ensure the operation of the circuit breakers and other safety devices used, so that the current may be instantly cut off on that section of the trolley wire on which the accident occurs. The guard wires should be of galvanised stranded steel, of not less than ⅜in. in diameter, and supported in a thoroughly substantial manner. Fig. 1 shows the most approved form of flexible bracket-arm suspension now being installed on the straight lines; and Fig. 2 modifications of the same form of suspension when used on curves. In both cases the supports for the guard wires are also shown. In the latter case—*i.e.*, the method of construction for curve work—it will be noted that the fittings are very much strengthened as compared with those used on

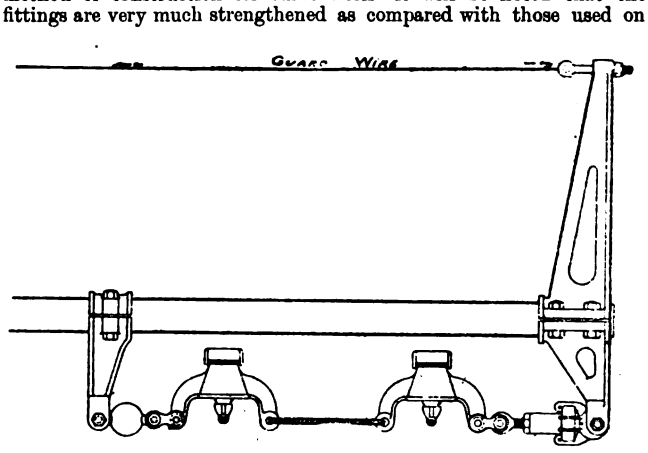

Fig. 2.

straight lines, which used not to be the case in earlier installations. Samples of both types of suspensions are shown, and likewise samples of the better forms of fittings for use in connection with the guard wire.

Arrangement of Guard Wire.

To ensure the better protection of overhead telegraph and telephone wires from contact with the trolley wire, great consideration has been given to the best methods of arrangement of the guard wires in reference to their position to the trolley wire, and the latest regulations issued by the Post Office authorities in this respect probably represent the best arrangements.

(*a*) *Telegraph or Telephone Wires Crossing above Trolley Wires.*—(1) When there is only a single trolley wire or two trolley wires not more than 12in. apart, two guard wires should be erected, as shown in Figs. 3 and 4; (2) when trolley wires are more than 12in. apart, and do not exceed 3ft., the guard wires should be increased to three in number, as shown in Fig. 5; (3) when the distance separating the trolley wire exceeds 3ft., each wire should be separately guarded, as shown in Fig. 6.

* Paper read before the annual meeting of the Incorporated Association of Municipal and County Engineers, at Leicester.

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(b) Telegraph or Telephone Wires Parallel to Trolley Wires.—In all cases in which telegraph or telephone wires and trolley wires are parallel, and within 30ft. of one another, suitable hooks should be fixed on the arm, stay, or on the span wire to support the guard wires, which should be erected on similar lines to the above. This is shown in Figs. 7, 8, and 9. These last arrangements, of course, refer only to a case where the telegraph or telephone wires are at a higher elevation than the trolley wires, so that broken wire may be blown transversely across a trolley wire. Where, however, the telegraph or telephone wires are at or about the same height as the trolley wire, when there would be no possibility of this happening, the guard wires need not be provided.

(c) Where the telegraph or telephone wires are so close to the trolley wires as to render the foregoing protection insufficient, the guard wires should be cross-laced (as shown in Fig. 10). This cross-lacing forms a

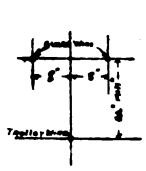

FIG. 3.

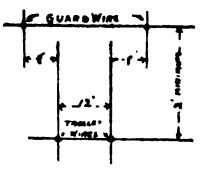

FIG. 4.

hammock netting, on to which the broken telegraph or telephone wire would fall, and is a very effective protection. The same arrangement can be used with great advantage where a number of telegraph or telephone wires are crossing the trolley wires and not running parallel to them, in which case the "hammock" can be suspended under the telegraph or telephone wires from pole to pole at the point where they cross the trolley wires. In such cases, however, it is probably better to arrange with the Post Office authorities or the Telephone Company that the mass of wires shall be dispensed with, and an insulated cable containing all the conductors be substituted therefor—a matter not of very considerable expense, seeing that only one span of the telegraph or telephone system is involved in such an arrangement. With the above arrangements effectively carried out, it is not very probable that a falling wire will come in contact with the "live" trolley wire, and it is highly improbable, should it do so, that it will fail to make contact with one or other of the guard wires. At the same time that this happens the falling wire would either be fused off at once, or,

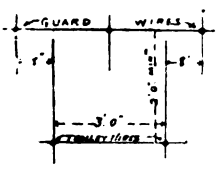

FIG. 5.

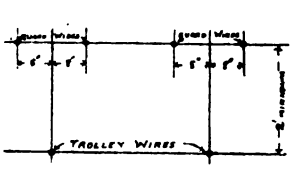

FIG. 6.

failing this, would operate one or other of the safety devices referred to hereafter. To ensure the operation of the safety devices by the short-circuiting of the trolley wire on the guard wire, it is essential that the guard wire should be in thoroughly good electrical connection with the track, and this should be effected by the direct connection of the base of the steel street standard to the nearest rail in at least one, and preferably two, cases in each detached length of guard wire. It is somewhat curious to note in this connection that in the older installations it was considered desirable to insulate the guard wires in place of effectively earthing, as is now the recognised and only safe practice.

ROLLING-STOCK.

Danger may arise in two respects from the rolling-stock: (1) entanglement of the trolley arm with the overhead construction; (2) shocks to passengers.

The entanglement of the trolley arm with the overhead construc-

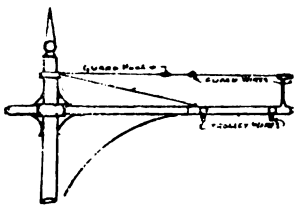

FIG. 7.

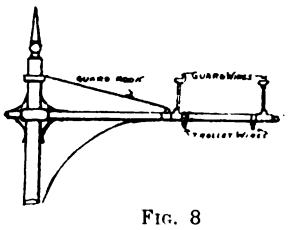

FIG. 8

tion in older installations was a constant source of accident. This has been to a very large extent overcome by the proper guarding of the trolley wheel, so that in the event of this leaving the trolley wire and coming in contact with the cross-suspensions, bracket arms or other fittings, it can hardly become entangled with any of these; and this is further helped by the trolley arm being so arranged as not to rise further than a predetermined limit when off the trolley wire. Perhaps there is more liability to accident and more difficulty in guarding against it in connection with the trolley arm than with any other portion of the system; and although the substantial construction of the overhead system as previously described will almost certainly prevent any disturbance to this should the trolley wheel become entangled, it is in that case difficult to prevent the trolley head being itself pulled off the trolley arm. For this reason the trolley arm should be long enough to carry the head free of the car, so that, should it be dropped, it will fall clear of the passengers.

Electric shocks to passengers carried on the cars are very rare, and should not occur at all if the precaution is taken of thoroughly "earthing" all metallic parts of the car, including the trolley standard itself. The springs used to give the trolley arm the requisite upward pressure against the trolley wire, if arranged externally, might also be a source of annoyance to passengers, and these springs should therefore be arranged within the trolley standard. This has been done very effectively lately in connection with a tramway with which the author is concerned, and will, no doubt, in the future be a standard arrangement. Fig. 11 shows a complete drawing of a trolley standard, and there is on the table a sample of a patent form of swivelling shielded trolley head, which has been found very effective in practice.

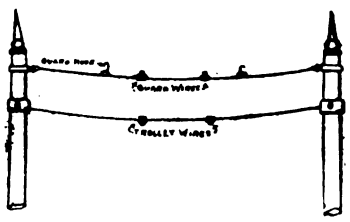

FIG. 9.

METHODS OF ENSURING SAFETY SHOULD A BREAKDOWN OCCUR.

If, notwithstanding the substantial construction advocated, a trolley wire should break, or if telegraph or telephone wires should come in contact with the "live" trolley wire, it is essential that means should be provided for immediately rendering that particular section of the trolley wire inoperative by automatically disconnecting it from the generator. In the earlier installations, and even to a certain extent to-day (abroad) the trolley wires and feeders were so interconnected and unguarded that an accident to one part of the system either produced serious results or involved the shutting down of a large part of the system on account of one local fault. To guard against this and to enable suitable safety devices to be effectively operated, the trolley wire should be divided into sections, not exceeding half a mile in length, and as few of these sections as possible fed through any single feeder proceeding direct from the source of supply. In between the adjoining sections of the trolley wire properly designed section pillars should be connected enabling any section of the up and down trolley wire to be disconnected from the circuit whilst continuing the supply to the remainder. The section pillar should be arranged so that the discontinuance of the supply of current to the particular section of trolley wire may be brought about either by the melting of fusible connections, the operation of hand or automatic switches, or a combination of these. The ends of the feeders supplying the fewest possible number of these sections should be suitably protected in the generating station by an automatic switch, arranged to open the circuit when a moderately larger quantity of current than the normal passes through its windings. Then, should a telegraph or telephone wire fall across the guard wire, and, at the same time by accident, come into contact with the "live" trolley wire, a sufficiently large flow of current will take place through the short-circuit thus produced to either melt the fuse or operate the automatic switch in the section box, in which case that particular section of the trolley wire only will be automatically put out of action, or, failing the effective action of the fusible cut-out or automatic switch in the section pillar, the circuit breaker at the end of the feeder in the generating station will open, stopping the supply of current in that case to the section of trolley wire on which the accident has occurred, and also the other sections of trolley wire fed by the same feeder. It will be obvious that in carrying out such an arrangement the sections of trolley wire fed from one feeder must not be interconnected with the sections fed from the other feeders, but the section boxes themselves should be provided with switches which will enable the gaps to be bridged over between adjoining trolley wire sections, fed off separate feeders, when a faulty section has had to be cut out. Fig. 12 shows the general arrange-

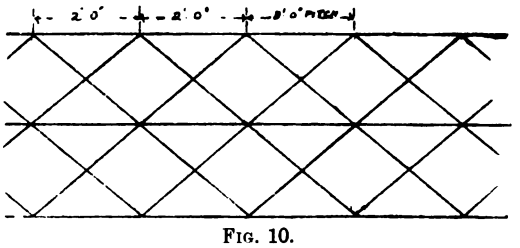

FIG. 10.

ment of a section pillar now in almost universal use on tramways in this country, varying only in the details of arrangement. In the figure in question fusible cut-outs are used for connecting up the various trolley wire sections to the distributor, and switches are provided for connecting up the distributor and the feeder. The fusible cut-outs are arranged to be used as switches when it is required to temporarily disconnect any trolley wire, and the switches are available for disconnecting the distributor or feeder for testing or other purposes. The feeder pillar also contains the terminals for the reception of the ends of telephone cables—the instruments themselves being carried on the cars—and terminals for the ends of the Board of Trade test wires; and in the case of any special safety device being used, such as the "Quin" automatic switch, described later on, the section pillar should also be arranged to contain any such fitting. [A sample of complete branch-way switchboard for use in section pillar is exhibited on the table.]

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The above arrangement may be described as the more usual arrangement adopted up to date, and whilst, if properly proportioned, it would be effective for the cutting out of trolley wire sections when telegraph or telephone wires have come in contact with them, is not generally applicable to accidents which might occur from the breakage of a trolley wire, the ends of which would hang down to the roadway, and which, unless the ends came into actual contact with the rails, might not convey sufficient current to open the circuit breakers or melt the fuses, and therefore might remain "alive," to the danger of any animal or person coming in contact with them. To meet this exigency several devices have lately been designed to ensure the circuit being opened as surely when a trolley wire is broken as when it is short-circuited to the guard wires through a fallen telegraph wire. These devices may be divided into two classes: (1) automatic switches requiring a pilot wire for each section of trolley wire, carried the whole length of the half-mile section; (2) mechanical devices brought into action by the severance of the trolley wire. The best-known example of the first of the above-mentioned types—namely, automatic switches requiring a pilot wire—is that designed by Mr. Quin, of Blackpool, and in use upon the electric tramway system there. This device involves the trolley wire being divided up into sections, which are not, as is otherwise usual, inter-connected with the adjacent ones. Each of these automatic switches has a main solenoid coil in series with it, and is so arranged that, should the current passing through this coil exceed the predetermined amount for which it is adjusted, a plunger within the solenoid is drawn up against two catches and releases the switch, so that in case of short-circuiting or excessive current the line is automatically cut out. At the back of this switch there is a shunt solenoid coil, which is in series with the pilot wire, which may be run either overhead on insulators, or as an insulated conductor underground at the end of the trolley wire section the switch is intended to control, and is there connected to the trolley wire. So long as the pressure between the trolley wire and the rails remains at about 500 volts this shunt coil holds up the plunger within it, but if the line were to break and the pressure thereby be cut off from the pilot wire, and, therefore, from the shunt coil, the plunger would be released, falling on to two catches, and operating the switch, thus automatically cutting off this section of the trolley wire. In this way, this particular switch takes both the place of the fusible cut-out

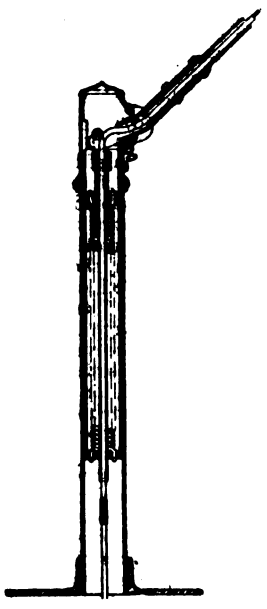

FIG. 11

previously referred to, and, in addition, ensures the current being cut off from the trolley wire should the wire be broken. It has, however, one disadvantage, and that is, that no current can be put on to any of the sections of the trolley wire until the switch has been set by hand once the pressure has been taken off the line, so that after shutting down at night it is necessary for an official on the first car proceeding out in the morning to stop at each section pillar and set the switch for the succeeding section before the car can proceed over it; whilst should there be an accidental short-circuit during the hours of operation of the tramway which might for a moment cut off the current entirely from the power-house, it would again be necessary for all the switches to be reset by hand as the cars proceeded. A diagram of the connections of the Quin switch is shown in Fig. 13, and a sample of the switch is exhibited.

The second type—that is, mechanical devices for cutting off the current and coming into operation by the severance of the trolley wire—depend for their action on the short-circuiting of the trolley wire to the rails, thus either melting the fusible cut-outs or opening the circuit breakers as previously described in the case of any ordinary excess of current taking place. So far as the author is aware, the only devices of this description that have yet been put into operation are those designed by Messrs. Blackwell and Co. In each form of this apparatus the necessary short-circuit is produced by a short lever being pulled over either against the bracket arm, when either the rigid or flexible suspension type of bracket construction is used, or against a loop hanging from a special earthing wire carried over the trolley wire when the cross suspension method of construction is in use. Fig. 14 shows one form of this device as adapted to the flexible suspension bracket-arm construction. From this figure it will be seen that the lever remains in a vertical position so long as there is no pull on the short stay wire connecting the short end of the lever with the trolley wire. Should the trolley wire break at any point along the span, a considerable pull is exerted on the short end of the lever which brings the longer end immediately into contact with the bracket arm, exerting considerable pressure between these two points, and ensuring a good contact to earth, with a consequent short-circuit and sufficient flow of current to melt either the fuses in the section box or open the circuit breaker in the power-house. The extreme simplicity of this device has much to recommend it. The same device might be conveniently used for safeguarding telegraph or telephone wires where they cross the trolley wire, and where they are not in sufficient numbers to make it worth while substituting an insulated cable, as recommended in an earlier part of this paper. Fig. 15 shows the modification of this device under such circumstances. The telephone pole, at points where the wires cross the trolley wire, must be permanently connected to the rail. The lever shown in the figure is fixed to each insulator by means of a clamp, and the weighted end is attached to the telephone wire. The stirrup shown is connected either through the pole to the rail, or, should the pole be a wooden one, through a special wire attached to each stirrup and connected to the rail. Should the telegraph or telephone wire break, the weighted end of the lever drops, and brings the other end into contact with the stirrup, thus earthing the broken wire. If the broken wire has come into contact with the trolley wire, sufficient current will flow through the trolley wire to the telephone wire to either melt the fuses in the section box, or open the circuit breaker in the power-house, or, alternatively, to fuse off the telephone wire itself. In this case the weight of the breaking telegraph or telephone wire would assist the movement of the weighted end of the lever.

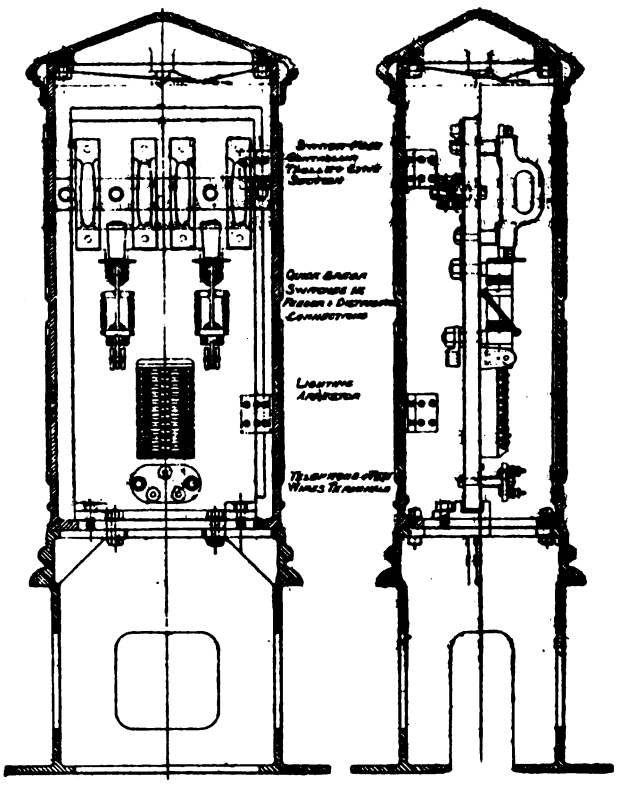

FIG. 12.

The author trusts that this description of means for rendering the overhead trolley system safe has not taken up too much of the time of the association, and his excuse must be that the increasing number of installations of this system in the country is such as to demand the careful consideration of all concerned in eliminating as far as possible the chances of accident.

DISCUSSION.

Mr. J. Lemon (Southampton) said he had very much pleasure in moving a vote of thanks to Mr. Manville for his kindness in attending the meeting and giving them so valuable a paper on the overhead system of electric traction. Mr. Manville's firm were engineers to the electrical tramways and works at Southampton. He could say that the works carried out from the designs of that firm had been a brilliant success, and if they were as well done in Leicester as in his borough, Leicester would have no cause to regret appointing Mr. Manville as their engineer. Engineers had to decide some time or other which was the better of the two modes of electric traction, the overhead or the underground. He presumed they must have come to the conclusion by now that there were advantages and disadvantages with both systems, and it was a question of which system had the fewest disadvantages. After giving the two systems a good deal of consideration in Southampton—and he was chairman of the Works Committee at the time—they came to the decision that the overhead system was the best to adopt. There were dangers, and would be dangers in a system of this kind. There were dangers in every form of mechanism they could have. But such advance had been made by electrical science that those dangers were reduced to a minimum. It must not be

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forgotten that if they introduced the underground system they might have a good deal of trouble with gas and water mains. He knew that in London some of the gas and water companies had asked Parliament to assist them from any dangers likely to occur from underground currents, but Parliament—he thought very properly—had refused to do so. With reference to the danger from telephone wires falling across the overhead wires, they had got over that in Southampton by refusing to allow the telephone companies to put wires overhead. He could not see what business a telephone company had to go to the top of a man's house and put up a station, sometimes with a man's consent and sometimes without. One of the objections raised to the overhead system was its unsightly appearance. Well, he had visited several towns where the overhead system was in vogue, notably Hamburg, and he came to the conclusion after being there 48 hours that he had forgotten the overhead wires altogether. He had not heard a single person who had become accustomed with it raise an objection to the unsightliness of the overhead system. There were certain advantages about it. If they had a breakdown they knew where to find it, but if they had a breakdown underground it would puzzle the old gentleman

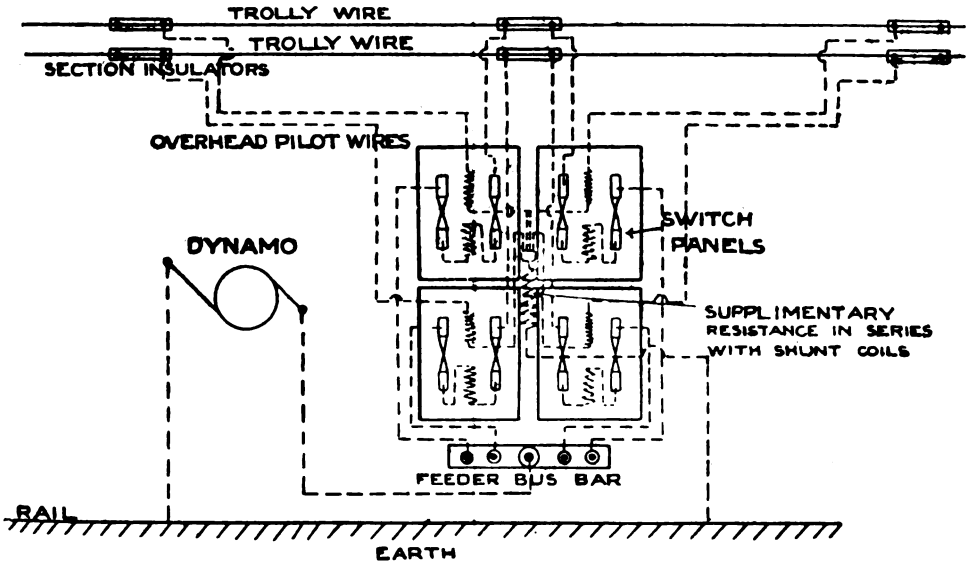

FIG. 13.

himself to know where it was. Sometimes they had a breakdown of the electric cables which supplied the houses, and it took time to locate the breakdown. That was not so with the overhead system. Everybody had come to the conclusion that the overhead was the better system of the two and far more economical. If they went into the question of cost, they would come to the conclusion that if they had to put down the underground system, as in London, they would not put down a system at all.

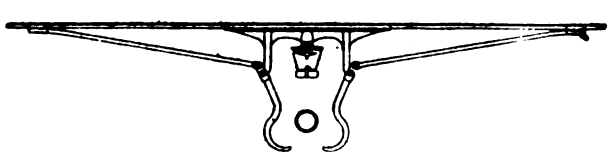

FIG. 14.

Mr. J. Lobley (Hanley), who seconded the vote of thanks, remarked that it was rather amusing to find how unanimous everybody was now in favour of the overhead system. He remembered that he was in a considerable minority nine years ago when he said very much the same words as Mr. Lemon had. He had not been in Boston half a dozen hours before he had got used to the overhead system there. From that time he had never seen any reason to change his opinion. When in Paris he was struck by the hideous monstrosities of cars which were running. The engines were like their old North Staffs steam

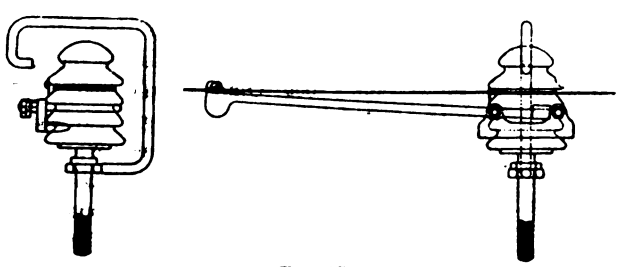

FIG. 15.

cars, and they were followed by two or three trailers. There was no comparison between the system, which was worked by compressed air, and the overhead trolley system, the latter being far superior in speed, accommodation, and everything else. They had every reason to thank Mr. Manville and his paper, which had come at a very opportune moment. They were always told of the dangers of the overhead system since the Liverpool accident. He did not think those accidents would have occurred if they had used guard wires in Liverpool, instead of wooden strips.

Mr. J. Gammage (Dudley) said they had had for some time the overhead system in Dudley. The general public were all up in arms against the system before the tramways were constructed, but since these had been in working order they had never had an accident, and the general public were quite satisfied and they never heard any complaint about them. In fact, as Mr. Lemon and Mr. Lobley had said, they forgot all about the overhead wires—they walked about the streets and did not know the wires were there. There was one advantage in having the overhead system. His corporation made an arrangement that they should use the poles for street-lighting by electric arc lamps. They had used the poles in this way, and instead of disfiguring the streets these had become ornamental. They were perfectly satisfied with the system, and had not had a single accident.

Mr. T. H. Yabbicom (Bristol) asked whether Mr. Manville considered there was greater safety in supporting the trolley wire from a bracket than from a span wire? He was rather in favour of the bracket system from the point of view of appearance.

The **President** said he had great pleasure in putting this vote of thanks to Mr. Manville. He could only say on behalf of the chairman and vice-chairman of the Tramway Committee, who had given an immense amount of time and study to this question, that they were grateful to Mr. Manville for coming down there. They considered themselves very fortunate in having secured the services of Mr. Manville as consulting engineer for their great electric traction scheme.

The vote of thanks having been unanimously accorded,

Mr. Manville, in reply, said that Mr. Yabbicom's question was one which he had very often asked himself, and he did not really think between the span-wire system and the rigid attachment on a bracket there was anything to choose in the way of safety. He thought both were equally safe, but there was no doubt that the span-wire system, apart from any æsthetic considerations, was the best in working, because it formed the easiest passage for the trolley wheel to pass over. There were no hard points along it at all. He had the opportunity of putting up the first electric system at Bristol, which was a bracket system with rigid attachments, but that was the first electric tramway put up in England. It was a subject which ought to be dealt with bit by bit and at great length, and not be crowded into a few words.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE POST OFFICE REPORT.

The annual report of the Postmaster-General is now before us, and a perusal of it gives rise to many speculations as to the future development of the many services controlled by him. Of the postal services we propose to say little beyond noting the fact that up to the present the attempts to introduce automobiles into the carrying business of the Department have not proved successful. We see, however, that the Postmaster is being represented at all the important trials of motor vehicles in this country. The expressed hope that a vehicle capable of performing a continuous and regular service over an extended period of time is likely to be soon realised, and the Department will have the advantage of starting with considerable expert experience obtained from these trials. It would seem to us that the parcel post carriage, which is now done to a considerable extent by horse vehicles, should be the first to be converted to motor vehicles, as a slight delay in the delivery of parcels in consequence of a breakdown is not of such vital importance as a similar delay in the ordinary mails. The report respecting the Telegraph Department shows a slight falling off in the total number of telegrams sent. The decrease is largely due to the reduction in the London telegrams, while those sent to the Stock Exchange show a falling off of nearly 14 per cent. The Press telegrams, on the other hand, show an increase. These messages average over sixteen million words per week. The Postmaster adds that "special measures have been taken to cope with this large amount of Press work, and to obviate delay in transmission. I am glad to think that these measures have been successful from the point of view of the newspapers concerned. At the same time, it is to be borne in mind that Press telegrams entail a heavy financial burden on the telegraph service, which has to provide highly-skilled officers and special apparatus for the disposal of the work, and to perform that work at a charge which is totally inadequate to meet the expenses." We believe that the Press rate was fixed at its present low figure in consequence of a printer's error years ago, and having once given the cheap rate to newspapers, no Postmaster has dared to meet the wrath with which newspaper proprietors would greet an increase. New cables have been laid during the year ending March, 1901, to Germany and to Holland, while direct telegraphic communication between London and Genoa was also secured. It is with the part of the report dealing with telephones that we have the most fault to find. The work of extending the trunk lines for telephone service is not proceeding so fast as it should. The report is not clear on the question, but we gather that there were some seventy-seven thousand miles of trunk wires in use, and that about 10 per cent. of that amount represented the extensions. In the same way, when looking at the record of the number of trunk messages which were passed, we find an increase of 10 per cent. This would justify the argument that the business on the trunk lines increases just as the facilities are provided, and hence, if the Post Office would carry out the work more quickly, they would still get the same percentage return on the outlay. In the meanwhile, the Post Office, for want of more trunk wires, actually discourages the use of the telephone as a means of communication between neighbouring towns. For instance, if an inhabitant of Tunbridge Wells comes to London and wishes to speak from a call office to his business premises, he must be quite prepared to wait an hour for his turn, and it is no uncommon occurrence for this period to be extended to an hour and a half. Again, according to the regulation, he has to pay in advance for his call, and in the event of his patience giving out before the connection is made he is fined

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the sum of twopence, which is deducted in returning the prepaid fee. We should, of course, be unjust to the Postmaster-General if we were to state that these fines are a valuable inducement not to add to the trunk wires. The average delay of an hour for all ordinary messages makes the telegraph more prompt than the telephone in getting a reply, and this should not be the case for interurban connections such as referred to above. Another sign of the same dilatoriness is the record of the increase in the number of post offices opened for trunk telephone business. The increase is only thirteen in a total number of three hundred and twelve offices. This number of offices could well be provided in Greater London alone. It is a curious fact that during the year there were also opened thirteen new telephone exchanges, although a note is added that arrangements had been made for the establishment of exchanges in other places in the provinces. A good proportion of these thirteen new exchanges are in the immediate neighbourhood of Newcastle-on-Tyne. It will be remembered that in this town a well-organised Post Office telephone exchange has existed for years, although it was not allowed to extend for fear it should interfere too much with the business of the National Telephone Company. The other places in which exchanges have been opened are mostly small, and include such names as Senghenith and Tylorstown, the exact position of which may be known to some of our readers. In fact, in no case but in Newcastle do we see signs that the Post Office are establishing in the provinces that active competition which the Telephone Committee recommended. No new news is given in the report respecting the London exchanges, or the rumoured agreement with the National Telephone Company. Our suggestion for the improvement of the present state of affairs as regards the trunk telephone service is that Lord Londonderry and the heads of all the departments should be compelled to use the trunk wires for all their business relations with outlying towns. Perhaps, if the delay so caused was added on to their office hours, they would realise the need for an increase of more than 10 per cent. per annum in the trunk-wire facilities.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

HIGH-SPEED DYNAMOS.

SIR,—Could you tell me if any dynamo or motor—continuous-current or alternating—of any considerable power, say 50 kw. or thereby, has been driven at 5,000 revolutions per minute? Perhaps some of your readers might oblige. The dynamo would be bipolar—5,000 revolutions per minute, 50 kw., 550 volts. Could you tell me whether electrical or mechanical reasons would first limit the speed? Any information on design of such a dynamo would much oblige.—Yours, etc., J. S.

1, Bird-street, Broadgate, Preston, Aug. 23, 1901.

[N.B.—Our correspondent would get such machines from Messrs. C. A. Parsons and Co., who have made large numbers of them for coupling to steam turbines.—ED. *E. E.*]

PERSONAL—Will Mr. F. W. Davies kindly send his address to the editor.

THE INTERNATIONAL ENGINEERING CONGRESS.

Perhaps we need hardly remind our readers that the engineering congress at Glasgow opens on Tuesday next. A full programme of the papers to be read in the various sections appeared in our issue of Aug. 2, and the visits to works will provide attraction for engineers of all classes embraced in the wide definition of a civil engineer. Should anyone now make up his mind for the first time to join the congress, we believe that he would do well to look for sleeping accommodation in the surrounding towns, or perhaps in the bathing machines at Rothesay Bay.

FARNWORTH ELECTRICITY WORKS.

OPENING CEREMONY.

The Farnworth electricity works, a description of which we gave in our last issue, were formally opened on Wednesday afternoon in the presence of more than a hundred invited guests, amongst whom were Alderman Topp, J.P., the chairman of the District Council, who presided; Alderman Nicholson, J.P., mayor of the neighbouring borough of Bolton; Messrs. S. V. Clirehugh and E. M. Lacey, of the firm of Messrs. Lacey, Clirehugh, and Sillar, consulting engineers, who have designed the works; Messrs. Stones and Stones, of Blackburn, the architects; Mr. S. J. Hodgkiss, the builder; Mr. W. B. Richardson, chairman of the Electricity Committee; Mr. J. D. Pember, resident engineer; Mr. J. F. Coates, assistant engineer; Mr. W. Tyldesley, clerk to the Council; Mr. England, general manager of the Bolton tramways; and the chairmen and clerks of the adjoining townships of Worsley, Kearsley, Little Hulton, and Little Lever. Mr. Clirehugh presented Mr. Richardson with a handsome gold key, bearing the Council's seal, with which to unlock the main door, and a gathering was afterwards held in the engine-room.

Alderman TOPP said the local authority had felt they would be neglecting their duty to the ratepayers of Farnworth if they did not take in hand themselves the provision of a supply of electricity. They feared someone else might have taken the work in hand, and so were forced to move in self-defence. They were as proud of that undertaking as if it was the largest in the country, and they hoped it was going to be a pronounced success.

Mr. RICHARDSON gave a succinct history of the steps which had been taken by the Council to secure these works from the time the first Electricity Committee was appointed. A provisional order was obtained from the Board of Trade in 1897 He said the committee had had their hands strengthened very considerably by an influential deputation of ratepayers, who waited upon them to urge the desirability of keeping the control of the electricity supply in their own hands, and by a resolution of the Farnworth Tenants' Association. These and other evidences of interest convinced them that they had the support of the town as a whole in their decision to erect those works. On May 19, 1900, the sanction of the Local Government Board was received to their borrowing £18,376 for 25 years for the carrying out of their scheme, and they were spending the balance of £3,624 for the provision of one engine and a boiler, and the traction switchboard, under their parliamentary Act passed the same year. Those buildings had been erected upon land which had belonged to the Council for a number of years, and the works, reservoir, and car-shed altogether occupied 5,937 square yards, leaving them 9,841 yards for extension. They had under the present roof space for a larger engine and another boiler. The sole desire of the committee had been to obtain the best they possibly could for the ratepayers, and they had secured thoroughly good works at as little expense as possible. They meant to make that a successful profit-making business, and would supply current as cheaply as they could. They were making a special feature of the supply of electricity for motor power, and to that end were charging 1½d. per unit for current and letting out motors on hire. They trusted the superior lighting of the town, combined with improved facilities for locomotion and cheap fares would be of good and lasting benefit to the inhabitants. That was a red-letter day to the town, not only from the fact that that was the first real trading undertaking of Farnworth ratepayers, but because they hoped to be able to supply current, perhaps, at a little

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cheaper rate than the majority of towns. He had pleasure in declaring the works open.

The MAYOR OF BOLTON said he rejoiced with Farnworth people in their new electrical undertaking. His honest conviction was that they were perfectly right in going into the matter in the first instance. It was a proper thing that governing bodies should as far as possible own everything in the way of water, gas, tramways, and electricity, whether for light or power. If they had not secured those works, a foreigner would have invaded their ground solely and exclusively for the making of money, and they would have had produced the dividend, whilst if in time they had seen the error of their way they would have had to pay a big price for the undertaking. Succeeding generations would say they had acted wisely in what they had done. No one could tell what would be the limit of the work in which they had just engaged. He believed that in 20 years their towns would be simply centres of industry, and that all their working people would live in the country, from which they would journey night and morning at cheap fares on their trams.

Mr. CLIREHUGH said they might congratulate themselves in these times of extreme competition from abroad that every particle of their machinery, with the exception of £10 worth, was made in England, and made also in Lancashire. So far as his knowledge went, that was the first electrical station which had been equipped in that county. Almost every portion, from the brickwork to the dynamos, had been made in Lancashire, which had become an enormous electrical centre, and was going to do a big business in future. Going on to describe the works in popular language, Mr. Clirehugh said that the engines were extremely serviceable and cheap compared with the power they were able to give, and were very economical in their running. Each dynamo was capable of driving about 12 tramcars, each containing about 64 passengers, at a speed of from 8 to 10 miles per hour, or of lighting 6,800 8-c.p. lamps. The very liberal-minded way the Council had approached the question of lighting was worthy of note, and he believed they would be satisfied when they saw the increased brightness the 45 arc lamps to be erected would give the town. Some people might be inclined to cavil at the cost of these lamps, but he would point out the advantage which would accrue in attracting people to the town. If Farnworth was made attractive at nights, they would find the inhabitants of adjoining localities would visit the town to make purchases, and their tradesmen and the rates would benefit. Some of the members of the Council were of a pessimistic turn of mind, but he could tell them so far as his experience went in lighting towns of that character, and so far as statistics were available as to profits, they would in three years be in a position to pay the whole of the current expenses, including interest and sinking fund, and make some sort of a contribution towards the relief of the rates.

The three engines were next named: the "Victoria" by Mrs. Foster, wife of the ex-chairman of the Electricity Committee; the "Edward and Alexandra" by Mrs. Sumner, wife of the vice-chairman of the Council; and the "Alfred" by Mrs. J. Almond. Alderman Topp started the engines and switched on the current, and after the usual vote of thanks the company adjourned to the Albert-road Congregational Schools, opposite the works, where he held a reception. During the evening the works were thrown open to the public, and were crowded with townspeople, and outside the Irwell Bank Prize Band gave a concert. The building was illuminated with streamers of coloured incandescent lamps after tasteful designs arranged by Mr. Macphail, of the British Insulated Wire Company, Limited. The general effect was much appreciated by the visitors.

The accompanying portrait of Mr. J. D. Pember reached us too late to appear in our last week's issue. Mr. Pember, the electrical engineer to the Farnworth Urban District Council, is the son of Mr. J. Pember, one of H.M. inspectors of schools. He was born at Worcester in 1873, and educated at the Cathedral Grammar School of that city. Subsequently he went to Finsbury Technical College, and after the usual course there was apprenticed to the Great Western Railway, serving his time at their branch locomotive shops at Worcester and Wolverhampton. Thence, in October, 1894, he went to Messrs. Crompton and Co., and worked as an improver in their arc lamp testing and armature building shops till November, 1895. After the outbreak of fire at the old works of this company, Mr. Pember went as a fitter in the alternator erecting shops of Messrs. John Fowler and Co., Leeds. In March, 1896, he was appointed one of the electrical staff on the North-Eastern Railway Company, whose headquarters are at York, and became one of the travelling inspectors of their electrical stations, assisting also in the drawing-office work.

MR. J. D. PEMBER, ELECTRICAL ENGINEER TO THE FARNWORTH URBAN DISTRICT COUNCIL.

In October, 1899, he was appointed chief assistant at the Corporation of York electricity works, and in January, 1901, took up his present duties, which will provide ample scope for the use of his previous valuable experience.

GLASGOW CORPORATION TELEPHONE EXCHANGE.

OPENING CEREMONY.

The central exchange of the Glasgow Corporation telephone department was formally opened and the system inaugurated yesterday by the Honourable the Lord Provost (Dr. Samuel Chisholm) in the presence of the Right Hon. Robert W. Hanbury, President of the Board of Agriculture. In recognition of the valuable services which he rendered in the promotion and passing of the Telegraphs Act, 1899, which made the establishment of the system possible, Mr. Hanbury was afterwards presented in the Merchants' House with the freedom of the city and entertained to luncheon in the City Chambers. The history of the movement for the institution of municipal telephones in Glasgow dates from February, 1893, when Councillor Starke, then a lawyer in the city and now resident in London, gave notice of the following motion at a meeting of the Town Council: "That in terms of the Treasury minute of March 23, 1892, the Corporation, as the local authority, resolve to apply to the Postmaster-General for a license to supply the community with an efficient telephone service." At the Council meeting two months later, a special committee was appointed to consider the subject. Councillor Starke was convener, a position in which he was succeeded by the present convener, Ex-Bailie James Alexander, while one of the members of the committee was the present Lord Provost Chisholm, who has from the outset been an ardent supporter of the movement. The special committee having reported in favour of the proposal, the Corporation resolved on Aug. 3, 1893, to apply for the license. For two years a correspondence took place with the Postmaster-General, and the Corporation gave evidence before a Select Committee of the House of Commons in support of their application. In 1897 the Postmaster-General appointed a commission to hear evidence in Glasgow for and against

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the application. Sheriff Jameson presided over this commission, which went very fully into the matter, and reported that a license should be granted. Notwithstanding this, the Postmaster-General informed the Corporation on March 16, 1898, that he could not grant a license. On May 10 of the same year a second Select Committee of the House of Commons was appointed to enquire if telephones were of such general benefit as to justify local authorities establishing them. This committee, before which the Corporation of Glasgow again gave evidence, reported that a general, immediate, and effective competition, either by the Post Office or by local authorities, was necessary. On Aug. 29, 1898, the Corporation renewed their application, and on Sept. 23 of the same year they were informed by the Postmaster-General that he was prepared to grant a license, expiring on Dec. 31, 1911, provided they secured from Parliament the requisite powers for working the system. The Corporation accordingly presented a Bill to Parliament, but ere it reached the committee stage Mr. Hanbury introduced what was at first known as the Telegraphic (Telephonic Intercommunication) Bill, which became law on Aug. 1, 1899. Immediately thereafter the Town Council reapplied for and obtained the long-sought license, which was dated March 1, 1900, and which, by request of the applicants, is terminable on Dec. 31, 1913. It covers an area of 143 square miles, and includes not only the city proper, but portions of the counties of Lanark, Renfrew, Dumbarton, and Stirling. To be able to give effect to the license, the committee applied to the Secretary for Scotland for leave to borrow £120,000, and this was granted without delay. Preparations were at once begun for the inauguration of the system. Mr. Alfred R. Bennett, M.I.E.E., who had taken a prominent part in the movement for the municipalising of telephones, was appointed general manager; Mr. John MacFee, M.I.E.E., was appointed assistant manager; Mr. J. L. Chambers, A.I.E.E., indoor superintendent; and Mr. F. W. Shorrocks, A.I.E.E., outdoor superintendent. The tariffs were fixed at £5. 5s. yearly for an unlimited number of calls over the whole extent of the telephone area, or, alternatively, £3. 10s. per annum and 1d. for each call made, this payment to be by the caller only. It was decided at the outset to join up 5,250 completed lines and to make provision for laying another 5,250, but so brisk has been the demand for lines and instruments—the actual number of orders on the departmental books is 5,382—that it was deemed judicious to lay cables containing a large margin of spare wires. The amount of this provision for the future may be inferred from the fact that there is accommodation in the switch-room for 20,000 subscribers.

ELECTRO-CHEMICAL INDUSTRY.*

BY J. W. SWAN, F.R.S.

The nineteenth century will be for ever memorable for the great scientific discoveries it produced, and the wonderful development that took place during its progress, in the applications of science to industrial uses in relation to chemistry and electricity. Considering the importance of the subject, it seems to me a fitting occasion for passing in brief review the leading events of the century in connection with the rise and progress of electro-chemistry, and for considering its present position and prospects. The birth of the century was heralded by signs and wonders; the whole horizon of chemical physics was aglow with the light of Volta's great discovery, and the constellation of brilliant discoveries it gave rise to. It was in that outburst of new light that the history of electro-chemistry began. The idea of the correlation of electricity and the energy that determines chemical action was then for the first time grasped; and the prescience of great minds, like that of Davy, led even to an anticipation of that then far distant result, the utilisation of electricity as an operative force in chemical industry.† But the light of that morning glory did not rapidly grow into noonday clearness. Much had to be done before industrial electro-chemistry was possible. In the first decade the marvellous analytic power of electricity was fully realised, and the idea was generally accepted that electricity was probably of the nature of the force that controls chemical combination. We also then became familiar with those heat-producing effects of the electric current that have only within the lifetime of our society been turned to practical use. The three succeeding decades show no sensational discovery such as made the first decade conspicuous, but they yielded an immense product, not only of new knowledge, but many indispensable extensions and developments of what had already been partly attained. Above all, they produced the work of Faraday, who mapped out and gave a code of laws to the new domain. So far all the work done was preparatory and scientific, and inspired by the pure and noble aim of the man of science who seeks truth and new knowledge for its own sake. But on the near approach of the fifth decade, the eyes of men of different ideas—practical men—were opened to the advantages of employing the hitherto useless power—electricity—to reach new and useful ends. We all know that the first outcome of this recognition was the origin of that small department of electro-chemical industry to which Smee gave the apt name of electrometallurgy. So long as this name applied only to the humble but beautiful art of electrotype, and electro-gilding and plating, it seemed pretentious. Smee felt the objection, answered it, and in doing so predicted with rare foresight the future expansion of this field. But, much as he foresaw, it was only the fringe of the wide territory that has since been added. Faraday had lately discovered and laid down with great exactness most of the governing laws of electro-chemical action—a work of infinite value, essential to progress. But our debt to Faraday, measureless as it was from that great service alone, was further increased by his discovery of magneto-electricity, whereby there was brought within reach a more economical means of generating electricity by the electromagnetic transformation of motive power. By the employment of this fundamental principle all the wonderful developments of the use of electricity that we see to-day have been rendered possible.

Historical relics are always interesting, and I feel sure many of you who may visit the exhibition will look with interest on one of the exhibits of Messrs. Walker and Hall—an ancient magneto-electric machine used long ago for depositing silver. It is a progenitor of the dynamo, that to-day is an essential means of supplying all the great cities of the world with electric light, of working railways, propelling cars through the streets and under them, and of performing a great amount of electro-chemical work. It is a singular coincidence that the discovery of the magneto-dynamic mode of generating electricity occurred almost at the very moment when several other discoveries and inventions were made which presently called for the assistance of cheaply-produced electricity. One of these inventions was submarine telegraphy, with its requirement of large quantities of the purest copper. As I have said, it was in connection with electrotype and electroplating that the first industrial application of power-generated electricity was made, and it is equally illustrative of the reciprocal action of demand and supply that the demand for pure copper, arising out of the use of copper wire for submarine telegraph lines, gave rise to the first large and improved mechanical generators, like those of Wilde. When other and yet larger uses for electricity developed, the electrical engineer discovered his vocation, and, by gradual steps, there was evolved that triumph of science, the modern dynamo. But several striking events in the development of electro-chemical industry had taken place before that evolutionary process was fully accomplished. I go back to the time of our last meeting in this city 13 years ago; it is a most interesting point of departure. In that year (1888) those responsible for the publication of the *Journal* of the society first paid to electro-chemical industry the homage of sectional recognition; then, for the first time, there appeared in the *Journal*, under the heading "Journal and Patent Literature, Section XI.—Electro Chemistry and Metallurgy." It is a tribute due to the editor and his colleagues to say that they hit the true psychological moment. Before that time electro-chemical industries certainly existed and flourished—notably electrolytic copper refining—but it is since then that they have grown, in number and variety, to a degree of importance which now requires the most respectful consideration of all who are interested in chemical industrial progress. Electro-chemical industry depends on the production of chemical effects in a new way; sometimes the effects themselves are new, and not otherwise producible, and in other cases the results are merely improvements on old chemical methods, either in respect of economy or superiority of the product, or both. Electrotype and electro-gilding belong to the first class; the results are unique, and constitute valuable additions to the resources of industry and art. Electrolytic copper refining is so great an improvement on the old method, both in point of economy and superiority of product, as to have largely supplanted it, and incidentally to have sensibly raised the value of commercial copper as an electrical conductor. In another department of electro-chemical industry, the manufactures of calcium carbide, of carborundum, and artificial graphite (all new products) have attained large proportions. These depend, as industrial processes, wholly on the high-temperature effects economically obtainable only by means of the electric furnace. The aluminium and sodium industries have developed into their present large dimensions solely in consequence of the much greater economy of production of these metals by electrolysis than was ever attained by the old chemical processes. These are a few typical examples of electro-chemical industries, and illustrate the causes of their existence. In reviewing the salient points of the different sections of electro-chemical industry, I propose first to speak of the electrolytic group of industries, and afterwards of that newer group in which, not electrolytic action, but the extremely high temperature obtained by the electric furnace is the operative agent. Outside these groups there is a miscellaneous group, to which I must also briefly refer. Prof. Chandler, in his most interesting and valuable presidential address of last year, gave a large amount of information relating to the progress of electro-chemical industries in America. I shall not repeat what he said, but confine my remarks almost entirely to the developments to be found on this side of the Atlantic.

I have attempted—with, I confess, imperfect success—to obtain authentic information concerning the present position of the electro-chemical and electro-metallurgical industries. I have been in communication with every firm I knew of in Europe applying electricity to the manufacture of chemical and metallurgical products. When I

* The presidential address to the Society of Chemical Industry delivered at Glasgow on July 24.

† In the Bakerian Lecture of 1806 Davy says: "It is not improbable that the electric decomposition of neutral salts, in different cases, may admit of economical uses."

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inform you that these firms now number over 150, you will recognise that this new field is being extensively cultivated. The information obtained in answer to a circular letter issued through the medium of Mr. John B. C. Kershaw, whose valuable assistance I here desire to acknowledge, has been tabulated, and is presented as an appendix. I take this opportunity of also thanking those firms who have placed at my disposal all the information asked, and thus assisted me to the utmost. In many cases figures have been given with the understanding that they shall not be published; hence there are many gaps in my tables. In a number of instances, however, manufacturers have declined to give any information whatever. Of this reticence I make no complaint, for I recognise that it is only natural that those who have acted as pioneers in a new industry and worked out new processes should desire to reap to the full the fruits of their labour. At the same time I cannot but regret that, in consequence, the picture I have to present to you will here and there be wanting in some of the detail that otherwise I should have been glad to be able to supply.

Copper Refining.

As the senior member of a new industrial line that has won its way to a great and commanding position, the place of honour in my review must be given to electrolytic copper refining. Prof. Chandler, in his address at our last meeting, gave the figures which represent the gigantic copper output of America, and I find that, bringing the production down to 12 months later, there is continued growth. The total production of raw copper in the year 1900 was 486,084 tons, to which total the United States contributed 268,787 tons. The latest published estimate of the proportions of these totals, refined by the electrolytic methods, gives roughly 172,000 tons for the American refineries* and 37,000 tons for the 27 refineries located in our own country and on the Continent. My own enquiries would seem to indicate that the latter estimate is rather too high, and that the European production of electrolytic copper is now less than 37,000 tons a year. The figures available are given in Table I. in the appendix, but as certain copper refineries have not filled up the return, this table is necessarily incomplete. America is by far the largest producer of copper, and, with characteristic thoroughness, she not only produces crude copper, but also refines it. The refining is often carried on in close proximity to the mines, although there is as little tie to a particular locality for an electrolytic copper works as there can well be in the case of any industry. But if there is water power conveniently near to the mines, the inducement to finish the work on the spot is sufficiently strong to make it worth doing. Electrolytic copper refining is one of the things that can be done profitably without the advantage of extremely cheap motive power. It is not one of the class of industries to which, for example, calcium carbide belongs, which can only be carried on with success where the motive power is of the cheapest. It has been said that an infinitely small amount of power can deposit an infinitely large quantity of copper. That is not quite true, but it is true that in copper refining the power element of cost is not vital, and that with skilful arrangements and the use of large depositing tanks for a given output, the cost of power, even when coal is used to produce it, is not the chief item in the total cost of the process. Hence this is one of the electrolytic industries that it is possible to carry on successfully in a country like ours, which is not largely supplied with water power. Copper refining is a conspicuous example of the advantages of electricity as applied in a large metallurgical industry. Here electricity has everything in its favour. Not only is the electrolytic process more economical because it requires little power to be expended and little labour, and because the precious metals found as impurities in the copper are more completely recovered, but the purity of the product is much greater than that resulting from the old process of refining, and when the copper is required for the purpose of an electrical conductor its money value is enhanced in proportion to the increased purity. In an interesting brochure, entitled "A Century of Copper," recently published, Messrs. Brown and Turnbull give statistical information relating to the growth of the copper industry, and state that at present 300,000 tons, or over 60 per cent. of the total output of copper, is utilised in electrical engineering. This demand, it may be noticed, is almost wholly the growth of the last 15 years, and it is rapidly increasing.

Before electrolytic copper refining became general, in the early days of the submarine telegraph, there was a great deficiency in the conductivity of commercial copper. Now, copper for conductors has almost uniformly the normal conductivity of pure copper, with the result of a saving of at least 10 per cent. (arising from the use of electricity in refining) in the quantity of copper used. Besides this saving there is a much more complete recovery of the precious metals commonly associated with crude copper. The total saving, at a moderate estimate, exceeds 1½ million pounds sterling per annum. It is the common practice to melt up the rough cathodes that come from the depositing vats in order to cast the metal in the form of ingots preparatory to its use for the foundry or the rolling-mill. This treatment is attended with an appreciable loss of conductivity. To avoid this loss it has been attempted, with considerable success, to deposit the metal in such forms as to render unnecessary the extra process of fusion. Those who visited the Paris Exhibition last year may have seen some of the results in the form of large and beautifully smooth tubes and plates shown by the French and German Elmore Companies. The chief hindrance to the direct production of the electrolytic deposits in the finally required form is the strong tendency of the copper deposited from solutions of the ordinary composition to be crystalline and rough and deficient in strength. Elmore has met this difficulty by causing the deposit to take place upon a revolving cylindrical surface against which an agate burnisher presses. The burnisher has imparted to it a slowly reciprocating lateral movement, which, combined with the rotary movement, results in the entire surface of the cylinder being repeatedly traversed while it is receiving the deposit. At the exhibition there was also some fine tubes shown by Cowper-Coles, who, in producing them, had employed, not a mechanical rubber, as in the Elmore process, but simply a rapid rotation of the cylinder in the copper solution, and in that way had obtained favourable conditions both of a mechanical and chemical kind. A third method for obtaining sheets and tubes of smooth copper by electrolytic deposition is that known as the Dumoulin process. In this process, specially prepared strips of skin supply the friction necessary for obtaining dense and homogeneous deposits.

From experiments I made many years ago I ascertained that it was possible, by varying the composition of the depositing solution, to suppress almost completely the common tendency to a strongly crystalline character of deposit, and to obtain a quality of deposited metal comparable to wrought copper in smoothness, hardness, and elasticity. A most remarkable effect in the changed character of the deposit was produced by the addition of a minute proportion of a solution of gelatine in dilute nitric acid, to an ordinary copper sulphate solution composed of a two-thirds saturated solution with 5 per cent. of sulphuric acid. If so much of the gelatine solution as represents 1 part of gelatine to 30,000,000 parts of the copper solution be added, instead of the deposit being pliant and crystalline, it will, under the proper conditions of temperature and current density, be smooth, bright, and elastic, and if the gelatine be in excess the deposit will be extremely hard and brittle. The usual slow rate of electrolytic deposition (necessary where the object is pure copper of the highest conductivity) is often a serious limitation to the utility of a most beautiful process. But in those cases where time is of essential importance, and where extreme purity is not necessary, the rate can be increased. Where even a tenfold more rapid rate would be necessary or advantageous, the means certainly exist for obtaining it—of course, not for nothing—the price to be paid is the use of a higher voltage, and, therefore, extra power. But considerable gain in speed of deposit can be obtained by taking proper advantage of the help that is given by working at a higher temperature, and employing a highly metalised solution of specific resistance, coupled with the use of means for obtaining rapid diffusion of the electrolyte at the cathode surface. Since efficient depositing machines can now be had of almost any size and at a moderate cost—the smaller ones adapted for driving by electric current derived from a general supply, and the larger by independent power—it would not be surprising to find the advantages of electrotype more widely recognised, and the scope of its operations greatly extended, in years to come.

Bullion Refining.

The principle of the separation and purification of metals by electrolysis, that has been so largely and so successfully employed in copper refining, has been also applied with advantage to the parting of gold and silver, and to the refining of base bullion. Silver bullion is refined at Frankfort by the Rossler or Gutzkow process, at Pforzheim by the Dietzel process, and at Hamburg by the Moebius process. Nitrate of silver or the corresponding copper salt is used as electrolyte, and the gold is recovered from the slimes by chemical methods. At Hamburg gold bullion is refined by the Wohlwill process, which depends upon the use of an acid solution of gold chloride. The silver and platinum pass into the anode sludge, and are recovered by chemical methods. The value of these recovered "impurities" helps to pay for the cost of treatment, and in particular cases more than covers it. Bullion refining by electrolytic methods is finding extensive use in America, and at the Guggenheim Refinery at Perth-Amboy a plant for refining silver by the Moebius process, having a capacity of 100,000oz. of silver per day, has recently been put in operation.

Electroplating.

It is an interesting point in connection with the rise of electroplating, the oldest but one of the electro-chemical industries, that it was to meet its requirements that mechanically-produced electric current was first industrially employed. The magneto-electric machine was patented by Woolrich in 1842, and the first machine built was used by Prime, of Birmingham, for electroplating. At the exhibition in Kelvingrove there are two exhibits in this class well worth inspection: one, that of Messrs. Walker and Hall, where the old magneto-electric machine I have spoken of is to be seen; and the other that of Messrs. Elkington, who 60 years ago obtained a patent for electroplating and gilding by means of cyanide of potassium solutions of gold and silver. During all the progress of later years in other branches of electro-chemical industry there has been little or no change in this. The solutions as patented by Elkington are identical with those in general use at the present day.

Zinc and Nickel Plating.

An important development in the application of the principle of electroplating is its use for the purpose of giving to an inferior metal a protective coating of a metal of a harder or less oxidisable metal, other than gold or silver. The most noteworthy instances of this kind are the galvanic coating of iron with zinc; of copper with a thin protective film of iron, industrially known as "steel facing"; and the plating of iron and other metals with nickel. So-called galvanised iron is, as we all know, a misnomer. There is nothing more galvanic about it than there is in coating iron with tin by dipping it in a bath of fused metal. But there is a true galvanic zincing process which is used to a limited extent in coating boiler tubes. The advantage claimed over the dipping method is that the physical properties of the iron are less altered. The deposition of iron on copper is mainly employed for preventing the wear of engraved copper plates. The steely hardness of the thin coating, which is nearly pure iron, except for occluded hydrogen, is very remarkable. The plating of small articles with nickel has now grown into a considerable industry, chiefly owing to the requirements of the cycle trade and the demand for nickel-plated accessories. Electrolytic coatings of cobalt, platinum, and palladium have also been quite successfully applied to other metals as protective coatings, but so

* Ulke, in a recent article, has "estimated" the U.S.A. production at 211,000 tons per annum.

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far no great use has been found for them. Perhaps one of the most notable of these outlying examples is that of the deposition of palladium on the electrotype concave mirrors made for projectors by Cowper-Coles in order to improve and preserve the reflecting surface.

Aluminium.

I now enter a different and a wider field—that of the extraction of metals from their ores—a field in which successful work was only possible after the dynamo was well developed, because the consideration of extremely cheap power is much more pressing in this case than in copper refining, or any of those cases in which the same metal is dissolved at one pole and deposited at the other. For the moment interest chiefly centres in aluminium and sodium. Both these metals had been for many years produced in considerable quantities by purely chemical means—the method of Deville in the case of aluminium, and that of Castner in the case of sodium—but the commercial results were such that the market price of aluminium never reached a lower point than 16s. per pound. A revolutionary change was brought about through the successful working out of electrolytic processes by Hall in America and Héroult in France, each working independently of the other. The Hall process was clearly described by Prof. Chandler in his address last year. The process of Héroult is similar. Some little difference there may be in the electrolytic bath and in the form of the apparatus, but substantially they are one and the same. These processes have now been in successful operation for 11 years, and the results are the total extinction of the chemical method and the reduction of the selling price of aluminium to between 1s. and 1s. 6d. per pound. This great reduction in the price of aluminium has led to the creation of a new and large metallurgical industry, by which a most valuable addition is made to the common metals. The production of last year has been estimated at about 6,000 tons. This is divided between Europe and America in the proportion of 2 to 1.

Before passing from the subject of aluminium I may refer briefly to its most important uses. First, we have the use of aluminium in the iron and steel foundry. The addition of a small amount of aluminium, or of an aluminium alloy, the moment before casting serves to remove any oxygen the melted metal may hold in combination, and consequently to increase the fluidity of the metal to be cast. The heat of combination, moreover, is sufficiently great to sensibly raise the temperature of the melted metal. I am unable to give figures showing the amount of aluminium used for this purpose, but it is undoubtedly one of the chief outlets for the metal at present. Probably the next most important use of aluminium is as an electrical conductor in lieu of copper. This application of aluminium has hitherto been chiefly confined to America, and our friends across the Atlantic have shown their confidence in the durability of the new metal by erecting several hundreds of miles of bare aluminium overhead transmission lines. Whether aluminium will prove as resistant to atmospheric corrosion as copper, time alone will show. Experimental trials of aluminium for similar purposes have also been made on this side of the Atlantic, but so far the results are not decisive. In the Glasgow Exhibition you will find an example of the use of aluminium, for the overhead wiring of the outside arc light installation has been undertaken by the British Aluminium Company with metal made at Foyers. This rivalry between aluminium and copper, even it be only a limited rivalry, may prove a salutary check on the price of copper. Limits of time forbid mention of all the various other uses that have been found for aluminium, which result in the consumption of more than 20 tons a day of what was an expensive metal before it became the product of an electro-chemical process. I am told that a large proportion of this huge quantity is used in the manufacture of small articles, such as cooking-pans, drinking-cups, water-bottles, scientific instruments, and innumerable knicknacks of various kinds. Aluminium bronze and aluminium brass and similar alloys are also applications of importance, and absorb a considerable quantity of the metal. Through cheap aluminium and the Goldschmidt process the engineer becomes possessed of a means of producing, in an easy and convenient way, an extremely high temperature applicable to the welding of iron. The chemist and metallurgist are already busy utilising the same means for the reduction of the oxides of the more infusible metals, and the formation of their alloys, in accordance with the original proposal of Vautin. Particularly useful members of this class are chromium and ferro-chromium. I trust that ere long new and still more important uses will be discovered for aluminium.

Sodium and Magnesium.

The electrolytic extraction of sodium is so closely related to that of aluminium that the few observations I have to make on it may be fitly made here. The sodium industry affords another instance of the displacement of an old and purely chemical process by an electrolytic one. The change has been brought about on the sole ground of the greater economy of the electrolytic method. The discovery of sodium recalls a memorable episode in chemical history that links past and present closely together, for the Royal Institution, where we held our meeting last year, is the birthplace of sodium. There, 94 years ago, in the Albemarle-street cellar, where, as of old, ambitious research is still carried on as actively and enthusiastically as ever, sodium first put off its rusty vesture, and in silvery splendour mirrored the eager face of Davy. The principle of Castner's sodium process is exactly like Davy's—both are electrolytic, and in both the electrolyte is fused sodium hydrate. The apparatus as patented is simple. An iron pan with a fire under it contains the fused sodium hydrate. The cathode passes up into this vessel through an opening in its base, and both it and the annular anode which surrounds its upper portion are, I believe, formed of nickel. A strong current is employed, which helps to keep up the temperature of the electrolyte to fusion point. The sodium is released as liquid metal, and rises to the surface of the fused soda, means being taken to remove it and to prevent its combustion on coming in contact with the air. By this process sodium is now manufactured by hundreds of tons, and passes into commerce partly in metallic form, chiefly for use in the cyanide manufacture, but a considerable portion is converted into peroxide of sodium. The total output in 1897 was 260 tons. The Castner sodium process is operated at Weston Point, at Rheinfelden, and at Niagara. Electrolytic processes are also in use at Bellegarde, at Bitterfield, at Hochst, near Frankfort, and at Neuhausen. Further details will be found in Table IV. It is worthy of remark that in England the electricity employed in the process is generated by steam power. In this manufacture advantage is taken of the exceptional purity of the soda produced by the Castner-Kellner alkali process. The consideration of the methods by which sodium is produced naturally leads me to speak of the sister metal, magnesium. In the extraction of magnesium also the electrolytic method has superseded the chemical method. The process is analogous to that used for the extraction of sodium. The electrolyte is fused carnallite. The magnesium industry is small, no large use for the metal having yet been found, and the only factory known to me is that at Hemelingen, in Germany. Quite lately a promising alloy of aluminium and magnesium (called "magnalium"), said to have excellent qualities, has been attracting attention.

Zinc, Copper, and Nickel Extraction Processes.

Before I pass from this section I ought to mention some of the numerous other attempts that have been made to apply electrolysis to the extraction of metals from their ores, and particularly I ought to mention the electrolytic extraction of zinc. Zinc ore has been the subject of innumerable essays, almost all of them failures from a commercial point of view. But I am informed that a process of electrolytic zinc extraction, in which chlorine as well as zinc is produced, is in successful operation at Winnington. This process is based on the patents of Hoepfner, and a considerable quantity of extremely pure zinc is the result. Specimens of this zinc, by far the purest commercial zinc ever made, testing 99·96 per cent., are shown by Messrs. Brunner, Mond, and Co. at the exhibition. The problem of the recovery of the metals contained in the mixed sulphide ores of the Broken Hill district of New South Wales has exercised the skill and ingenuity of many chemists—a full description of the various processes tried would itself occupy more than the time at my disposal to-day. In this field electrolytic methods have not, it must be confessed, met with the success that was at one time hoped. The Swinburne-Ashcroft process is still in the experimental stage of development. Many modifications in the original method have been made, and that now being tried consists, I am told, in the mixture of the pulverised ore with fused zinc chloride, in the removal of the silver and lead after chlorination by chemical substitution, and in electrolysis of the molten mass containing only zinc chloride. The attempts to apply electrolytic methods in the extraction of other metals directly from their ores have nowhere as yet achieved distinct success. Both copper and nickel ores have been the subjects of many experiments, and in some cases large installations of plant have been put down and operated. In the eighties the Siemens and Halske and Marchese methods for treating copper ores received industrial trial, I believe without permanent success. More recently the Hoepfner processes have been the subject of similar large scale tests in Germany; and in America there has been considerable activity in connection with processes for nickel extraction at Niagara, and at Saulte Ste. Marie. I have been unable to ascertain the commercial results of these recent industrial trials. The Hoepfner process for treating nickel-copper ores and residues is operating at Papenburg, in Germany. The production towards the end of 1900 was stated to be at the rate of one ton of nickel per day. I am not aware of the existence of any other nickel works in Europe using this process; but electrolytic nickel is said to be produced by two firms using methods similar to those employed in copper refining—*i.e.*, using anodes of raw nickel. Dr. Mond has estimated that the total consumption of nickel is now 9,000 tons per annum, and the new Clydach works in South Wales, where his most beautiful nickel carbonyl extraction process is about to be worked, are designed to produce 1,500 tons of nickel per annum. Nickel may therefore now be regarded as one of the common metals.

Gold Recovery from Cyanide Solutions.

On the border of the field of electrolytic metal extraction we find in successful operation a process for the recovery of gold from the weak cyanide solutions yielded by the treatment of the tailings and slimes of the Rand goldfield. The process is that of Messrs. Siemens and Halske. An extremely weak electric current is used, and the gold is deposited as a brown coating on thin lead cathodes. When the gold deposit has sufficiently accumulated the cathodes are exchanged for new plates, the gold-coated plates being melted, and the gold recovered by cupellation. The lamentable war in South Africa has caused the suspension of all mining operations for nearly two years, and consequently no very recent statistics of this process are available. On Jan. 1, 1898, it was stated that 13 works in the Rand district were using Siemens and Halske's process, and that 12 others were about to adopt it. Pauli, in the same year, estimated that 88,000 tons of tailings and 46,000 tons of slimes were being treated monthly by this process. But improvements in the older zinc process, which are said to have made it the equal of the electrolytic process for treating very dilute cyanide solutions of gold, had been made shortly before the war broke out. The first cost of the plant for the improved zinc method of treatment is considerably less than that required for an electrolytic plant, and therefore the limits of expansion for the electrolytic process may probably have been reached. The costs of operating the two processes were given by Yates in 1897 as 3s. 2d. for the electrolytic, and 2s. 6d. for the zinc, process per ton of tailings, but the modified zinc process costs rather more than the original one; and the cost of treatment (neglecting interest on capital outlay) is now, I believe, about equal. Before leaving the subject of gold recovery I may refer to the Riecken process, now being tried on a large scale in Western Australia. In this process the finely-divided ore is agitated with a

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solution of sodium chloride containing potassium cyanide; and during agitation the mixture is electrolysed, with amalgamated copper plates as cathodes, and carbon anodes. The mechanical difficulties involved in this method of treatment are obvious.

THE ELECTROLYTIC ALKALI AND CHLORINE INDUSTRY.

I now pass on to speak of the electrolytic alkali and chlorine industry, embracing the production of caustic and carbonated alkali, and of bleaching powder, hypochlorites, and chlorates. For obtaining chlorine and sodium, or chlorine and soda, no process can, theoretically considered, be more beautifully simple and complete than the electrolysis of chloride of sodium; but when an attempt is made to carry out this form of decomposition on an industrial scale a number of perplexing practical difficulties present themselves. If, with a view to obtain a high yield from a small plant, the chloride is used in the state of fusion, then the selection of a suitable material for the electrolytic cell, and the separation of the electrolytic products, both at a high temperature, are found to be matters of serious difficulty. Numerous attempts have, nevertheless, been made to overcome these obstacles, and two processes—namely, that of Hulin and that of Ackers—have attained industrial trial in France and America respectively. The Hulin process has not yet achieved financial success, and modifications of the original process are now, I understand, being introduced. The Ackers process is more recent, and though now in operation at Niagara, its ultimate value is uncertain. Greater success has attended the employment of aqueous solutions of common salt, as the electrolyte, for the production of alkalies and bleach. The electrolytic decomposition of brine, or of potassium chloride solutions, has already attained the rank of a stable and successful industry. The forms of apparatus employed have not yet settled down to a uniformity of type, such as obtains in the competing chemical processes; and there is much obscurity concerning details of the processes employed at several of the Continental electrolytic alkali works. I may, however, state that there are two well-marked types of cell employed in the electrolysis of brine for production of alkalies and chlorine. One is the type in which mercury is used to amalgamate with and separate the sodium or potassium set free at the cathod, and to remove it from the area of electrolytic or chemical reactions within the primary cell. In the other type of cell a diaphragm is used to divide the anode and cathode compartments, and the chemical reaction by which the metal is transformed into the hydrate is, as far as possible, restricted to the cathode compartment.

With respect to the first type of cell, two forms are in actual use, and are working with satisfactory results—namely, the Castner-Kellner and the Solvay cells. The former is operated at Weston Point, at Osternienberg, and at Niagara; while the latter is stated to be in use at Jeneppe, in Belgium, and at Donetz, in Russia. The process worked out by the "Elektron" Company, of Frankfort, and now operated in a large number of electrolytic alkali works in Germany, France, Switzerland, and Russia, is stated to be a diaphragm process; but this company refuses to give any information upon this point, and the above statement is only conjectural. The Castner-Kellner and the Solvay cells have so often been described in print that it is unnecessary for me to repeat the description. Through the courtesy of the directors of the Castner-Kellner Company I have been permitted to visit their works at Weston Point. There I saw in full operation a chemical works employing 4,000 h.p., and yielding a large output of very pure soda and very strong bleaching powder, and also a large quantity of sodium and its products without creating any kind of nuisance. There were, it is true, four tall chimneys, but these were almost smokeless. The ashes from the engine furnace and a little thin smoke from the chimneys were the sole products in the nature of refuse. The solid contents of the brine, brought into the works by a pipe from the neighbouring salt beds, were wholly transformed by steam power into valuable products. The bleaching-powder plant covered two acres. I believe it is the largest in the world. The cleanliness and regular working of an electrolytic alkali process are not unimportant points in its favour.

Turning now to a consideration of the industrial position of the diaphragm type of cell, I find that three modifications of it are in actual use. One of the best known of this type of cell is that devised by Hargreaves and Bird, and described in great detail by Mr. Hargreaves before the London section of this society in December, 1895. The success of an experimental plant which was worked for six years at Farnworth has led to the erection of a large factory at Middlewich, in Cheshire. On the occasion of a recent visit to these works, the building of which is not yet completed, I saw a double series of 11 large cells in operation, each cell taking an E.M.F. of nearly five volts and a current of 2,000 to 2,500 amperes. The higher E.M.F. required per cell than that given by Mr. Hargreaves in his original paper is stated to be due to the use of thicker diaphragms. The product here is not caustic, but carbonate of soda, and bleaching powder. Asbestos and Portland cement rendered porous by the admixture of various salts during setting and subsequent lixiviation, have both been successfully employed as the material for the diaphragms. Other diaphragm processes in actual operation are the Outhenin-Chalandre and the Le Sueur processes. The first is worked at Chevry, near Geneva, and at Montiers, in France; while the second is operated at a paper mill near Berlin Falls, New York.

(To be continued.)

LIGHT RAILWAY COMMISSION.

List of Applications made to the Light Railway Commissioners in May, 1901, for Orders Authorising Light Railways.

Title.	Promoters.	Engineer.	Mileage.	Motive power.	Gauge.
					ft. in.
Canterbury, Herne Bay, and Whitstable	O. W. Bowen and W. J. Kershaw	Pritchard, Green, and Co.	16	Electric	3 6
County of Middlesex (extensions) No. 1	Middlesex County Council	V. B. D. Cooper	10½	Electric	4 8½
County of Middlesex (extensions) No. 2	Middlesex County Council	V. B. D. Cooper	11¾	Electric	4 8½
County of Middlesex (extensions) No. 3	Middlesex County Council	V. B. D. Cooper	25¼	Electric	4 8½
County of Middlesex (extensions) No. 4	Middlesex County Council	V. B. D. Cooper	30¾	Electric	4 8½
Crewe	British Electric Traction Company	S. Sellon	6½	Electric	4 8½
Crowland and District (amending)	Crowland District Light Railways Company	—	Extension of time,		etc.
Holmfield and Southowram	Wm. Oates and J. S. Hartley	W. B. Myers Beswick	4½	Steam	4 8½
Lizard (amending)	Lizard Light Railway Company	—	Level	crossings,	etc.
London United Tramways (Light Railway Extensions)	London United Tramways Company	J. Clifton Robinson	21¾	Electric	4 8½
Middleton (deviation)	British Electric Traction Company	S. Sellon	(40 yards)	(Deviation)	
Preston and Horwich	Auxiliary and Light Railways and Tramways Company	C. Chadwell	24	Electric	4 8½
Preston and Lytham	E. Bois, G. Hunter, and C. Osborne	C. Chadwell	12¼	Electric	4 8½
Rotherham and Laughton	T. Marrian and W. Binns	E. O. Ferguson	8	Steam	4 8½
Rother Valley	Rother Valley Light Railway Company	H. F. Stephens	8	Steam	4 8½
Southend, Burnham, and Bradwell	Railways and General Construction and Maintenance Company	M. Noel Ridley and V. B. D. Cooper	20½	Electric	4 8½
Southowram and Elland	J. Morton, Limited, Southowram Stone Company, and others	J. H. Rhodes	9¾	Steam	4 8½
South Shields, Sunderland, and District	British Electric Traction Company	S. Sellon	8¼	Electric	4 8½
Spen Valley and Morley (extensions)	British Electric Traction Company	S. Sellon	3¼	Electric	4 8½
Tottenham, Walthamstow, and Epping Forest	Metropolitan Tramways and Omnibus Company	S. Sellon	10	Electric	4 8½
Turton, Tottington, Ramsbottom, and Rawtenstall	Lancashire Light Railways Company	A. H. Gibbings	18½	Electric	4 8½
Wakefield (extensions)	J. Fell, J. J. Gittings, E. Horton, and W. J. Kershaw	Pritchard, Green, and Co.	6½	Electric	4 8½
Woodbridge District and Bawdsey	Sir Wm. C. Quilter, Major Cobbold, and R. Johnson	Cecil Brown	8¾	Steam	4 8
Woolwich, Eltham, and District	Auxiliary and Light Railways and Tramways Company	C. Chadwell	4½	Electric	4 8½
Gower (amending)	Light Railways Syndicate	—	Extension of time,		etc.
Vale of Rheidol (amending)	Vale of Rheidol Light Railway Company	—	Extension of time,		etc.

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THE ELECTRICAL ENGINEERS IN SOUTH AFRICA, AUGUST, 1901.

We have received the following tabulated report of work being done by our Electrical Engineers in South Africa from Sergeant-Major C. T. Ruse at the London head quarters. The report gives in a very brief way a good idea of the work which the men have in hand, and shows that the corps is split up into very small detached units, each required to show individual enterprise and expert knowledge in carrying out the work entrusted to them.

Where employed.	Nature of work.	N.C.O. or sapper in charge is named first.
Headquarters.....	Commanding	Major A. Bain.
	Regtl. Sergt.-Major ...	Sergt.-Maj. J. Gunn, R.E.
	Pay sergt.	Sergt. W. McLeod.
	Storeman	Sap. Boult.
	Transvaal.	
Johannesberg.....	Officers	Capt. O. Shaughnessy, Lieuts. Pearce and Rich
	Fort and barrack installation.	Sergt. Marshall, Saps. Solomon and Hawkins.
	No. 6 general hospital.	Sap. bigge.
	Supt. of electric lighting of buildings occupied by military.	Corpl. Hamilton.
Belgravia and No. 13 general hospital.	Searchlight installation.	2nd-Corpl. Clarke, Saps. Hebden, Nebel, Collins, Squire.
Forest Hill.....	Searchlight.....	Saps. Jones, Portway, Cameron.
Crown Reef.....	,, ...	Saps. Price, Linck, Coleman, Smith.
Springs	,, ...	2nd-Corpl. Bell, Saps. Bayley, Cornelius, Dellagana.
Klerksdorp.....	,, ...	Corpl. Shaw, Saps. Kelly, White, Crowder.
Randfontein	,, ...	Saps. Lewis, Cockburn.
Krugersdorp	,, ...	Corp. Rogers, Sap. Padmore.
	(2) Hospital installation	Sap. Amos
	(3) Staff offices installation	Sap. Edmunds.
Heidelburg	Searchlight.....	Sergt. Peart. Saps. Hedgecox and Peck.
Eden Kop	,,	Corpl. Dobson, Saps. Rumble, Bartlett.
Standerton	Installation, lighting, hospital, and railway station and bridge	Sergt. Davis, Saps. Beatty, North, and Gayford.
Pretoria	(1) Barrack installation	Sergt. Holmes, Saps. Francis, Bryant, Dallison, Gentle, and Macgregor.
	(2) Traction engines ...	Lnce.-Corpl. Durling, Saps. Alcock, Middleton, Lowe.
	(3) Fort installations...	Corp. Botting and four sappers when available.
	Orange River Colony.	
	Officers	Capt. the Hon. R. C. Craven, Lieut. Leaf.
Bloemfontein	Hospital installation...	Corpl. Thorpe, Sap. Stark.
Kroonstad	,, ...	Being installed.
Norvals Pont	,, ...	Corpl. Liddle, Sap. White.
	(2) Bridge defence	Lynn, Jones, Gallimore.
Bethulie	,, ...	Saps. Porte, Harrington.
Vereeninging	,, ...	Corpl. Welling, Sap. Webb-Bowen.
	Cape Colony.	
	Non-commissioned officer in charge: C.S.M. J. H. Field.	
Simons Bay	Boer prisoners' camp installation.	Lnce.-Corpl. Haswell and four sappers.
Wynberg	Hospital installation.	Sap. Hickling.
Green Point	Boer prisoners' camp installation.	Saps. Harris and Hunt.

Sergeants J. Holmes and Brander, Corporals Devonshire and Holliday, Second-Corporals Bertram and Coxon, and sappers not enumerated above, are employed installing new lights or on necessary camp routine. All the foregoing installations, with few exceptions, have been put in by the Electrical Engineers. It is interesting to note that this detachment has been remarkably free from sickness and casualties; the health of the men has been capital; they have plenty of work to do, of a varied nature and also instructive. The letters that arrive are very cheerful, and altogether they seem to be having as good, if not a better time than the first South African contingent had.

GREAT NORTHERN AND CITY RAILWAY.

The excavation work on this railway has now so far progressed as to render the ordering of the electrical equipment necessary, and the contract for this was recently secured by the British Thomson-Houston Company, Limited. In this all the plant and apparatus for the operation of a three-minute service between Finsbury Park and Moorgate-street is included. Each of the trains will consist of seven cars. The two end cars and also centre car will be equipped with motors. The schedule time allowed for the journey of seven miles is 13½ minutes, allowing for three intermediate stops of 20 seconds each. The weight of the complete train will be approximately 200 tons. This road is of more than ordinary interest, from the fact that it is the first electric railway in Great Britain to be operated entirely on the train control system. As regards the generating station, the exact number and type of the boilers has not yet been fully decided upon, but the working pressure will be 160lb. per square inch. The boilers will be fed by three vertical duplex pumps, and the feed-water heater (vertical also) will have a capacity of 7,500 gallons per hour. The economiser will consist of 480 tubes, arranged in sections 10 tubes wide. All the steam-pressure piping will be of heavy lap-welded pipe tested to 500lb. per square inch. There will be provided a Hunt coal-conveying plant, of the noiseless automatic gravity bucket type, sufficient to handle 30 tons of coal per hour. There will also be two vertical three-throw single-acting lifting pumps, a storage tank of 21,000 gallons capacity, and water-softening plant to treat 8,500 gallons per hour, and two receiving tanks, each of 4,700 gallons capacity. The economiser, mechanical stokers, coal-conveyor, and lifting pumps are all to be operated by electric motors.

The engines, of which there will be four, will be of the vertical cross-compound condensing type, made by John Musgrave and Co. Each engine will be capable of developing 1,250 i.h.p. as a normal load, and 1,875 i.h.p. as a maximum, when running at 100 revolutions per minute and working with a steam pressure of 150lb. per square inch. Each engine will be arranged to drive an 800-kw. generator, which will be mounted on the main crankshaft between the engines. The specifications call for a speed variation of not more than 2½ per cent. either way between full load and no load. There will also be two vertical, tandem, compound non-condensing auxiliary engines capable of developing 83 i.h.p. continuously. The condensing plant will consist of four surface condensers, with combined air and circulating pumps. The engine-room will be provided with a 30-ton overhead travelling crane, operated by three electric motors.

The dynamos will be of the standard Thomson-Houston railway type, having 14 poles and a capacity of 800 kw., voltage 525 no load, 575 full load, when running at 100 revolutions per minute. There will be two auxiliary generators of the same type, each 50 kw. capacity, voltage 550 no load, 575 full load, running at 400 revolutions per minute. These two generators are intended to supply current for the lighting and power required at night for the stations and repair-shop tools, etc., when the main generators are shut down.

The switchboard will consist of four main generator panels, four main feeder panels, two auxiliary generator panels, three auxiliary power panels, three auxiliary lighting panels, and voltmeter equipment. These panels will be equipped with magnetic blow-out circuit breakers, Thomson astatic instruments, wattmeters, switches, etc., all of the British Thomson-Houston standard pattern.

The third rail to be of channel section, weighing 80lb. per yard. The resistance of the material, as specified, not to exceed 0·32 ohm per mile per square inch of cross-sectional area. The bonds will be of the copper plastic type, and the rails will be supported every two yards on porcelain insulators of the double petticoat type. At intervals the collector rails of the up and down tracks will be interconnected, an automatic circuit breaker being placed in each interconnecting circuit, so as to enable either pair of rails to be isolated from the other when desired.

Under the contract there will be provided 36 motorcars,

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each mounted on two four-wheel trucks, each truck carrying one Thomson-Houston GE-66 geared motor, and each car will have four collector shoes and the usual controllers, circuit breakers, etc., making complete motorcar equipment. The brake equipment will be of the Christensen type.

The working of this line will be a great convenience to a large section of the population of Greater London, as the speed scheduled of over 31 miles per hour, including stops, is a great advance on any present connection from the suburbs to the City. Thus the average schedule time on the "Tube" is about 15 miles per hour, including stops. The difference is largely accounted for by the difference in the distance between stations, but in this respect the Great Northern and City Railway is an example of what must be done to provide to get people out of and to the City quickly. Thus express routes are wanted, not stopping trains.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

407. How would you find out the current that is required for a 5-h.p. alternate-current motor at 100 volts 50 ⁓? Can the formula be applied to polyphase motors? Give example.—T. H. A.

408. How would you ascertain the efficiency of a single-phase alternator separately excited? Should the exciting current be taken into account? Give a practical example of the losses likely to be found.—J. B.

ANSWERS.

Question No. 401.—Is there any method of protecting an overhead telephone line, about half a mile in length, running over the tops of houses, from lightning discharges? The instruments have the ordinary arresters fitted, and evidently the lightning passes through them owing to the discolouring of the points; but a month ago during a storm the induction coil was burnt out, and a week ago, during another storm, the receiver coils were fused.

Answer to No. 401 (*awarded* 7*s.* 6*d.*).—The best method of protecting an overhead telephone line is either by means of a suitable lightning arrester or by means of a fine wire fuse or cut-out placed in the circuit. It is most probable that the results of these mishaps were due to the ineffective working of the arrester, which, probably owing to the warping of the timber used for the base of the arrester, the distance between the gaps had been increased, and not until damage to the instrument had been done by the coil fusing or burning out, and thus breaking the circuit, had the lightning any other passage to earth other than across the gap, thus discolouring the points; or the gap may have been full of dirt, and thus being in a parallel circuit with the instrument and the earth and the lightning discharge dividing between the two circuits, thereby damaging the instrument and discolouring the points on the arrester.

A very good lightning arrester which has the advantage of having a cut out in the circuit consists as follows: The apparatus represented by Fig. 1 consists essentially of three brass cylinders, m_1, M, m_2, fitted upon a common spindle, but insulated from one another. The middle cylinder, M, is directly soldered on the spindle, *s*, and its two extremities are turned down to a smaller diameter than the central portion. The cylinders at each end, m_1 and m_2, are insulated from the spindle and from M by means of ebonite collets. On the reduced ends of M is wound a single layer of silk-covered wire about 40 mils in diameter, which passes from one end of M to the other, crossing the central portion of M in a groove made for the purpose. The two ends of this wire are passed across the ebonite collets, and the cylinders, m_1 and m_2, in similar grooves, and clamped respectively into electrical connection with those cylinders by means of the nut, *n*, and the disc, *a*. The two cylinders m_1 and m_2 are thus brought into electrical connection, whilst the cylinder M is insulated from them by the silk covering of the wire. The spindle is inserted into three brass blocks, p_1, p_2, p_3, in which it fits accurately; good electrical connection is further ensured by the metallic springs, *f*, which press against flattened portions of the cylinders, m_1, M, and m_2. The left-hand block, p_1, is connected to the wire leading to the apparatus, the right-hand one, p_3, to line, and the centre one, p_2, to earth. The line circuit thus passes from the right-hand block, through the silk-covered wire and the left-hand block, to the apparatus. If a current of dangerously high potential passes from the line to the lightning protector it must pass through the silk-covered wire, which it will melt or heat so as to destroy the silk covering, thus passing to M, and thence to earth. The

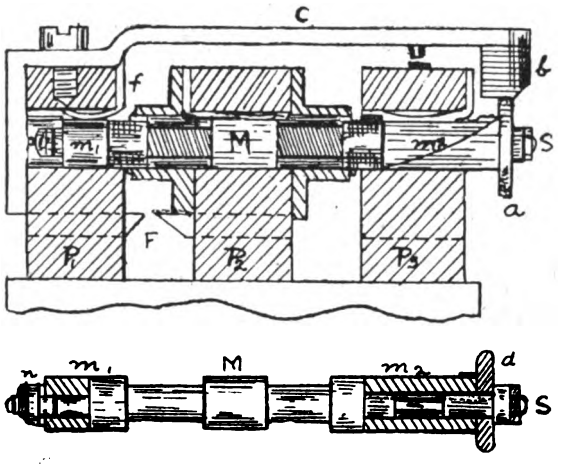

FIG. 1.

circuit of the apparatus will, therefore, be broken by the melting of the wire, or diverted to earth, and in either case the apparatus itself is secured against damage. When the protector has acted in this way, and consequently broken down the circuit, working conditions may be restored by simply removing the bobbin. When in position, the disc, *a*, at the end of m_2 lifts the spring, C, by means of the ebonite block, *b*, so that the platinum contact upon C is clear of p_3, but on the removal of the bobbin p_1 and p_3 are joined across by the spring, C, and the circuit is restored, but without the bobbin protector. There is, however, a protector of the toothed form at F, which prevents the circuit from being absolutely unprotected in any case. If a new bobbin be now inserted, the disc, *a*, again raises the spring, C, and places the protecting wire of the new bobbin in circuit.—L. B. H.

Answer to No. 401 (*awarded* 7*s.* 6*d.*).—The arresters that are fitted to ordinary telephones are, to say the least, very crude, and are also uncertain of action, especially if the two plates get shifted apart too much. Undoubtedly the best form of arresters for telephones are those used by the Post Office on their long trunk lines. Each trunk line is connected up to a test hole, which is connected by a U-link to the switch sections; an arrester is connected to each of these test holes where the trunk lines come in, as shown in the sketch. They consist of a brass tube, A, secured to an ebonite base by means of a nut and washer, D. A hole, *e*, is drilled through the tube, and through this the trunk main is passed, bent over and soldered, thus making an excellent joint. Into the end of the test hole is secured a brass plate carrying a carbon disc, F, which is one of the pair of plates of the lightning arrester. The mica disc, G, has three $\frac{3}{16}$in. holes in it, through which the discharges may take place, from plate F to plate H, which latter plate is connected to earth by means of a clamping spring, K, which is used to mechanically hold the plates together; thus it will be seen that the two plates are separated by only a very small air-space. In the case in point

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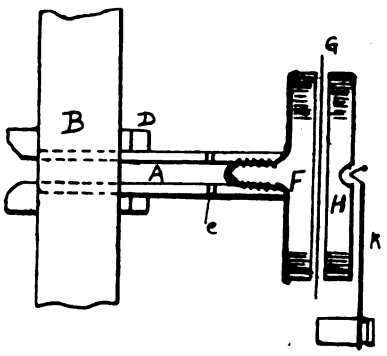
an arrester would be fixed at each end of the line; the test hole would, of course, not be required, but the line would be connected straight through. The above figure is full size. The mishaps might have been the result of the long drought, which had dried up the ground round the earth-plate, thus making practically no earth at all, in which case no type of arrester would have been of any avail. A remarkable incident of this kind happened at about the time "F.G.C." is alluding, and may be of interest to the readers of the *Electrical Engineer*. It happened to an electric lighting system in the North of England, the supply being on the three-wire system with the middle earthed; the middle wire was earthed on to a water-main and also a earth in the bed



of the river. Some wires on a consumer's premises run close up to a lightning conductor, and during the storm a discharge took place down the conductor, but not having a proper earth—on account of the drought—pierced the insulation of the wire and went straight through the system and put an ammeter to earth, arcing over $\frac{1}{16}$in. air-gap, two voltmeters, piercing $\frac{1}{16}$in. ebonite, and burnt out the coils of four more voltmeters on the main switchboard. These voltmeters were on either side of the system (220 volts); all the 440-volt meters were unharmed, as they were not connected to the middle wire.—C. L. E. S.

Answer to No. 401 (*awarded* 5*s.*).—The question does not say whether the circuit is a metallic line or only single. If metallic, then it is probable, since there is no reference to it, that no earth-wire is installed to arrest the lightning. Fig. 1 shows how the arrester plates are connected on most instruments. In the case of a single line, where the earth-wire takes the place of line 2, this should be strapped across to the middle terminal, marked E. Sometimes a circular hole is provided, as shown, to receive a tapered metal plug, which if inserted during lightning storms short-circuits the instrument and makes its safety certain. If "F. G. C." has the arrangement of his arrester according to the sketch, he should make certain of his earth-wire and trace it to its termination, which should be a *soldered* con-

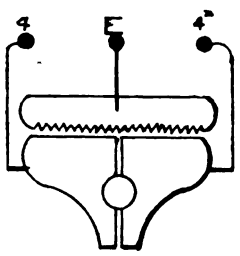


FIG. 1.

FIG. 2.

nection on either a water-pipe (on main side of cistern) or a metal plate buried in moist soil; this plate should be preferably of copper, 9in. by 9in., and buried at least 4ft deep.

It sometimes happens that the frequent fusing of an instrument is traceable to unsoldered connections of the earth-wire on the water-pipe, or, perhaps, wrongly attached to a waste-water pipe. On a double-wire circuit this bad workmanship is not noticed in the use of the instrument, but with single lines not only is danger from lightning continually present, but bad communication is caused. If the earth-wire is difficult to trace or is suspected broken, then join up an earthed battery and galvanometer, as shown in figure, remembering to use a separate temporary earth from the nearest gas-pipe or water-pipe, and test for the continuity of the suspected earth, which, if good, will complete the circuit of the earthed battery and show a steady deflection on the galvanometer. As both receiver and induction coil were fused, it appears that the instrument must have been in use at both times, for on all modern instruments the secondary circuit is entirely cut off from the line when the receiver is on the rest. The careful adjustment of the arresters also calls for attention, for if the line plates are not very close up to the earth-plate, the low resistance of the secondary circuit makes an easy alternative path for lightning in preference to wholly striking across the plates. The adjustment is easily effected by loosening the line plates and pressing them close to the earth-plate with the edge of a sheet of notepaper intervening, and then screwing up again. A very small air-

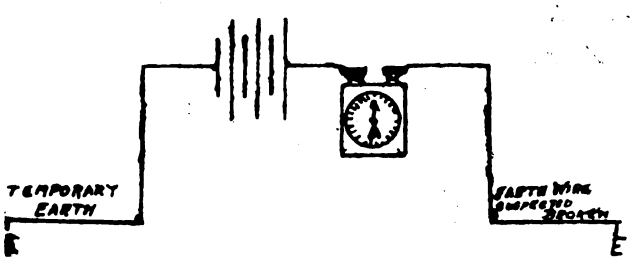


FIG. 3.

space is then left, and there is no reason why the whole of the lightning should not be diverted if the serrated points of the earth-plate are sharp and free from verdigris. On the latest type of instruments the arrester is of a different type, consisting of an oblong earth-plate with the two line plates screwed tightly on to it, but electrically separated by means of perforated mica ·0055in. thick.

To sum up, "F. G. C." had better make sure of the following points: (1) is the earth-wire a good one; (2) are his plates closely adjusted; (3) was the instrument in arc on both occasions, or was the receiver taken off, thinking it safer, whereas the lower resistance made it more dangerous. F. R.

Answer to No. 401 (*awarded* 5*s.*).—There are several efficient methods of protecting telephone lines from lightning, and it is evident that the querist has one of these in use, which, however, has not been properly installed or maintained. The principal cause of trouble in these installations is the earth-plate conductor, which, on account of its exposed position, is likely to be either broken or corroded away. Varley's arresters are evidently in use, and the trouble should not be due to these if in proper working order. The querist should see to this and to all connections between the arrester and the earth-plate—taking care to do so on a bright day, in case of further atmospheric demonstrations—and he will probably find a broken circuit. Should, however, this not be the cause, a new arrester should be purchased; or by stringing a length of barbed fence wire alongside of the telephone wire, and connecting either end to an efficient earth, the pernicious juice may be kept off the telephone line altogether. And a perusal of Mark Twain's monograph, describing the historical experiment which culminated in the installation of 4,875 lightning conductors over his house, and the totally unlooked-for result, may be recommended to the querist should he be inclined to trust himself to the tender remedies of the trade.—B. C. H. J.

Question No. 402.—Could any of your readers give me a description of the duties of a sea-going electrician on board a large liner?

Answer to No. 402 (*awarded* 7*s.* 6*d.*).—The duties of an electrical engineer on board of a large liner are not, as a rule, very heavy. (I speak from P. and O. experience.) You are in entire charge of all the electrical plant aboard, including the dynamos and their engines, usually three, sometimes two, and often four machines. You do all gland packing and minor repairs, and start and stop your own engines. You don't keep any regular watch, but you must be on hand at all times, night and day, whether in port or out of it. You have shifts of greasers and cleaners, who, by the way, are generally Lascars, and a knowledge of Hindustani is required to work them properly, but this you

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can pick up in a week or two—at least, all that is necessary. You are directly responsible to the chief engineer for everything, including all stores you use aboard for repairs and running of plant, and you must have his permission to go ashore. You must be able to work searchlight projectors, as these are used in going through the Suez Canal, in conjunction with arc lamps, which you have to connect up on arrival at Port Said and Suez. Sometimes it is required that at some ports the wharf-sheds are wired for lighting. You have to supply energy from the ship. All motors, fans, and bells aboard the ship you have to keep in working order, and a lot of temporary wiring is required for concerts, balls, and other entertainments given aboard by the passengers. You are recognised aboard the ship as an engineer officer, and have to wear and provide a uniform as such. Your kit will cost about £20, which you can conveniently clear by leaving your half-pay payable to your tailor.—J. D. A.

Answer to No. 402 (*awarded* 7*s.* 6*d.*).—

When eight bells have died away,
Then begins the 'trician's day.
Dress and breakfast plenteously,
Till the bell tink-tankles three.
Call upon the watch below,
Just to see how things do go.
Sample cigs. and pouches, too,
With a nip of Mountain Dew.
Look into the engine-room
(At the greaser swear and fume).
Spin a yarn with "Doc." and "Cash,"
When the time goes like a flash.
Lunch has come and lunch is past,
Hammock-chairs around the mast,
Games and jokes and laughter free,
Every kind of jollity.
Lady passengers galore,
All one wants and plenty more.
Afternoon has simply skimmed,
Time to see if brushes trimmed.
Look into the engine-room
(At the greaser swear and fume).
Tea-time passed, and dinner done,
Turn the steam on No. 1.
When the lamps go very dim
Wake the greaser, pummel him!
When the lamps o'errun and burst,
Have the greaser kicked and curst!
Six bells gone—it's time to turn
Out day circuits; only burn
Alley-ways and engine-room.
(At the greaser swear and fume.)
After nightcaps with the mate
Sleep in peace till bell strikes eight.

* * * *

These the duties are on liners
Where the plant is worth the shiners;
But when plant is cut for profit:
Of the two please give me Tophet!

—B. C. H. J.

Answer to No. 402 (*awarded* 5*s.*).—Having had two years' experience as sea-going electrical engineer, I am in a position to describe what duties are expected from the electrician-in-charge. After a successful interview with the medical inspector, I was sent down to the docks on a month's trial, and was engaged with others in repairing the electrical gear on board steamers which arrived in port. At the completion of this time I was appointed to a large liner of some 7,000 tons sailing to India and Australia. There were some 500 lights fitted throughout the ship, including masthead and side lights. These were all incandescent lights, with the exception of one arc lamp, which was used when entering the Suez Canal. The electrical plant, of which I had entire charge, consisted of two Tangye open-type engines coupled direct to two dynamos, having an output of 100 volts and about 250 amperes. Each machine was capable of affording the necessary power for lighting the ship. These machines were fixed at one side of the main engine-room; the main switchboard was fixed at the back of these sets. The latter was of very simple design, and, curious to say, no voltmeters or ammeters were supplied. A spare armature was carried in the event of a breakdown. A searchlight of some 27,000 c.p. complete, with a cage and extra cable, was carried. This was lowered over the bows on arrival at either end of the canal under the direction of the chief officer and myself. My duty was to run this light after dark through the canal, keeping the beam of light so that it covered the channel which was buoyed out for safe passage; and woe betide the electrician if the light failed at this time, as the ship was then in imminent danger of running aground on the sandbanks on either side. However, with ordinary care and a trial beforehand of all the gear, this was not likely to happen. The electrical engineer should be capable of repairing his engines and adjusting same, should be able to carry out any repairs to dynamos, lamp circuits, be able to manage a searchlight. If his boat goes *vid* the Suez Canal he will also be called upon to rig up extra lights at times for stage lighting, dances, etc., which are held on board frequently. Electric bells are fitted throughout, and after a rough day the indicators often give considerable trouble. These get choked up with cockroaches—in fact, most of the trouble with the bells is due to these pests in the writer's experience. Before sailing I had to see that all the necessary stores for my department were got on board, and on the morning of sailing all lights on the ship had to be switched on, and both dynamos running for general inspection. Generally speaking, for the first day or two at sea the lights give a bit of trouble, but these defects are soon remedied. Two native greasers were told off for attending to the machines. My duties for the day were as follows: If the weather was fine the sets were shut down about 9 a.m. From 9.30 to 1 p.m. I did any repairs that were necessary. There was no fixed rule about working hours, and I could choose my own time as long as things were in good order. There were no accumulators on board, and therefore no lights available until starting up a set an hour or so before dark. It was my duty to start up the sets myself, and when this was done, after a look round, I was able to get into deck uniform, the sets being left in charge of a native. With the exception of an occasional stroll round, I was free until 11 p.m., when I had to switch off saloon and smoking-room lights, and after a final look round could turn in for the night, the sets being run by one of my natives until daybreak. This routine is followed day after day throughout the voyage. On one occasion the lamps at the masthead went wrong, and the writer has a lively recollection of a trip aloft in a painter's chair to repair the fault. This happened on a rough day entering the Bay of Biscay, and when hoisted up some 50ft. above the deck the chair started winding itself up round the mast in a series of wide circles, which was most unpleasant to anyone not used to the experience. These matters break the monotony of the voyage somewhat. The life is a very pleasant one when one once gets used to it, the accommodation and food being very good as a rule. The electrician ranks as an officer, and if he behaves himself can, as a rule, go where he likes on the boat when properly dressed. Pay ranges from £8 per month. He is under the chief engineer, and receives all his orders from him or from the second engineer.—G. SWETENHAM.

COMPANIES' MEETINGS AND REPORTS.

BLACKPOOL AND FLEETWOOD TRAMWAYS.

The half-yearly meeting of the shareholders of this Company was held on the 22nd inst. in the Accountants' Hall, King-street, Manchester. From the report of the directors it appeared that the number of passengers had been 648,569 and the receipts £10,183. The balance of profit after providing for debenture interest was £3,556, and the directors recommended a dividend of 4 per cent., which would absorb £3,000. Five hundred pounds was written off for the depreciation reserve, leaving a balance of £56 to carry forward.

The **Chairman** (Mr. George Richardson), in moving the adoption of the report, said that considering they had not taken anything from the reserve, and were yet able to pay the same dividend as last year, the report was a satisfactory one. There had been a slight increase in wages, but every possible economy was exercised. The gross receipts, in spite of the bad weather in the early part of the year, were £126 in

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excess of those of the previous period. The new Fleetwood estate was being laid out, and soon, he hoped, there would be a continuous line of houses from Fleetwood to Blackpool. As a specimen of their takings in fine weather, the chairman gave the receipts for the current week as follows: Sunday, £323; Monday, £492; Tuesday, £452; and Wednesday, £375. In bad weather the receipts were very low.

The report was adopted.—*Manchester Guardian.*

DUBLIN AND LUCAN ELECTRIC RAILWAY.

The report of the directors, submitted to the shareholders at the thirty-ninth ordinary half-yearly meeting of the Company, held on Monday, the 19th inst., stated that after including £49. 12s. 8d. brought forward from the previous half-year, and providing for debenture interest to June 30, there remained a balance of £497. 13s., which was rather more than sufficient to pay a dividend at the rate of 5 per cent. on the preference shares. Having regard to the present being an unfavourable time for raising the small amount of new capital, which had been authorised to pay off the balance of expenditure due for electrical equipment (about £1,000), the Board recommended that £400 out of the half-year's profits be used towards reducing the above amount, leaving a balance of £97. 13s. to be carried forward to next half-year. The traffic receipts showed an increase of £129 over the corresponding half of last year, whilst the expectation forecasted in the last report had been realised in a reduced expenditure of £260, as compared with the first six months of last year, the saving having been effected in each heading of expenditure, but mainly in motive power, and the directors look to a similar saving being made in the current half-year.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Amsterdam.—The Municipality invite tenders for electric motor wagons by Sept. 2.

Bucharest.—The Post and Telegraph Department invite tenders for copper sheets by Sept. 2.

Erivan (Russia).—The Municipality invite tenders for 2½ miles of electric tramways by Sept. 14.

Paris.—Post and Telegraph Department invite tenders for 420,000 porcelain insulators by Sept. 19.

Cairo.—The Public Works Department invite tenders for public and private lighting for Fayouni by Sept. 2.

Listowel.—The Urban District Council are desirous of treating with a responsible firm for the supply of electricity for street-lighting. Tenders by Sept. 30. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of overhead construction for electric tramways. Tenders by Sept. 13. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of arc lamp-posts, wall brackets, and switch boxes. Tenders by Sept. 16. Details in our advertisement columns.

Aston Manor.—The Urban District Council invite tenders for pipework, fitters' shop, and cables for their proposed electric power station. Tenders by Sept. 4. Details in our advertisement columns.

Whitehaven.—The Water and Lighting Committee invite tenders for the supply of incandescent lamps for a period of six months from October 1, 1901. Tenders by Sept. 16. Details in our advertisement columns.

Torquay.—The Electric Lighting Committee invite tenders for the supply and delivery of arc lamp carbons for a period of 12 months from Oct. 1, 1901. Tenders by Sept. 13. Details in our advertisement columns.

Poplar.—The Electricity Committee invite tenders for the supply of multiple-core, covered, lead feeder and network cable and accessories for mains extensions. Tenders by Sept. 18. Details in our advertisement columns.

Doncaster.—The Corporation invite tenders for the supply, delivery, and erection of tramway poles, and overhead construction for the system of Corporation electric trams. Tenders by Sept. 14. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of trolley wire, etc., for overhead equipment; line materials for ditto; span wire, brackets, etc., for ditto. Tenders by Sept. 14. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the electric lighting installation, etc., of the second portion of the Colinton Mains fever hospital, the number of lighting points being about 800. Tenders by Sept. 9. Details in our advertisement columns.

Warrington.—The Corporation invite tenders for the execution of electric lighting, etc., works at the Delph-lane pumping station. Specification, etc., may be obtained from the engineer, Mr. James Deas, A.M.I.C.E., M.I.M.E., Bank House, Warrington. Tenders by Sept. 14.

Kingston-upon-Hull.—The Electric Lighting Committee invite tenders for two high-speed three-crank compound steam-engines, 800 i.h.p. each, and four steel Lancashire boilers, 30ft. by 8ft., for 150lb. steam pressure. Tenders by Sept. 26. Details in our advertisement columns.

Southend-on-Sea.—The Corporation invite tenders for supplying and laying, on the solid system, certain electric lighting cables within the borough. Specification, etc., may be obtained from Mr. D. F. Adamson, M.I.E.E., borough electrical engineer, Corporation Electricity Works. Tenders by Sept. 7.

Madrid.—The Department of Agriculture invite tenders for the installation and working of an electric tramway for not more than 60 years. The route is from Linares to the mines of San Rogue and Tortilla. The deposit is 11,105 pesetas provisional, and 55,526 pesetas finally. Tenders by Oct. 17.

Aston Manor.—The Urban District Council invite tenders for water-tube boilers, stokers, and economiser, two 500-kw. steam dynamos, one 200-kw. steam dynamo, motor balancer, switchboard and testing-room, travelling crane, and arc lamps for their proposed electric power station. Tenders by Sept. 4.

Rotherham.—The Corporation invite tenders for supply of a three-crank compound engine and four-pole dynamo, with normal output of 165 kw.; also for an extension panel on the existing switchboard at the electric light station. Tenders to be sent to Mr. H. Hampton Copnall, town clerk, Town Hall, Rotherham, by Sept. 3.

London, W.C.—The British Electric Traction Company invite tenders for the supply of about 5,000 tons of steel grooved girder tramway rails, fishplates, etc. Specifications, etc., can be obtained on application to the Chief Engineer of the Company, Donington House, Norfolk-street, London, W.C. Tenders by Sept. 20.

Mansfield.—The Electric Lighting Committee invite tenders for refuse destructors (to deal with the whole of the refuse of the borough) by Sept. 5. Specification, etc., may be inspected at the offices of Mr. Robert Hammond, M.I.C.E., the consulting engineer to the Corporation, 64, Victoria-street, Westminster, London, S.W.

Dundee.—The Town Council invite tenders for the overhead equipment of the following routes of the Dundee city tramways—viz.: Constitution-road route and Victoria-road and Fairmuir route. Specifications, etc., may be had on application to Mr. Walter H. Tittensor, city electrical engineer, Dudhope-crescent-road, Dundee. Tenders by Sept. 14.

Lowestoft.—The Corporation invite tenders for the supply and erection of one 500-kw. steam dynamo (vertical enclosed engine), with pipework connections complete, and switchboard panel with cable connections to dynamo. Specifications, etc., may be obtained at the office of Mr. R. Beattie Nicholson, town clerk, 115, High-street, Lowestoft. Tenders by Sept. 9.

Middlesbrough.—The Electric Lighting Committee invite tenders for the supply and erection of mechanical coal-handling plant in connection with the municipal electricity works. Specification, etc., may be inspected at the offices of Mr. Robert Hammond, M.I.C.E., consulting engineer to the Council, 64, Victoria-street, Westminster, London, S.W. Tenders by Sept. 3.

Bournemouth.—The Town Council invite tenders for steel grooved girder rails, etc.; conduit permanent-way construction and rail bonding, etc.; ploughs and carrying attachments to cars; wood block, tar macadam, and granite sett paving. Specifications, etc., may be obtained from Mr. W. Lacey, M.I.C.E., borough engineer, Municipal Offices, Bournemouth. Tenders by Sept. 17.

Oldham.—The Electricity Committee invite tenders for the supply, delivery, and erection of two electric overhead travelling cranes. Specification, etc., can be obtained from Mr. Arthur Andrew, Gas and Water Offices, Oldham. The specifications and drawings can be seen at, but not obtained from, the offices of Dr. Alex. B. W. Kennedy, 17, Victoria-street, Westminster, S.W. Tenders by Sept. 10.

Batley.—The Corporation invite tenders for the supply, delivery, and laying in the borough of Batley of steel rails, points, crossings bonds, and accessories, granite setts, stone setts, wood blocks, concrete, and all excavation work, and laying of the permanent way for tramway (approximately 3½ miles). Specifications, etc., may be obtained from the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by Sept. 14.

London County Council.—The County Council invite tenders for work to be done in supplying, fitting, and fixing lifts, motors, pumps, ventilating fans, lamps, cables, wires, conductors, switchboards, and columns, together with all supports, apparatus, fittings, and accessories which may be necessary or required for the electrical equipment of the Greenwich footway tunnel and its approaches. Specifications, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a continuous-current 1,500-kw. dynamo working at from 550 to 625 volts, and the erection of these sets in the generating station of the South London Electric Supply Corporation, near Loughborough Junction. Also for three auxiliary 250-i.h.p. vertical high-speed enclosed steam-engines, each coupled direct to a continuous-current dynamo working at from 200 to 225 volts, and for the erection of these sets in the Council's generating station at Greenwich. Specifications and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a three-phase 1,500-kw. generator working at from 6,500 volts between conductors, each with an exciter, and for one 750-kw. reversible synchronous motor-generator, with exciter, designed so that either the low-tension or the high-tension side of the set will act as generator, and for the erection of these sets in the Council's generating station at Greenwich; also for nine 300-kw. synchronous motor-generators, working at from 550 to 600 volts on the low-tension side, each with an exciter, and for three 50-kw. induction motor-generators, working at from 200 to 225 volts on the low-tension side, and the erection of these sets in sub-stations provided by the Council. Full particulars may be had at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

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RESULTS OF TENDERS.

Brighton.—The Guardians have accepted the tender of H. J Galliers, Brighton, at £688. 16s., for installing electric light in a portion of the workhouse premises in Elm-grove.

Farnworth.—The Urban District Council have accepted the tender of the British Insulated Wire Company, Limited, Prescot, for the overhead equipment of about five miles of tramways and tramway poles.

Tyne Docks.—The Tyne Improvement Commissioners have accepted the tender of Messrs. Crompton, amounting to £5,185, for arc and incandescent lighting and mains at the Albert Edward and Northumberland Docks, in accordance with the specification prepared by their consulting engineers, Messrs. Handcock and Dykes, of 3, St. Nicholas-buildings, Newcastle-on-Tyne.

Mansfield.—The Council have accepted the following tenders :—

J. Musgrave and Sons, Limited, boiler-house plant	£3,162	0	0
T. Parker, Limited, engine-house plant	6,180	0	0
Johnson and Phillips, condensing apparatus	725	0	0
B. Thomas, switchboard	1,462	14	3
Tudor Accumulator Company, Limited, accumulators (with 100 per cent. maintenance capacity guarantee)	2,987	0	0
Carrick and Ritchie, overhead crane	316	0	0
Western Electric Company, mains	8,895	11	11
Gilbert Arc Lamp Company, Limited, public lighting	428	14	0
Chamberlain and Hookham, meters	768	15	0
Britannia Company, workshop equipment	336	3	11

Weston-super-Mare.—The Urban District Council have received the following tenders for electric lighting of the new pavilion, according to plans and specifications prepared by Mr. W. C. C. Hawtayne :

Edwards and Armstrong, Bristol	£970	5	0
Tyler and Duncan, London	484	0	0
Weston-super-Mare Electric Wiring Company	372	6	5
W. J. Badman and Co., Weston-super-Mare	353	0	0
C. W. Clark, London	335	10	0
National Wiring Company, Limited, Weston-super-Mare	312	0	0
South and Co., London	310	0	0
Bryant and Sons (accepted)	290	0	0
J. P. Curtis	247	19	9

Greenock.—The Police Board have received the following tenders for electricity works :—(Contract No. 7)—Condensing plant : Mirrlees-Watson Company, Glasgow, £2,158 (accepted). Also tendered : A. F. Craig and Co., Paisley ; Babcock and Wilcox, Glasgow ; Douglas and Grant, Kirkcaldy ; Mather and Platt, Manchester ; Alley and Maclellan, Glasgow ; British Power, Traction, and Lighting Company, York ; India Rubber, Gutta Percha, and Telegraph Works Company, London ; A. Koppel, London ; F. Nell, London ; Worthington Pumping Engine Company, Glasgow ; Cole, Marchent, and Morley, Bradford ; Wheeler Condenser Company, London ; W. H. Allen, Son, and Co., Bedford. (Contract No. 8)—Fan for induced draught : Babcock and Wilcox, £380 (accepted). Also tendered : W. H. Allen, Son, and Co. ; Mavor and Coulson, Glasgow ; Bumsted and Chandler, Hednesford ; Woodburn and Co., Glasgow ; Jackman and Co., London ; F. Nell ; American Blower Company, London. Extension of engine-room building : R. Aitkenhead and Son, £1,175. 18s. 10s. (accepted). Also tendered : A. Whitelaw and Co. ; J. and R. Houston ; E. E. Miller and Co. ; J. Agnew ; J. McEwan ; A. Stevenson. Rest of Greenock.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Wellingborough.—The electric lighting provisional order has received the Royal assent.

Buxton.—Sanction has been obtained to the borrowing of £16,520 for electric supply extensions.

Skegness.—The Post Office authorities are installing the telephone, and the exchange is to be opened this week.

Hoylake.—The work of converting the street gas lamps into electric lamps is to be commenced in about a month.

Bognor.—The Urban District Council have decided to adopt an electric supply scheme at an estimated cost of £15,000.

Finchley.—The salary to be paid to the resident electrical engineer by the Urban District Council has been fixed at £300 a year.

Keynsham.—The Parish Council have accepted a tender from the Keynsham Electric Light Syndicate for lighting 96 lamps for the sum of £188. 10s.

Victoria University (University College, Liverpool).—Session 1901-1902 of the department of engineering commences Oct. 3. Full particulars will be found in another column.

Bristol.—Mr. W. O. E. Meade-King has held an enquiry into the application of the Corporation for sanction to borrow £950 for the purchase of land for electric supply purposes.

Dunstable.—The written report on the electric lighting of Dunstable by Mr. Snell has been received by a committee of the Council, and will be published after the next Council meeting.

Barnsley.—The Park and Lighting Committee have given instructions to the borough electrical engineer to prepare a report upon the provision by the Council of a telephonic system for the borough.

New Catalogue.—Messrs. Robert W. Blackwell and Co., Limited, 59, City-road, E.C., have just issued a new catalogue (No. 39) of their "column" type indicating and recording volt and ampere meters.

Spalding.—The newly-established Post Office telephone exchange at Spalding was opened on Wednesday week. There are 24 local subscribers, and the connection with the trunk line is by way of Boston.

Newark.—The Electric Lighting Committee are to visit Peterborough on Sept. 3 to inspect the electric plant there, and compare the cost of that undertaking with what it is estimated to cost at Newark.

Amble.—The Urban District Council intend to support the application of the Northern Electricity Company for a provisional order for supplying Amble with electricity for public and private lighting purposes.

Barnstaple.—After much discussion the report of the Electric Lighting Committee, recommending the Council to proceed with their electric lighting scheme, and the application to borrow £27,000, has been passed.

Worksop.—Mr. J. P. Crowther has been appointed resident electrical engineer to the Urban District Council. The amount already spent on the electricity supply works is stated to be £11,900, leaving £2,300 in hand.

Bexhill.—The Electric Light Committee's last report stated that, owing to the number of applications for the supply of electricity, it will be necessary to make some extensions. Over 10,000 additional electric lamps have been applied for.

Pacific Cable Board.—The Pacific Cable Board has appointed Mr. Charles Henry Reynolds, C.I.E., late Director-General of Telegraphs in India, as its general manager. Mr. Reynolds will enter on his duties in the course of the ensuing month.

Newton Abbot.—The Local Government Board have declined to sanction the Council granting a lease of a piece of land to the Electric Supply Company, Limited, as a site for their generating station. They advised the Council to sell the property outright, a course the Council decline to take.

Manchester.—It is reported by the local Press that the Electricity Committee of the Manchester Corporation have recommended for the Council's acceptance a tender by a Berlin firm for the switch gear and appliances required for the Stuart-street generating station and 15 sub-stations. The amount involved is stated to be £50,000.

Addington.—Before the Croydon County Bench on the 21st inst., William Anscombe, aged 17, of Addiscombe, was sent to prison for two months, and George Carter, 16, and George David Evans, both of Addiscombe, for 14 days each, for wilfully breaking £2 worth of insulators on Government postal telegraph poles at Addington.

Outing.—The Elswick works of Armstrong, Whitworth, and Co., at Newcastle-on-Tyne, were closed from the 22nd to the 26th inst. to allow the workmen to have their annual excursions. There were trips to no fewer than 90 towns, including places as far apart as Inverness and Southampton. About 12,000 men were thus enabled to have a good holiday.

Elevators at Buckingham Palace.—Letters have appeared in the daily Press from Mr. C. Clark, secretary of the Otis Elevator Company, 4, Queen Victoria-street, E.C., stating that the contract for the supply and erection of elevators at Buckingham Palace has been placed with the Otis Elevator Company, an English company, and not with an American firm.

Mica Insulator Co.—We are informed that the selling agency of this company, hitherto entrusted to Messrs. Bergtheil and Young, 12, Camomile-street, London, E.C., has ceased, as a new company has been formed, named the Mica Insulator Company, Limited, who will in future carry on the whole of the business from their factory located at Stansted, Essex.

Accident.—A serious accident occurred at Glasgow last week While four telephone linemen were engaged in fixing wires on a pole 100ft. high at Shields-road Station, near Glasgow, the pole snapped. Two of the men leaped clear, but the other two fell with the staff, one of them being crushed to death. The remaining three were removed to the infirmary, one of them in a dying condition.

Damage to Telephone Wires.—John Nolan, 44, labourer, of 7, Factory-road, Barking, was sentenced to two months' hard labour at the Stratford Petty Sessions last week, having been charged with being a suspected person found attempting to steal telephone wires from poles in a field off Charlemont-road, East Ham, at 9.30 p.m. on Aug. 18, and, further, with cutting and damaging 27 telephone wires to the amount of £5. 8s. 6½d., the property of the National Telephone Company.

Alloa.—The Town Council having written Mr. John Thomson Paton, donor of the town hall, informing him of their resolution to light the town hall by electricity instead of gas, Mr. Paton replied that as the expenditure would amount to a considerable sum, and it was his expectation the town hall would never be a felt burden on the rates, he was willing to defray the entire cost provided the scheme of lighting and the fittings were approved by the architect of the building. The offer has been accepted.

Lowestoft.—The Corporation electricity accounts for the year ending June 30 last state that the receipts for private lighting were £341. 8s. 11d. ; public lighting, £293. 6s. 8d. ; and meter rents, £16. 10s. 9d.—total, £651. 6s. 4d. The payments were as follows : coal, £220. 17s. 7d. ; oil, waste, water, and stores, £31. 11s. 3d. ; wages, £226. 4s. 7d. ; repairs, £10 ; engineer's salary, £100 ; proportion of accountant's salary, £12. 10s. ; rates, taxes, and insurance, £75 ; repayment of loan and interest thereon, £1,008. 2s. 8d.—total,

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£1,684. 6s. 1d.; leaving a deficit of £1,032. 19s. 9d. The capital expenditure to June 30, 1901, amounted to £26,830, leaving £23,170 yet to be expended.

London Gazette.—The first meeting in the estate of T. Morley, 16, Whalley-road, Accrington, will be held to-day at 3 p.m. at official receiver's offices, 14, Chapel-street, Preston, and the public examination on Oct. 9, at 10.30, at the County Court House, Blackburn. An adjudication order has been made out against same.—A first and final dividend of 2s. 3½d. per £ has been declared in the estate of J. Brown, lately residing at 278, High-street, West Sunderland. Payable now at official receiver's offices, 25, John-street, Sunderland.—Mr. L. H. Lemon, 32, King-street, Cheapside, E.C., has been appointed trustee in the estate of C. A. Church (trading as H. Conolly and Co.), residing at Aldborough Thatch, Ilford, Essex, and carrying on business at 42, Hampstead-road and 120, Kentish Town-road, London.

Stirling.—The latest statement of the progress of the electric light undertaking for the four weeks ending June 15, 1901, shows that for week ending May 25, 820 units were generated; for week ending June 1, 955; for week ending June 8, 771; for week ending June 15, 706—a total of 3,252 units. The whole of the arc lamp cable for the Craigs district have been laid, and also the cable down Wallace-street, Bruce-street, Douglas-street, and Union-street, provision having been made for the erection of the arc lamp pillars in the position fixed upon by the Lighting Committee. The committee have been empowered to substitute, where the cable was laid, electric light lamps for gas lamps, where necessary, making use of old pillars as far as possible. Tenders for the extension of the electricity works buildings have been accepted. The total cost will be £612.

Halifax Telephones.—At the monthly meeting of the Halifax Chamber of Commerce on Wednesday the question of going in for a municipal telephone exchange for Halifax and district was discussed. The secretary had asked 954 local subscribers to the National Telephone Company, and of 324 replies received, 160 were directly in favour of the municipal idea, and 96 would support it providing the charges were reduced and that it was not necessary to subscribe to the two systems. A resolution that the chamber urge the Halifax Corporation to obtain powers for the establishment of a municipal telephone exchange in Halifax was not carried. It was urged in opposition that the telephones should be nationalised or stay as they are, with a few alterations in the charges; that a municipal exchange was not workable except in conjunction with the National Telephone Company; also that it was very doubtful if intercommunication could be satisfactorily established between subscribers to the municipal system within the same municipal area.

Glasgow Corporation and the National Telephone Co.—The case in which an interim interdict was granted by Sheriff Fyfe on Aug. 20 at the instance of Glasgow Corporation against the National Telephone Company opening up the pavement and roadway in Argyll-street, and in which application for full interdict was continued for a week, was down for consideration by his Lordship at the County Buildings, Glasgow, this week. Neither party, however, appeared. It is understood that an arrangement has been come to, and approved by the Sheriff, by which the Telephone Company made application to the Corporation that the opening already made in the street be allowed to remain on condition of their agreeing that the permission be during the pleasure of the Corporation, and on their undertaking to restore the solum and surface of the street to their original condition on one week's notice from the Corporation The company further agree to pay the expenses incurred by the Corporation in connection with the interdict proceedings. The application will be considered at the first meeting of the Corporation Statute Labour Committee.—*Scotsman.*

Limerick.—A a recent special meeting of the Electric Lighting Committee a report was received from Mr. Enright with reference to the tenders which had been submitted to him for analysis. Mr. Enright stated that the tender of Messrs. Porte and Sykes, Dublin, for cables, was the lowest at £4,222. 2s. 6d. He pointed out that there were no special quotations for dynamos only, as the tenders also included engines, etc., and the lowest appeared to be sent in by Lowdon Bros., Dundee, at £12,165. It could be inferred, however, that the lowest tender for dynamos alone was that of the Helios Company. By employing three contractors the whole could be done for £16,805. 4s. 9d., while Porte and Sykes offered to do the whole for £17,000, and it would be advantageous if one firm were made responsible for the whole work. It was decided that Mr. Enright be invited to Limerick for the purpose of consultation with the committee as to the best means of carrying out the provisional order for the electric lighting of the city, and also that in consequence of the fall in the iron and coal market since tenders were received 12 months ago, new tenders for electric lighting plant in whole or part be invited, and that Mr. Enright be consulted as to the advisability of this course.

Ryde.—The Town Council have adopted a report of the Electric Lighting Committee, giving details of the state of the electric lighting question. It appears that in November last the committee asked the Board of Trade whether power to transfer the electric lighting order could be obtained, and the Board replied that they had no power to consent to a transfer. The Board of Trade were then asked for an extension, and they informed the committee that the Board did not appear to have any powers to extend time prescribed. In the meantime the committee were in correspondence with several companies in order to ascertain the terms on which works for the supply of electric energy to the town could be constructed and maintained, and the terms offered having been considered, it was found that those offered by Edmundsons', Limited, for the Isle of Wight Electric Light and Power Company, Limited, appeared the most favourable to the town. Subsequently a draft agreement was arrived at with Edmundsons', Limited. Counsel prepared the form of a free-wiring agreement between the company and consumers, but as the company declined to give way on a certain point they had been informed that the subject of a free-wiring agreement would have to be abandoned, and the agreement had been altered accordingly. The committee having communicated the proposed agreement to the Board of Trade, the latter decided to defer consideration of the revocation of the order for one year from the 13th prox., being practically an extension of the time given by the order. The committee therefore recommended that the Mayor be authorised to affix the corporate seal to an engrossment or print thereof, and that the same be completed as soon as possible.

Russian Electrical Companies.—The Russian Schuckert Company of St. Petersburg, in which the German company is interested to the extent of £144,000, has a capital of £317,000, and the surplus for the past year amounts to only £22,780, which is to be carried forward to the next account. It has branches in Moscow, Kieff, and Odessa. A correspondent to the *Financial Times*, after commenting upon the absence of dividend this year, states that the negotiations which have been proceeding for some time past between the three electric light supply companies in St. Petersburg have now been brought to a successful issue, whereby a uniform system of charging will come into force in the autumn. Under agreements entered into with the municipal authorities, the Electric Lighting Company of 1896, the Petersburg (Helios) Company for Electrical Installations, and the Eclairage Electrique de St. Petersbourg were authorised to charge consumers at the rate of 3½ copecks per hectowatt-hour, but the price has varied from as low as 1·8 copecks to 2·5 copecks. In future, however, the charge by each company will be 3½ copecks, as provided under the concessions, and thus the competition prevailing in the past will now be avoided. The directors of the St. Petersburg Shore Railway Company have been authorised to consider the question of introducing electric traction on the line. A scheme for this purpose has already been submitted by the Lahmeyer Company, of Frankfort-on-the-Maine, which is supplying 25,000 h.p. of electrical machinery for the Charing Cross and City Electric Lighting Company, and in the event of the railway company deciding to make the change it is reported that the contract will be given to the Frankfort company in question.

Durham.—It is expected that the electric works of the County of Durham Electrical Power Distribution Company will be able to supply current by November. The *Durham County Advertiser* contains a report of a visit, from which we quote: The new electrical works occupy a site abutting on to Silver-street back lane, and are in extent 120ft. by 90ft. The buildings are all on the ground floor, and, commencing from the river, consist of an accumulator-room, engine-room, and boiler-house, with the company's offices situate some few yards distant to the right. There are two sets of boilers, four in all, by Babcock and Wilcox, the coal being shot direct into the bunkers from the back lane. A Berryman feed heater has been laid down, whilst the boiler is fed from a tank designed to hold 55 tons of water. This tank is from the Barrowfield Ironworks, Glasgow, and the feed pumps by Messrs. Weir. There are at present two steam dynamos, each of 40 h.p. These are simply for generating electricity for the lighting, it being intended to lay down another dynamo of 280 h.p. when the electric trams are commenced. The engines and dynamos, balancer and booster are by the Brush Electrical Engineering Company, of Loughborough. The accumulators are by the Hart Company, whilst the switchboard is by Messrs. Verity's, London. The smoke stack which formerly did duty for the factory has been taken down to the extent of 25ft., and rebuilt 40ft. This work was carried out by Messrs. Reid Ferens, of Durham. The buildings generally are being erected by Mr. T. Weatherell, of Newcastle, the architect being Mr. H. Graham, also of Newcastle. The whole of the work is being carried out under the superintendence of Mr. J. S. Frain, manager to the company. The work of laying the distributing mains in the town will be commenced this week by the Callender's Cable and Construction Company, Limited.

TRACTION.

Blackpool to Fleetwood Tramway.—The directors have declared a dividend of 4 per cent. for the past half-year.

Aberdeen.—A tramway line from Aberdeen to Torry is under consideration, and will be discussed at the next meeting of the Tramways Committee.

Stockport.—Colonel von Donop has made his official inspection of the first two electric tramway routes constructed by the Corporation—viz., the route through Portwood and Bredbury to Woodley, and that up Lancashire-hill to Reddish.

Ayr.—The Corporation electric tramway is ready for the Board of Trade inspection. Mr. David Christie, who has been connected with the Dundee tramways for 11 years, has been appointed traffic inspector in connection with the Ayr tramways.

Metropolitan District Railway.—The Board of Trade enquiry will be held in about three weeks' time, and the Ganz, the British Westinghouse, the British Thomson-Houston, and the Frank Sprague systems will come in for consideration.

Spen Valley Light Railway.—It is proposed to call a meeting for Sept. 10 of the local authorities interested in this line to discuss plans, etc. The districts affected are Ravensthorpe, Dewsbury, Batley, Heckmondwike, Liversedge, Cleckheaton, Gomersal, Birkenshaw, Hunsworth, Thornhill, and Bradford.

Manchester.—The work of laying tramlines along Princess-street and Upper Brook-street is to be proceeded with. The Improvement and Buildings Committee of the Corporation are being asked to include powers for the widening of Cross-street in the next omnibus Bill of the Corporation. The obtaining of these powers will permit the laying of a double line of tramrails throughout its entire length.

Merthyr Tydfil.—A special meeting of the Merthyr Urban District Council was held last week for the purpose of considering a notice

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received from the British Electric Traction Company of their intention to apply to the Board of Trade for sanction to the proposed transfer of their undertaking at Merthyr to the Merthyr Electric Traction Company. The notice remained undiscussed for want of a quorum.

Cheltenham and District Light Railway.—This railway, which extends from Lansdown Castle, on the south-western side of the town, to the top of Cleeve Hill, a stretch of 5½ miles, was ceremoniously opened for traffic on the 22nd inst., although the cars had been running since the previous Saturday. The promoters intend to seek powers to extend the line to Charlton Kings, a suburb of Cheltenham on its eastern boundary.

Elton.—The *Bury Guardian* says a new private limited company has been formed to manufacture electric car trucks at Elton works, and understands that already orders have been booked, and that the necessary alterations of the works are in course of progress, so that these orders will be commenced in a short time. Our contemporary believes that an order from the Birkenhead Corporation will be one of the first to be started in the new works.

Durham.—It is probable that the electric trams will commence running next summer. The light railways order for Durham City, which was passed by the Light Railway Commissioners some time ago, has recently been confirmed by the Board of Trade. The company, however, did not wait for this sanction, but let the contract in order that the conduits for the tram cables might be laid simultaneously with the lighting cables, and this is now being done.

Greenock.—Mr. John M'Ewan, Structural Ironworks, Dellingburn-street, has secured the contract for the erection of a tramway car depot and repairing shop at Ladyburn. The building is to cost £7,000. Another trial of the electric cars took place on Thursday last week on the Gourock section of the line, which it is reported was entirely successful. It is expected that the electric cars will be running from Rue End-street to Ashton early next month.

Personal.—We are informed that Mr. J. B. Atherton and Mr. Jacob Atherton have resigned their posts as directors of the South Lancashire Electric Traction and Power Company, Limited, the South Lancashire Tramways Company, Limited, and the Lancashire Light Railways Company, Limited. Mr. William Morrison, the traffic manager for the Sunderland Corporation tramways, who resigned that position a short while ago, has been appointed manager for the North of England and Scotland districts of the British Electric Traction Company.

Glasgow.—A complaint has been made to the sheriff, at the instance of a resident in Pollokshields, craving the statutory penalties against the Corporation for violating the terms of their Tramways Act of Parliament and the Board of Trade regulations so far as regards the excessive speeds at which the cars are propelled. It is complained that the speeds go up to as high as 22 miles per hour, while the statutory limit under the Board of Trade's regulations is eight miles per hour, and that the excessive speeds constitute a nuisance, and are dangerous to the inhabitants.

Scarborough.—The tramways question was discussed at last week's meeting of the Streets and Buildings Committee on a letter from Mr. A. A. C. Swinton, engineer to the proposed new tramways company, asking if the Corporation approved of obtaining powers in their Bill for the Corporation to put £10,000 into the concern. The opinion was expressed that the Corporation might be inclined to loan the money or take debenture stock, but under no circumstances could they take ordinary shares. There was only a small attendance of members, and no definite decision was arrived at.

Newcastle.—The electric tramway capital account is included in the Corporation accounts for the year ended March 25, 1901. On the debtor side appears a sum of £220,000 as loans, consisting of £170,000 from the Public Works Loan Commissioners on account of a loan of £400,000 and a loan of £50,000 from the bank. In the items of expenditure is included a sum of £31,100 for purchase of the tramways at Gosforth, and land and buildings at Gosforth, and Haymarket, Newcastle. The electric tramways construction account shows that the amount expended in that department up to March, 1901, was £272,603, 3s. 9d.

Street-Watering.—The manager of the Bradford tramway system has submitted to the Tramways Committee of the Corporation a plan by which he promises to water the main streets of the city and the suburban roads in less than a third of the time at present required by horsed vehicles. The work would be done by means of a tank car carrying 500 gallons of water and propelled along the car lines by electricity. Behind the tank car would be coupled up a watering-cart having the familiar scattering equipment. A scheme by which refuse for the destructor could be conveyed along the lines by electric power is also under consideration.

New West Riding Tramways.—At the last meeting of the Pontefract Rural District Council it was stated that the West Riding Tramways Company, Limited, had been registered, and that the first Board meeting would be held in London this week. It was, therefore, most probable that there would very shortly be a practical commencement of the work of laying down the tramways between and through Normanton, Castleford, Glasshoughton, Pontefract, Purston, and Featherstone. The capital of the company is £275,000, and this the engineers (Messrs. Lemaitre and Parker, Leeds) has informed a correspondent has already been privately subscribed.

Epping Forest Tramway.—It appears that the application to construct certain light railways running through the districts of Tottenham, Walthamstow, Woodford, Buckhurst Hill, and Leyton, will not now be opposed, a local committee having received from the promoters an undertaking to withdraw the following sections: Railway No. 3 in the urban district of Walthamstow, Railway No. 5 in the urban district of Walthamstow, Railway No. 6 in the urban district of Woodford, Railway No. 7 in the urban district of Buckhurst Hill, Railway No. 8 in the urban district of Leyton, Railway No. 9 in the urban district of Wanstead, and Railway No. 10 in the urban district of Woodford.

Leicester.—The shareholders of the Leicester Tramways Company, Limited, have agreed to sell the entire undertaking of the company to the Leicester Corporation for the sum of £134,100, and to take the necessary steps to transfer the undertaking and wind up the company. The share capital of the company amounts to £100,000, and this has for some years yielded an annual dividend of 5 per cent. The purchase money includes the amount required to pay off the company's debentures, which amount to £23,900. The Corporation have already decided to extend the tramlines from the present nine to 22 miles, and apply the overhead trolley system of electric traction, at a roughly estimated cost of about £300.000.

Margate.—A Board of Trade enquiry into the accident on Aug. 10 was held on Saturday. The driver admitted that in descending Forthill he might have unconsciously applied the current instead of the power brake, both of which are worked by the same controlling handle. There was another accident on Saturday evening. The driver lost control of a car as it reached the top of Paradise-street (a particularly steep and difficult hill to ascend) through the trolley arm coming off the overhead wire, and the car ran back on to the parade, amid the screams of the crowded passengers and people in the street. One woman was badly cut about the face and head, and a man was severely injured. Others were more or less seriously hurt.

Stockton.—The *Northern Echo* says that the electric cars have been a boon to the three Tees-side boroughs which they serve will be admitted by all but the prejudiced few. Year after year the traffic returns of the company have increased, and during the present week a big record has been established. As is well known, the Stockton race week is an annual holiday for large numbers of people in Middlesbrough, Stockton, and Thornaby, and special consideration has to be given by the tramway company to the resulting increased traffic. Additional cars are put on the lines, and each one is doubly manned. On the three Stockton race days, no less than 141,444 people were carried, as against 127,675 last year, and 108,810 in 1898, the first year the cars ran. As all this appears to have been achieved without any serious accident, those responsible for the organisation of the traffic are to be congratulated.

Light Railways in Glamorgan.—The Parliamentary Committee of the Glamorgan County Council have directed that the necessary month's notice required by the Light Railway Act be given in respect of the undermentioned lines, with the view to the passing of special resolutions to make applications for orders for such of them as may be decided on by the Council: (1) a line from Aberdare by Mardy, Porth, Tonyrefail, Blackmill, and Tondu to Bridgend; (2) a line from the boundary of the county borough of Swansea, or the end of the authorised Swansea light railway, to Ystalyfera by Clydach and Pontardawe; (3) a line from the county borough of Swansea, or the end of the authorised Swansea light railway, to Loughor; (4) a line from the authorised Swansea light railway at Morriston to the end of the existing tramway at Neath Abbey; (5) a line from the termination of the Neath Corporation tramway at Briton Ferry to Taibach. And, if found desirable, to make such applications jointly with the Swansea Borough Council or the district councils of the districts wherein any part of such light railways may be situate, and to make working or other arrangements with such councils, both as to the proposed and authorised light railways and the existing and authorised tramways, and also, if thought fit, to advance money to a light railway company promoting any of the above-mentioned light railway.

Tramway Employes.—There are now pending resolutions on the demands of tramway men in Dundee and Manchester. The Corporations claim that the men are better off now than they were under the old companies. The Bristol strike was soon over, owing to the energetic action of the directors. The men who proposed to strike timed their "notices" so that the company would have found themselves deprived of a large part of their staff on the morning of the Bank Holiday. The Board at once dismissed the men who had given notice. The service was for a time very seriously affected, and this deprived the men of any general public sympathy. A large number of cases of assault, etc., occurred, rendering the work of the men who kept at work by no means agreeable. A place was fitted up at Brislington as a place of residence for the men, and the Board announced that medals would be issued, the possession of which would carry extra pay of 2s., 1s., or 6d. a week to all foremen, inspectors, drivers, and conductors who had remained loyal to the service during the strike, conductors receiving 6d. to have 1s. on promotion to drivers, and so on, drivers becoming inspectors or foremen to have the 2s. In addition, the Board resolved to set aside the whole of their fees for the current year, amounting to £2,200, for distribution amongst the men who remained in the company's service on the strike occurring and continued in the service.

Paisley.—Mr. Murphy's Tramways Bill has now received the Royal assent, and the question is settled at last. The Bill has been finally passed in much the same form as described in previous issues. The system is to consist of a double line of tramways from the East-end of Paisley (where the line will join that of Glasgow and thus ensure a through service) to Johnstone, also lines, chiefly single, to Renfrew, Abbotsinch, Glenfield, St. James's Park, and Meiklerigg. And the terms of purchase by the local authorities remain those latterly insisted on by Mr. Murphy—namely, that the local authorities may combin and purchase the whole undertaking (or any one local authority may purchase the whole undertaking) at the end of 25 years, or at the end of any subsequent period of five years, on paying the fair market value of the tramways as a going concern; or, alternatively, that, at the end of 40 years, the local authorities may purchase the system on paying for it the then value, exclusive of any allowance for goodwill. The

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fares are fixed by the Act at ½d. per half-mile stage, the universal penny fare alternative having apparently been dropped. The whole system, according to the Act, must be completed within three years from the date of the Royal assent. Mr. Murphy's company is to have a share capital of £300,000 in 30,000 of £10 each. The first directors are to be Mr. Murphy himself, Mr. J. B. Glen, and Mr. A. J. Salter. Mr. Murphy's agent in the district through the past two years' negotiations has been Mr. J. W. Turner, writer, Greenock; and a very active part has been taken in the promotion of the Bill by Mr. T. R. Jacobs, writer, Greenock, who conducted most of the negotiations in Paisley and Renfrew.

Tramways in South Lancashire.—The South Lancashire Tramways Act of 1900 authorises the construction of tramways between St. Helens and the Manchester district by two main trunk lines intersected by branch lines connecting up the smaller towns *en route*, amounting to nearly 90 miles of single track. The 1901 Act empowers the company to construct other tramways, including the line from Prescot through Huyton and Roby to Broadgreen at the Liverpool city boundary, where it will shortly be in connection with the tramways of the Liverpool Corporation, an omnibus connection being maintained in the meantime for a distance of 1 mile 100 yards. Also a tramway line from Newton-in-Makerfield to the Warrington Corporation boundary, and from Worsley through Walkden to Little Hulton, both these lines being extensions of the powers granted by Act of 1900, also a short section of tramways joining Farnworth with Radcliffe through the township of Little Lever. The powers of this Act authorise the construction of over 20 miles of single track, so that the combined Acts of the South Lancashire Tramways now authorise the construction of the important total of 110 miles of single track. The new Act further gives to the South Lancashire Tramways Company powers for the compulsory purchase of land for a number of street improvements along the route of the tramways. Arrangements have already been made for the actual constructional work of a line from Haydock, through Ashton-in-Makerfield, Abram, Hindley, West houghton to Bolton; and from the Burtonwood side of the St. Helens boundary through Newton-in-Makerfield, Lowton, Leigh, Atherton to Bolton. The work will be commenced forthwith, and the connection between Hindley, Hindley Green, Atherton, and Tyldesley will also be carried out at the same time. On the other side of Prescot the connection between these lines and Liverpool will be made complete by the Liverpool and Prescot Light Railway, which has now sufficiently advanced for the completion of the line between the existing terminus of the new St. Helens Tramway Company at Prescot. There appears to be every probability of the line being opened for traffic during October.

Bradford.—The Idle and Thackley tramways, which are the sole remaining portions of the batch of extensions for which parliamentary powers were obtained previous to the last session, are now approaching completion. Idle-road has been widened from the junction with Bolton-road for about a quarter of a mile, so as to admit of the laying of a double line for the whole of the distance to Thackley railway station. The Demerbe rail has been used, and the overhead electrical equipment is, with the exception of a small length, carried on bracket arms in the manner adopted on the Thornton and Queensbury lines. A trial car has been run between Bolton-road and Thackley. The branch from Five Lane Ends to Idle is expected to be completed in a few days, and through cars will be running to Idle probably by Sept. 21. It is expected that if the ensuing winter should be moderately open, the tramways department of the Corporation will be in a position by February next to take over and work by electricity the lines in Manningham-lane and Keighley-road, Sunbridge-road and Girlington-road to Four Lane Ends—completing the electrical connection with Thornton—Leeds-road, and Manchester-road. This, of course, means a great amount of work to be got through in a few months, but the matter has been anticipated for some time, and a good stock of materials has been accumulated, so that the delays—which used to be frequent—in obtaining the necessary rails, granite setts, and equipment will be obviated. The lines on Manningham-lane were relaid a few years ago, and are ready for electrical equipment, and those from the park gates to the city boundary, and thence to Saltaire, will now be taken in hand. Preparations were begun some months ago for the widening of the road at Frizinghall so as to get the necessary width for a double line of rails. In the narrow stretch between the park gates and the Turf Tavern it is intended to remove the footpath adjacent to the park wall, and it is hoped that the Parks Committee may eventually, despite their previous decisions, bring themselves to consent to one or other of the many schemes which have been put before them for securing either a removal or an improvement of the wall itself. When these preliminary works have been completed the tramways will be at once relaid. The Shipley Urban Council, upon whom lies the responsibility for the equipment of the tramway from the city boundary to Saltaire—though when completed it will be worked by the city authorities—have also the matter in hand. The relaying of the Leeds-road tramway was commenced some weeks ago, and satisfactory progress is being made. For the existing girder rails, with crossing-places at a distance of about 300 yards apart, will be substituted a double line on the Demerbe principle. The relaying of the Manchester-road route for electric traction has also been commenced near the Manchester-road railway station, and the work is proceeding upwards On this line the girder system is being adhered to, and the rails are being connected with Cooper's patent joints. In the work of relaying busy lines an immense advantage has been gained by the use of a temporary movable track, which has been recently brought into use for the first time in Bradford. A length of this can be easily laid in a night, and the work of opening out the old rails and replacing them by new can proceed calmly without any material disturbance of the existing tramway traffic. The rolling-stock, which at the moment amounts to 68 cars, is being rapidly added to. The motors come from Belgium, the ironwork of the supporting trucks is of American construction, and the bodies of the carriages are built at Loughborough. All these come in parts to the tramway department's works at Thornbury, where they are put together and completed at the rate of two a week. Altogether the Tramways Committee have either on order or are on the point of placing contracts for 230 more cars. The city surveyor (Mr. J. H. Cox) is responsible for the work done to the permanent way, the tramways manager (Mr. C. J. Spencer) supervises the erection of the overhead equipment of the lines, and on the electrical engineer (Mr. R. A. Chattock) devolves the duty of designing and laying the cables and feeders for the supply of electrical power.

LEEDS ELECTRICITY ACCOUNTS.

The accounts of the Leeds electricity works for the year ended March 25, 1901, show a total expenditure on capital account of £368,097. Abstracts of the revenue account and general balance-sheet are appended:

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Loans	217,420	0	0
Due to treasurer	148,237	3	0
Sundry creditors	14,748	5	6
Surplus	27,723	17	3
	£408,129	5	9

Cr. Assets.	£	s.	d.
Capital expenditure	368,097	13	9
Cash in hand	20	0	0
Stock in trade	22,263	15	10
Sundry debtors and miscellaneous	17,747	16	2
	£408,129	5	9

REVENUE ACCOUNT.

Expenditure.

Dr. Generation of Electricity.				£	s.	d.
Coal	£4,727	2	2			
Oil, waste, water, and stores	402	9	9			
Wages at generating station	2,446	10	11			
Repairs, maintenance, etc., of buildings and machinery	829	17	10			
				8,406	0	8
Distribution of Electricity.						
Stores	76	11	0			
Wages	415	15	0			
Repairs and maintenance	452	14	0			
				945	0	0
Rents, Rates, and Taxes.						
Rents	2	1	0			
Rates and taxes	1,356	6	7			
				1,358	7	7
Management Expenses.						
Salaries—Engineer's department	1,621	18	0			
Clerical staff (including outdoor representative)	863	9	2			
Stationery and printing	127	18	11			
General establishment charges	247	7	5			
				2,860	13	6
Insurances				200	1	3
				13,770	3	0
Interest				15,384	13	4
				29,154	16	4
Balance, being net profit for the year				14,514	5	10
				£43,669	2	2

Cr. Income.	£	s.	d.
Sale of current	44,066	17	2
Rental of meters and other apparatus	1,327	12	3
	45,394	9	5
Less estimated discounts, £1,419. 5s. 7d.; and leakage, £351. 0s. 8d.	1,770	6	3
	43,624	3	2
Proportion of costs of defending transformer patents action, now returned	44	19	0
	£43,669	2	2

KINGSTON-UPON-THAMES ELECTRICITY WORKS.

The following is an abstract of the seventh annual report of the borough electrical engineer (Mr. J. E. Edgcome, M.I.E.E.) for the year ending March, 1901. The capital expenditure to date was £59,954:

Buildings.—Large extensions have been made to the boiler-house. The foundations for the boilers and flues are completed, and the work of building the two main flues to connect the range of boilers to the new shaft is being carried on rapidly. The foundations for the

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condensing and pumping plant will be put in hand shortly. The work is in progress on the new shaft, which will be octagon in form, 10ft. by 10ft. internal diameter, 150ft. high.

Machinery.—The new 200-kw. combined steam alternator has been erected and running for some months, and is working satisfactorily. A steam exciter is on order, and will be installed towards the end of the year. This plant is specially designed to give current at a pressure of either 100 or 200 volts, and can be used either as an exciter or for launch battery charging. A third arc lighting machine has been sanctioned, which will be capable of supplying current to a further 38 street arc lamps, when the street-lighting extension is completed. The necessary circuit and exciter panels required for this work are also being put in hand. Two further boilers of the water-tube type have been erected in the new boiler-house. They are of Messrs. Babcock and Wilcox's make, and each boiler will evaporate 13,000lb. of water per hour, using good slack coal with the chain grate stokers. Two Pimbley economisers, each consisting of 80 6ft. double pipes, fitted with positive scrapers, will be installed in the main flues between the boilers and the new shaft. Each of the two parallel main flues is fitted with a set of damper doors and inspection manholes, to enable either flue to be inspected and cleaned without interfering with the working of the other. A condensing plant, capable of dealing with 20,000lb. of steam per hour, will be installed in the boiler-house and connected by a supplementary 18in. exhaust pipe to the present exhaust mains. A special oil extractor is being fitted to extract the oil from the exhaust steam before it enters the condenser, so that the water from the condensed steam may be used for boiler feed purposes. Two cross-compound, vertical type Blake and Knowles feed pumps will be installed, each capable of supplying feed water at the rate of 7,800 gallons per hour to all or any of the seven boilers on the range. Provision is being made for fixing marine type feed-water filters between the pumps and the boilers should it be found necessary to supplement the work done by the oil extractor on the exhaust main. A hot-feed tank 8ft. by 8ft. by 12ft. will be provided, with a capacity of 4,800 gallons. Complete steam mains in duplicate are being provided to connect the new boilers to the existing steam ring, and likewise a duplicate service to the auxiliary plant. The exhaust mains are being extended, and pipes of ample capacity are being laid down for the supply of circulating water from the new sump well to the new condenser, and the feed-water mains are being installed in duplicate from the new feed pumps to the economisers and boilers.

Mains.—Considerable extensions have been made during the last 12 months, the same type and class of cables being used as in former years—namely, concentric cables, heavily insulated, lead-sheathed and armoured with steel tapes lapped, the cables being laid direct in the ground.

Progress.—I regret that in drawing the attention of the committee to the revenue account, I should have to present such a disappointing balance-sheet. Owing to the extraordinary and almost unparalleled rise in the cost of fuel, the coal bill has risen to an alarming extent, although the revenue has not increased in proportion, the committee having decided not to raise the price of current to consumers. Unfortunately, also, we were unable for a considerable time to condense during our heavy load, owing to the insufficient supply of condensing water. An ample supply is now available, and as soon as the new condensing plant is completed we shall be in a position to condense continuously, which will naturally result in a very considerable saving on the fuel account. The items of interest on loans and repayment of principal have likewise increased to a considerable extent, being, in fact, heavier for the last 12 months than for the preceding 15 months. Unfortunately, a considerable amount of the charges both for interest and repayment of principal are on capital expended on new plant not yet in use, such charges having to be paid before the plant has commenced to earn a revenue. The number of consumers during the 12 months has increased from 311 to 376, an increase of 65; and the number of 8-c.p. lamps connected to the mains has increased from 16,130 to 18,899, an increase of 2,769.

REVENUE ACCOUNT.

Expenditure.

Dr.	Generation of Electricity.	£	s.	d.
Coal	£4,236 6 8			
Oil, waste, water, and stores	219 15 4			
Wages at generating station	552 14 0			
Repairs, maintenance, etc., of buildings and machinery	274 0 10			
		5,282	16	10
	Distribution of Electricity.			
Repairs, maintenance, renewals, and wages		119	14	11
	Public Lamps.			
Attending and repairs, carbons, etc.		203	11	11
	Management.			
Salaries—Engineer's department	350 0 0			
Clerical	89 8 4			
Stationery, printing, and advertising	53 9 3			
General establishment charges	77 14 8			
		570	12	3
	Rents, Rates, and Taxes.			
Rates and taxes	127 15 7			
Insurance	68 9 6			
		196	5	1
	Special Charges.			
Interest on loans	1,434 3 5			
Repayment of principal	1,461 12 7			
		2,895	16	0
Lamps, stores, etc.		14	16	0
		£9,283	13	0

Cr.	Receipts.	£	s.	d.
Sale of current per meter		5,458	2	7
Sale of current for launch and battery charging		39	14	9
Rental of meters and apparatus		171	0	0
Public lighting, arc and incandescent		859	0	0
Sundry sales and receipts		34	14	0
		6,562	11	4
Debit balance		2,721	1	8
		£9,283	13	0

HALIFAX ELECTRICITY ACCOUNTS.

From the accounts of the Corporation of Halifax electricity works for the year ended March 31, 1901, it appears that the total expenditure on capital account amounts to £137,884. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended:

REVENUE ACCOUNT.

Expenditure.

Dr.	Generation of Electricity.	£	s.	d.
Coal and coke	£4,678 2 5			
Oil, waste, water, and stores	630 14 1			
Wages at station	1,539 6 11			
Repairs and maintenance—Buildings	507 15 0			
Engines and other machinery	278 11 6			
Transformers, etc.	66 17 1			
		7,701	7	0
	Distribution of Electricity.			
Wages	92 4 0			
Repairs—mains, meters, etc.	239 4 7			
Paving	20 4 9			
Coke	23 18 11			
		375	12	3
Rents, rates, and taxes		846	13	8
Management expenses and general establishment charges		1,093	3	2
Law and parliamentary charges		10	0	0
Special charges		52	14	7
Accident insurance fund		78	17	4
		10,158	8	0
Balance carried to net revenue account		8,923	3	9
		£19,081	11	9

	Income.	£	s.	d.
Sale of current—As per meter		8,517	5	4
Tramways, 1,310,547 units, at 1⅞d.		10,238	13	0
		18,755	18	4
Meter rents		190	14	9
Rents		53	3	6
Installation account		57	17	2
Sundry interest		6	5	0
Money returned in lawsuit *re* Rucker's patent		12	14	0
Old iron		4	19	0
		£19,081	11	9

BALANCE-SHEET.

Dr.	Liabilities.	£	s.	d.
Loans		69,116	19	10
Treasurer, due to him		62,641	6	3
Sundry creditors		468	6	3
Total liabilities		132,226	12	4
Surplus		10,989	8	0
		£143,216	0	4

Cr.	Assets.	£	s.	d.
Expenditure on capital account		137,884	2	1
Stock of meters, cables, etc.		2,907	17	11
Sundry debtors for current supplied		2,303	1	11
Other debtors		120	18	5
Total assets		£143,216	0	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units		2,001,181
Quantity sold: Public lamps	93,397	
Quantity sold: Private consumers by meter	1,803,270	1,896,667
Quantity used on works		43,212
Total quantity accounted for		1,939,879
Quantity not accounted for		61,302
Number of public lamps		57

NEW COMPANIES.

The following new companies have been registered since our last issue:

Empire Boiler and Engineering Company, Limited.—Capital, £10,000. Objects: to acquire certain land, buildings, etc., situate at

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Shay-lane, Holmfield, formerly belonging to the Holmfield Estate Company, Limited, with these rights connected therewith, and to carry on the business of iron and brass founders, mechanical and electrical engineers, etc.

Pneumatic, Electric, and General Engineering Company, Limited.—Capital, £370,000. Objects: to adopt an agreement with Richard Payne, and to carry on the business of machine-makers, iron-founders, compressor manufacturers, engineers, contractors, and manufacturers of pneumatic and electric tools and appliances, and pneumatic, electric, and hydraulic railway and marine signal appliances, producers, storers, and suppliers of heat, steam, compressed air, and other power, coal, oil, gas, and electricity, etc.

Rhodes Bros. (Wakefield), Limited.—Capital, £20,000. Objects: to acquire the business of engineers, etc., carried on at Grantly-street, Wakefield, Yorkshire, by James Rhodes, H. Rhodes, G. L. Rhodes, Joseph Rhodes, and A. Rhodes as Rhodes Bros., to adopt an agreement with the above-mentioned parties, and to carry on the business of machinists, civil, electrical, gas, and general engineers, etc.

Mica Insulator Company, Limited.—Capital, £20,000. Objects: to carry on the business of manufacturers, importers, and exporters of and dealers in paints, varnishes, paper cloths, papers, electric, magnetic, galvanic, and other apparatus and machinery and appliances of all kinds, electrical and general engineers, makers of mica, micanite, asbestos goods and insulating materials, etc.

Lancashire and Yorkshire Electric Tramways, Limited.—Capital, £100. Objects: to construct, maintain, and work any tramways, light railways, electric and other railways, and motors therefor, and to carry on the business of builders of vehicles of all kinds propelled or drawn by mechanical, animal, or other traction, producers and suppliers of electricity for the purposes of light, heat, or power, indiarubber manufacturers, makers of and dealers in tyres for cycles and other vehicles, etc.

Lancashire United Electric Tramways, Limited.—Capital, £100. Objects: to construct, maintain, and work any tramways, light railways, electric and other railways, and motors therefor, and to carry on the business of builders of vehicles of all kinds propelled or drawn by mechanical, animal, or other traction, producers of electricity for the purposes of light, heat, or power, indiarubber manufacturers, makers of and dealers in tyres for cyles and other vehicles, etc.

PROVISIONAL PATENTS, 1901.

AUG. 19.

16615. Improvements in or relating to controlling apparatus for electric motors. Alfred Julius Boult, 111, Hatton-garden, London. (Niels Anton Christensen, United States.) (Complete specification.)

16628. Improvements in mercury or other interrupters for use with induction coils. Herbert Charles Newton, 3, Fleet-street, London.

16651. Improvements in secondary batteries. Victor Jeanty, 60, Queen Victoria-street, London.

16653. Improvements in the manufacture of filaments for incandescing electric lamps and in apparatus for use in such manufacture. William Lawrence Voelkler, Clun House, Surrey-street, Strand, London.

16670. Improvements in electrical indicators. John William Manley, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

AUG. 20.

16677. Improvements relating to the manufacture of electrodes for galvanic batteries. Rudolf Pörscke, 27, Chancery-lane, London. (Complete specification.)

16707. Improvements in means for transmitting and receiving musical sounds electrically applicable to harmonic telegraphy or telephony. Arthur Thomas Metcalf Johnson and George Guyott, 109, Calabria-road, Highbury, London.

16710. Improvements in electrical switches. Harry William Cox, 8, Quality-court, Chancery-lane, London.

16712. Improvements in or relating to automatic apparatus for controlling the speed of tramcars, automobiles, and other electrically or mechanically propelled vehicles. Harry Edward Yerbury and the firm of Estler Bros., 52, Chancery-lane, London.

AUG. 21.

16759. An improvement in electric arc lamps. Charles Edwin Foster, 24, Keymer-road, Streatham-hill, London.

16762. Improvements in and connected with electric switches. Henry Oliver Farrell, 106, Princess-street, Manchester.

16766. Improvements in armatures for dynamos, motors, and like machines. Henry Newton, Imperial-chambers, Albert-street, Derby.

16767. Improvements connected with the switch-points of overhead electrical traction conductors. William Ellison Rowlands, 10, St. George's-crescent, Liverpool.

16783. Improvements in the mode or method of reproducing at a distant place or places scenes, events, or the like occurring at the time of transmission by the aid of electricity. Richard Robert Harper and Ludolph Fränckel, 5, South-grove, St. Ann's-road, South Tottenham, London.

16818. Improvements in or relating to phonographs. Charles Ullmann, 18, Buckingham-street, Strand, London.

16814. Improved means applicable for use with overhead electric conductors for the prevention of danger in the case of telephone, telegraph, or other wires falling across them. Reginald Page Wilson, Clun House, Surrey-street, Strand, London.

AUG. 22.

16827. Improvements in apparatus for the electric ignition of the charges in internal-combustion engines. Joseph Edmondson, Penny Bank-chambers, Halifax.

16847. A new or improved cord grip for electric pendant lamps. Russell Oswald Wright, 4, St. Ann's-square, Manchester.

16874. Improvements in electrolytic apparatus for production of chlorine and alkali. James Mactear, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16898. Railway signalling on engines and in cabins—contacts—mechanical, electric, or pneumatic. George Spurgeon, 9, Bulwer-road, Leytonstone, Essex.

16902. Electric typewriter. William Humphrey Wheatley, 40, Chancery-lane, London. (The Electric Typewriter Company United States.) (Complete specification.)

AUG. 23.

16911. An improved plug and socket detachable switch for electrical connections. Frederick William Heaton and Harry Smith, Salford Switch Works, Sidney-street, Salford.

16941. Improvements in and relating to electric arc lamps. Llewellyn Burbane Codd, Standard Works, Dame Agnes-street, Nottingham.

16950. Improvements in and relating to electric switches and to combinations of the same with wall plugs and the like. Thomas Herbert Marsh and Owen David Lucas, 322, High Holborn, London.

16955. Improvements in and relating to electrical intercommunication. Anthony Van Wagenen, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16979. An improved electric cut-out. William Joseph Davis and Albert Edward Palmer, 67A, Corporation-street, Birmingham.

AUG. 24.

17023. Improvements in alternating electric current transformers. Henry Metcalf Hobart, Bush-lane House, Cannon-street, London.

17024. Improvements in insulating material for electric apparatus. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Walter C. Fish, United States.) (Complete specification.)

17025. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Alexander D. Lunt, United States.) (Complete specification.)

17026. Improvements in electric circuit breakers. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

17027. Improvements in locks for electric motor controller handles. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (John B. Linn, United States.) (Complete specification.)

17028. Improvements in electric brake systems. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Charles E. Barry, United States.) (Complete specification.)

17029. Improvements in lightning arresters. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Howard R. Sargent, United States.) (Complete specification.)

17030. Improvements in electric insulating material. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (William Le R. Emmet, United States.) (Complete specification.)

17039. Improvements in or relating to rifle range telephones. Charles Robert Crosse, 165, Queen Victoria-street, London.

17045. Improvements in driving gear for dynamos. Otto Böhm, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 14.

1900.

11344. Manufacture of filaments for incandescing electric lamps. Voelker.

13036. Dynamo-electric machines and electric motors. Joel.

15730. Material composition suitable for use as an electrical cement and insulator. Alexander Matheson and Margaret Tatham, executors of the late Edwin Tatham.

16052. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Steinmetz.)

18681. Electric fire alarms. Simpson and Tomlinson.

18757. Safety devices for the trolley poles of electric cars. Bellamy, Turner, and Hardman.

18793. Electric railways operated on the conduit system. Chapman.

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18865. Apparatus for the production of electrical oscillations. Fleming and Marconi's Wireless Telegraph Company, Limited.

18924. Electric switches. Chipperfield and Cook.

19922. Insulator for trolley wires and overhead conductors. Estler and Kleinsteuber.

22353. Electric switches for use in controlling motors. Parker. 1901.

11847. Electrometers. Addenbrooke.

14760. Electrical speed indicators. Collinge.

14963. Electric arc lamps. Heany.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Aug. 24	1,015	794	+ 220	—	—
Birmingham Tramways	,, 24	4,872	4,449	+ 422	150,630	— *b*
Birkenhead Corporation	,, 18	580	—	—	—	—
Blackburn Corporation	—	—	—	—	—	— *b*
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 24	2,421	1,845	+ 576	11,824	11,606
Bolton Corporation	,, 25	2,032	1,604	+ 428	49,345	39,349*b*
Bradford Corporation	,, 25	1,361	454	+ 907	27,586	14,907*b*
Bristol Tramways Company	,, 23	4,123	3,454	+ 669	—	—
Carlisle Tramways Company	—	—	—	— *b*	—	—
Central London Railway	,, 24	5,409	4,385	+ 1,024	45,615	—
City and South London Railway	,, 25	1,697	1,473	+ 224	14,608	12,008
Cork E. T. and L. Company	,, 22	577	463	+ 113	15,706	13,702*b*
Darwen Corporation	—	—	—	—	—	—
Dover Corporation	,, 24	335	324	+ 10	7,270	6,834*b*
Dublin & Lucan Electric Railway	,, 25	138	115	+ 23	1,188	972
Dublin U. T., electric cars	,, 23	4,149	3,729	+ 420	—	—
Dublin S. District, Electric	,, 23	1,187	1,048	+ 139	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 24	13,424	8,866	+ 4,588	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 24	1,726	1,296	+ 430	14,124	10,730
Liverpool Corporation	,, 17	9,357	9,456	- 99	291,205	251,881*b*
Liverpool Overhead Railway	,, 25	1,778	1,767	+ 11	14,084	13,960
Oldham-Ashton-Hyde Tramways	—	—	—	—	—	— *b*
Portsmouth Corporation	,, 24	1,378	—	+ 90	—	—
Potteries Tramways	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 25	3,980	—	—	—	—
Southampton Corporation	,, 22	1,153	819	+ 333	—	—
Southport Corporation	—	—	—	—	— *d*	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. *b* From Jan. 1. *d* From April 1. 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £356 decrease.
Barcelona Ensanche y Gracia, £30 decrease. Barcelona, £329 increase.
Brisbane, £280 increase.
Buenos Ayres and Belgrano Electric, £526 increase.
Calcutta, £134 increase.
Cape Town (month of July), receipts, £13,440; expenditure, £6,832.
Mexico Electric (month of July), receipts, £17,600; expenditure, £10,800.
Perth Electric, £252 increase.
Port Elizabeth (month of June), receipts, £2,983; expenditure, £1,800.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅜-¼
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅜-½
—— Ordinary, 1-125,000	1 ..	⅜-½
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8½-9½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	6-6½
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4½-5½
Brush Electrical Engineering, Ordinary	2 ..	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2½
—— 4½ per cent. Debenture Stock	100 ..	103-108
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	108-112
—— Ordinary	5 ..	15-16
—— 5 per cent. Pref.	5 ..	5¾-6½
Crompton and Co.	3 ..	3½-3¾
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	0-½
—— 5 per cent. Debentures	5 ..	1½-2½
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	85-90
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1½-2
—— 7 per cent. Cumulative Pref.	2 ..	2½-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10½
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16½-17½
—— 4½ per cent. Preference	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	101-104
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref.	5 ..	5¾-6½
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¾-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	95-100
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	7½-8
—— 7 per cent. Preference	5 ..	8½-8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7½-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10½ xd
Charing Cross and Strand ,, ,,	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5½-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105
Chelsea Electricity Supply	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	107-110
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	11½-12½
—— 5 per cent. Debenture Stock	100 ..	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	100-102
County of London and Brush Provincial, Ordinary	10 ..	8-9
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	103-106
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¾-6½
—— 6 per cent. Cum. Pref.	5 ..	5½-6
—— 4½ per cent. First Mort. Deb.	100 ..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4½-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5½-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7½-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10½
London Electric, Ordinary	3 ..	1½-1¾
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13-14
—— ,, 85,001-98,769	5 ..	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	110-113
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6½-6¾
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1½-1¾
—— £5 Shares	5 ..	7½-7¾
—— £4½ Shares, New	4½ ..	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5¾-6¼
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8½-9½
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	12-13
Electric Railways.—		
Central London, Ordinary	100 ..	103-106
—— 4 per cent. Pref.	100 ..	105-108
—— ,, deferred	100 ..	98-101
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	52-54
—— Ordinary	10 ..	5½-5¾
—— 4 per cent. Debenture Stock	100 ..	113-118
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	92-95
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-129
Blackpool and Fleetwood Tramroad	10 ..	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-4¾
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	102-104
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6-6½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9½-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¾-14¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11½-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅝-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5½-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5½-5¾
—— 5 per cent. Deb. Stock, Red.	100 ..	105-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	1½-2½
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5½-5¾
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	98-102
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	105-107
New General Traction, Ordinary	5 ..	3-3¼
—— 6 per cent. Cum. Pref.	10 ..	4½-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	12-13
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9½-10½
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8s. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	3¼-4⅛
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅜-5
—— 4 per cent. Deb. Stock, Red.	100 ..	91-94
—— 3½ per cent. Deb. Stock, Red.	100 ..	95-98
Oriental Telephone and Electric Company	1 ..	¾-1

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NOTES.

Notice.—We have received a copy of the September number of *Cassier's Magazine*, which devotes a considerable portion of its space to the Glasgow Exhibition. An interesting article on the machine tools shown at the exhibition is contributed by Joseph Horner.

Hanover.—The tramway company are seeking permission to dispense entirely with the use of accumulator cars on their lines, and to work the whole of their system on the overhead trolley principle, but the town authority is strongly opposed to the change.

Municipal Telephones.—Accrington bids fair to follow the lead taken by Tunbridge Wells and Glasgow in the matter of municipal telephones. At the meeting of the Town Council on Monday the question was discussed in a manner which augurs well for action, as reported in another column.

Car Racing in Germany.—The practical sense of the German nation is evidenced by a ministerial degree forbidding motorcar racing in public thoroughfares throughout Germany. So far as Germany is concerned, then, we are to have no more of those senseless competitions, the results of which have been quite devoid of any practical value, except to show their futility.

Northampton Institute.—A copy of the Northampton Institute's new issue of "Announcements" for the session 1901-2 has reached us. The lectures which have been arranged for in connection with the various special courses for electrical engineers seem to be very comprehensive in their range. Numerous changes in detail calculated to ensure greater efficiency are announced.

The Energy of Three-Phase Motors.—In an article contributed to a recent issue of the *Elektrotechnische Zeitschrift*, Mr. Stern discusses two methods of measuring the energy of three-phase motors—viz., the "zero point method" and the "three-wire method"—and gives calculations based on a series of measurements to show that both methods are very inaccurate, wherefore he concludes the construction of meters or wattmeters should not be based upon them.

Tesla's Sanguine Hopes.—It is reported by the American Press that Nikola Tesla is about to establish his first wireless telegraph station at Wardenclyffe, nine miles from Port Jefferson, L.I. Two hundred acres of land have been purchased, and the necessary buildings will be put up at once. The main building will contain a 350-h.p. electric plant. This will be the first of a chain of stations by means of which Mr. Tesla expects to communicate with all parts of the world.

Berlin.—An electric railway for the conveyance of goods has been opened in the neighbourhood of Berlin. It connects the manufacturing district on the right bank of the Oberspree with the goods stations, on the trunk line, in Rummelsburg and Nieder-Schöneweide. Two electric locomotives constructed by the Allgemeine Elektricitäts-Gesellschaft, who supplied the complete electrical equipment, serve to work the line. The Oberspree works of the Berlin Electricity Supply Company furnish three-phase current, which is transformed into continuous current for supplying the locomotives

Victoria.—Electricity is making rapid headway in Victoria. Recently the foundation stone of the Victorian Electric Supply Company's extensive power-house in Hargreaves-street, which is to supply the electricity for the illumination of the city and borough of Eaglehawk, as well as for the overhead system of tramway service in both municipalities, was laid by the mayor (Mr. S. Ryan) in the presence of a large and representative gathering of citizens. The estimated cost of the combined service is £120,000. The first section of the tramway to be laid will be from Charing Cross to Arnold-street, and after that the main line from Eaglehawk to Quarry Hill will be taken in hand. Every effort will be made to have the service in working order by the end of the year.

Canadian Water Power.—Another big power scheme is to be brought before the Provincial Parliament at Toronto, Ont. It aims to develop the water power north-west of the town of Port Arthur, Ont. The capitalists behind the scheme estimate that on the completion of the Canadian Northern Railway Port Arthur will become a great flour-milling centre. They propose, therefore, to buy land for a canal 22 miles long to connect with and divert the Keministikuia River. There is said to be an easy route between the high levels to a point 3½ miles north of Port Arthur, where the syndicate proposes constructing a reservoir with an area of 1,500 acres. When the route has been secured, it is not expected that much influence will be required to ensure the water power of the river in West Algoma being quietly conceded by the Ontario Government to a company

Electric Submarines.—Commenting upon the future possibilities of the electric submarine boat, the *Electrical World* of New York thinks that the storage battery of to-day is adequate for motive power if great speed is not attempted, and the rest is merely a delicate piece of marine engineering, with the Whitehead torpedo for a working prototype. There is no trouble whatever in carrying battery enough for any speed at which it is safe to manœuvre the craft even with the present lead cells, while if the new Edison battery fulfils the hopes of its inventor, its small weight and freedom from noxious fumes should make it a favourite in such work. At the same time our contemporary regrets that neither the Lake nor the Holland boat was given a chance at Santiago, and suggests that a submarine cable-cutting cruise on the bottom of a hostile harbour would have done wonders in testing the practical value of the boats and in teaching their real place in warfare

The Conduction of Electricity through Metals. Regarding the theory of ions in the conduction of electricity through metals, a brief account is contributed by Herr Riecke to the *Phys. Zeitschrift* of an experiment conducted by him to determine whether positive metallic ions play a part in the phenomena. The apparatus used consisted of three equal cylinders two of copper and the third of aluminium, the latter being placed between the two copper cylinders. The whole system thus constituted was inserted in the charging circuit of a storage battery for a year. During this time 958 ampere-hours passed through the cylinders. In an electrolytic cell they would have caused the deposition of 1·14 kg. of copper. Careful determinations of the weights of the single parts at the beginning and at the end of the year, however, showed no variation of the weights, whence the conclusion is arrived at that movable positive metallic ions play no part in the conduction of electricity through metals.

Good Road Surfaces.—The necessity of having good road surfaces for automobiles is being felt keenly in New York State, where the roads are proverbially bad. According to State Engineer Bond, cost has been the principal obstacle to the building of good roads in the past. But those who have most to gain from improved highways, although they have been slow to appreciate the fact, are

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now represented to be generally in favour of reform. As regards reducing the cost of road building, Mr. Bond thinks he has found the solution of the difficulty in the proposed establishment of a State rock-crushing plant, near Rockland Lake, across the Hudson from Sing Sing, where the convicts could be employed in converting the trap rock, abundant there, into road metal. He regards the location as excellent for the purpose, and would expect the returning canal-boats to carry loads of broken stone up into the State at cheap rates, rather than to go back light. The provision of good road material is one step, but its proper application is another, and if the Americans prove more successful in the latter than we have been over here, we shall be willing to learn from them.

The Electrical Conductivity of Gases.—A paper on the "Electrical Conductivity in Gases Exposed to the Action of Cathode Rays," by J. C. McLennan, recently published in the *Zeit. Physikal Chem.*, is abstracted in the *Journal* of the Chemical Society for September as follows: "The conductivity of gases under the influence of cathode rays may be completely explained on the hypothesis that positive and negative ions are produced in the gas. By the action of cathode rays on an insulated conductor positive charges are completely dissipated, whilst uncharged or negatively electrified conductors retain a residual negative charge. In the author's experiments the effects are due, not to the Röntgen, but to the cathode rays. Methods for the determination of the extent of the ionisation in gases are considered, and experiments with air, nitrogen, carbon dioxide, hydrogen, and nitric oxide show that the ion concentration with constant cathode rays is proportional to the density of the gas and independent of its chemical nature. Ionisation in the same gas at different pressures is similarly proportional to the pressure, whilst in all cases it is further shown that the ionisation is directly proportional to the energy absorbed.

Electric Towers.—That the Americans are keen on spectacular effects may be gathered from a long illustrated article devoted to the subject of electric towers, which appears in the *Electrical World* of New York. The writer (Mr. Luther Stieringer, consulting engineer of the Pan-American Exhibition at Buffalo) traces their history and evolution, and explains how certain magnificent spectacles might be obtained with other towers. The manner of placing the lights so as to obtain the desired effects is gone into. In concluding, Mr. Stieringer points out that a longing weakness of human kind is to soar skyward, and as an example presents a series of designs of steel towers which were proposed for London shortly after the famous Eiffel Tower was erected. If the architectural designer, he surmises, could clothe the exterior of one of these tall towers in ornate form and make suitable provision for the association of light, a spectacle rivalling the wildest fancy of the most imaginative mind could be created. Perhaps so, but first of all we must have the tower—maybe some enterprising American syndicate will oblige us in the matter, and either complete the Watkin tower project or devise an entirely new scheme. Meanwhile, we must content ourselves with the brilliant effects provided as advertisements, such as those of the "San Toy" order, an example of which is to be seen just outside Waterloo Station. For brilliancy commend us to the "San Toy" advertisement.

Motorcar Trials.—On Monday last there commenced a series of motorcar trial runs in connection with the Glasgow International Exhibition. The trials were organised by the Automobile Club of Great Britain and Ireland, with the co-operation of the Scottish Automobile Club, and are being carried out under the supervision of the Sports Committee of the Glasgow Exhibition. Medals will be given by the committee for the vehicles which come out of the contest with the greatest distinction. The practical value of the trials is greatly enhanced by the fact that the results are not dependent on relative speed, but on reliability. Speed, except in ascending three hills which have been selected for hill-climbing trials, will not count for much in the results, as no speed in excess of the legal limit for Scotland of 10 miles an hour is to be recognised. Reliability and endurance, then, are the factors of importance. The popularity of the contest, notwithstanding its restriction to tourist cars, is sufficiently demonstrated by the fact that over 50 cars were entered. We hope to give the results of the trials, which terminate to-day, in a future issue, and at the same time to record a success for the British-made article. A lot of money is leaving the country for the purchase of automobiles and their parts, and the Automobile Club are certainly to be commended in the effort which they are making to bring the manufacture of motor vehicles in this country to such a state of excellence as to render purchasers independent of the Continental makers.

Rival Systems.—We notice in the *Electrical World* of New York a digest of an article contributed to a recent issue of the *Elektrotechnische Zeitschrift* by Mr. Mueller, chief engineer of Schuckert and Co., in which the author discusses the reason why engineers build plants with 220 volts at the consumers' terminals. The only point which he can find in their favour is that less copper in the line is required, so that the total plant is 10 to 20 per cent. cheaper than a 110-volt plant. On the other hand, there are many disadvantages of the 220-volt pressure, especially where the current is used mainly for incandescent lighting. A comparison of 110 and 220 volt incandescent lamps shows that the latter consume on the average one-third watt more per candle and have a shorter life besides. For arc lighting in general 110 volts are better, as many consumers burn only two or three arc lamps, while to use up 220 volts four or five arc lamps are required. Although the 110-volt pressure is not at all dangerous, this cannot be said, under any circumstances, of 220 volts. Some accessories in the wiring are, therefore, more expensive for the latter pressure. Only in plants where many motors and comparatively few lamps are in use is the higher voltage of 220 volts preferable. He says that in many cases where the installation had been made at 220 volts, great hopes were entertained that in a short time 220-volt lamps would be just as good as 110-volt lamps. He thinks that this will never be the case, as the thicker carbon filament of the 110-volt lamps will always be stronger, and, therefore, stand a higher temperature and give a better efficiency. Any improvements would affect the 110-volt lamp just as much as the 220-volt lamp.

Electric Light Highly Eulogised.—A correspondent to the *Western Mail* speaks in high terms of the advantages of electric light from a hygienic point of view. "As an illustration" (says the writer) "of the effect of electric light on the health, we have high medical authority for the opinion that the remarkable youthfulness of middle-aged society leaders which is so often commented upon, is directly due to the fact that electric light is now almost universally used in the West-end. Formerly, dowagers and *débutantes* were utterly exhausted at the end of a London season, if, indeed, they did not break down before. Night after night they spent long hours in the destructive glare of foul gaslight Wrinkles came in early life, and women in their thirties became worn and *passée*. Now 40 is regarded by many as a woman's most attractive age. She spends her night in the pursuit of pleasure as before, but in the house, the restaurant, the ball-

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room, the theatre, the opera-house, she is continually accompanied by the cool and clean rays of the electric light. She has no headaches because she breathes no poison. She is in fresh air and she remains fresh herself. She has found electric light matchless for the complexion, and in middle age she has a smooth skin, a bright eye, and a well-preserved figure. For her, as for everyone else, electric light is able to prolong youth and prolong life, while making it also more enjoyable. So well is this understood that anyone now proposing to light his hotel or theatre or restaurant with gas would be regarded as a madman. In every respect except the cost competition between gas and electricity is at an end The only healthy illuminants are sunlight, moonlight, and electric light."

Testing Three-Phase Generators.—A digest of an article, by M. Breslauer, on the "Testing of Three-Phase Generators," which was published in the *Zeitschr. Elektrotechn.*, Vienna, is given by "A. H." in *Science Abstracts* as follows: "A complete test of a large three-phase generator is frequently attended with difficulties, on account of having to provide the necessary large amount of power and the three equal non-inductive load resistances. On a non-inductive load, which is the load generally employed in carrying out such a test, the drop from no load to full load should not exceed 3 per cent. in good machines of moderate output, and should not in any case be greater than 6 per cent. A very good estimate of the qualities of a machine may, however, be arrived at without actually running the machine at full load by making use of the open-circuit (exciting current and voltage) and short-circuit (exciting current and armature current on short-circuit) charac teristics. In order to find the load characteristic of the machine under constant excitation (the load being non-inductive), a right-angled triangle is constructed whose hypotenuse is equal to the constant exciting current, and one of whose sides is equal to the exciting current required to produce the given load current on short-circuit. The point on the open-circuit characteristic corresponding to an exciting current equal to the remaining side of the right-angled triangle then gives the terminal potential difference at that load. The author tested this theoretical method on a machine giving very bad regulation (and, therefore, very suitable for the purpose), and found practically perfect agreement between theory and experiment."

Stoppage on the Central London Railway.—The breakdown which occurred on the Central London Railway on Monday last, whereby a complete stoppage of the system for over half an hour was caused, emphasises the risk of making radical changes in central-station practice without preliminary experiment. However, the circumstances in the particular case under notice were peculiar. Judging from the company's intention to increase their boiler plant, the reserve was in the first place already recognised in responsible quarters to be too small. Then came the urgent necessity of remedying an alleged smoke nuisance from the company's smokestack, and in the absence of a better expedient a change of coal was decided upon. Monmouth coal was substituted for that previously in use, and the boiler reserve being small, the change seems to have been effected through boilers upon which the immediate supply of steam was absolutely dependent. Though not necessarily of less calorific value than the coal previously used, the new fuel, it seems, called for different handling on the part of the stokers, but this knowledge was gained only at the expense of the steam head, which gradually decreased until it became insufficient to drive the engines effectively. We can recall to mind at least one similar experience, also the outcome of a change of coal and for a like reason, when the chief and his satellites took off their coats and worked at the fires as if life depended on maintaining that head of steam, but alas to no purpose on a heavy load, the decrease in head having once set in. Circuit after circuit was cut out, and engine after engine shut down, until one circuit only remained in, and that, too, with the last of the generators making a mournful hum instead of sounding its customary high note, and with the switchboard incandescents at a dull glow. Experiences of the kind are fortunately not of frequent occurrence in central-station practice, but at the same time one wonders that such experiences—their causes and effects—are not common property to those engaged in such practice.

High-Tension Switch and Fuse Gear.—The *Journal of Electricity, Power, and Gas*, which is published at San Francisco, contains each month a series of articles devoted to high-tension transmission work. The editorial offices of our contemporary are situate right in the middle of the best field for high-tension transmission work, and it has used its opportunities to the best advantage. In consequence, we know of no better source from which to obtain practical hints as to the difficulties to be overcome when designing large schemes for the transmission of electrical energy at abnormally high voltages. In the issue of the journal for June is given a paper by Mr. R. S. Masson, entitled "Some Suggestions in High-Tension Switching.' This paper opens with the paradoxical statement that high-tension switching is best done when it is not done at all. The author states emphatically that the earlier transmission plants, which consisted of single units without switch and fuse gear, have given undoubtedly less trouble than the newer installations, in which attempts have been made to nterrupt high-tension circuits. He divides the causes of abnormal strains to the insulation of high-tension circuits under three heads. The first of these is atmospheric discharges, including lightning and static discharges from one wire to another. The next is the effect of sudden short-circuits or earth on the system; while the third cause includes those surging effects produced by the changing and under-balancing of the electrostatic capacity of the circuit by the use of switch gear. The protected position of most water-power plants in deep gorges renders the line wires over the first considerable distance from the power station fairly safe from lightning discharges, and the danger caused by such discharges is much less if the lightning enters the system at some considerable distance from the machinery liable to damage. The third cause of discharges due to switching and fusing is directly under the control of the engineer, and Mr. Masson holds that this danger can be avoided if a proper arrangement of apparatus is adopted, together with a correct method of operating. His conclusion is that the one fact to be kept in mind in arranging the circuits in a station is that no high-tension circuit should be made or broken unless there is a source of E.M.F. and power on each side of the switch. He then goes in detail into the various combinations of apparatus which may be required, and shows that in every case it is possible to so arrange the apparatus that the high voltage is never broken by means of switch or fuse. His arguments as to the strains set up if the high voltage be interrupted are quite correct, and the adoption of the precaution suggested by him greatly simplifies the construction of the switch and fuse gear used.

Electric Motors on Warships.—The *Globe's* correspondent on naval matters, who is generally well informed on questions pertaining to the service, contributes the following unfavourable criticism on the application of electricity for power purposes on board warships: "Considerable difference of opinion exists among gunnery experts in

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various navies with regard to the motive power for working and training the heavy guns which form the main armament of a modern battleship. In the new battleships 'Kearsage' and 'Kentucky,' of the United States navy, which have both been fitted with the superimposed system of turret mounting for their main armament of 13in. and 8in. guns, electricity is used, and this motive power is likewise applied to the mountings of the 13in. guns of the battleship 'Illinois.' Electricity is also adopted for the main armament of some of the older French battleships, of which the 'Jauréguiberry' is an example. In our own navy we have tried the same motive power in some of the smaller battleships, such as the 'Barfleur,' and it has also been fitted for working the 9·2 guns which form the heavy armament of the cruisers 'Powerful' and 'Terrible'; but in the British navy opinion is decidedly in favour of hydraulic power in preference either to steam, compressed air, or electrical power. The disadvantage in using steam is that in action the fracture of a pipe may cause general confusion and disaster, and at all times there is great inconvenience due to heat. Compressed air is very extravagant, the pipes conveying it are liable to explosion, and the engines driven by it are very noisy. Electric motors of sufficient power have to run at a very high speed, are also very noisy, considerable difficulty occurs in locating faults in the electric circuits, and trouble is frequently experienced in obtaining a sufficiently slow movement for sighting the guns. Hydraulic gear possesses none of these disadvantages, and has the additional merit of allowing the training and working of the heavy guns and their turrets and mountings to be under the most perfect control." In our opinion there is not one of the objections raised but could be successfully removed, and the real ground for complaint is to be found rather in the half-hearted manner in which the attempt has been made to apply electricity for power purposes on our battleships. The installation on the "Barfleur," for instance, is not exactly an example of up-to-date practice, and it is obviously unfair to condemn a system with a few early models only as a standard for comparison especially in face of the reputed success of the system in the German navy, where it has been given a real trial. As for the difficulty in locating faults in the electric circuits, common-sense would suggest that the electric system is by far the most flexible of the several systems compared, and in case of actual damage by shot or shell would lend itself more readily to rapid repair.

E.M.F. between Magnetised and Unmagnetised Iron.—It has been found that if two iron electrodes are placed in acidulated water, one of these upon being magnetised becomes positive to the other, causing an E.M.F. to be set up. The experiments of Dr. Hurmuzescu have shown that up to a magnetisation of 7,000 units the curve which unites the E.M.F. to the strength of the magnetic field developed in the iron has a form analogous to the curve of magnetisation of iron—that is, the E.M.F., increasing at first with an increase of magnetisation, afterward increases more slowly. Mr. René Paillot has extended these researches to very intense magnetic fields, and finds that the E.M.F. seems to arrive at a limit beyond which it cannot be increased by further magnetising the iron. In order to reach this limit a very intense magnetic field was needed, and this was obtained by using the semi-circular electromagnet devised by Dubois, by which in the intrapolar space a magnetic field as high as 30,000 units is obtained. The experiment was carried out with electrodes in the form of iron wire carefully annealed. These were placed in the vertical branches of a tube bent up at each end, and filled with a dilute solution of acetic or oxalic acid. One of the branches of the tube, containing an electrode, is placed in the magnetic field between the poles, and as the lower straight portion is 12in. long, the second branch with its electrode is entirely outside the field. The E.M.F., which was very small, was read by a Lippmann electro-capillary voltmeter sensitive to the ten-thousandth part of a volt. The magnetic field was measured by the ballistic galvanometer. A number of observations were made, which agreed very closely, and the results are expressed in the following table:

Field strength H.	E.M.F. volts.	Field strength H.	E.M.F. volts.
804	0·0022	20,210	0·0298
1,698	·0040	23,492	·0328
3,106	·0074	24,500	·0324
5,000	·0110	26,505	.0330
8,712	·0171	27,018	·0328
10,504	·0191	28,886	·0330
12,193	·0210	29,510	·0332
17,043	·0272	30,187	·0330

It will thus be seen that the E.M.F. developed between magnetised and unmagnetised iron cannot be made to pass a certain limit. This limit, which is 0·0330 volt, is reached when the iron is magnetised to 25,000 units, and is not increased at a field strength of 30,000 units, which is about as high as can well be obtained. The value of this limit depends somewhat upon the sample of iron and the strength of the acid, but does not vary greatly from the above.—*Scientific American.*

Electromagnetic Effect.—In a contribution to the *American Journal of Science*, Mr. E. T. Adams discusses the electromagnetic effects of moving charged spheres. It was indicated by theoretical considerations some 25 years ago that an electrostatic charge, when moving at a velocity small by comparison with the velocity of light, acted like a flow of electricity in a conductor, and was capable of exerting a magnetic force in its vicinity in the manner of an active electric conductor. The late Prof. Rowland successfully demonstrated this magnetic effect of a moving charge in 1876, and similar results have been obtained from time to time by other experimenters. It seems, however, that M. V. Cremieu, of Paris, has recently thrown doubt upon the experimental results by describing experiments of his own in which no such effects were obtained. Mr. Adams, on the other hand, describes experimental results recently obtained which tend to show that Cremieu has been deceived in some way by his results, and that the Rowland effect does exist. When an electric charge is whirled in a circle about an axis, the mean electromagnetic effect in its neighbourhood, according to the theory in question, is equal to that of an electric current delivering the same electric quantity per second around a turn of wire coincident with the path of the revolving charge. Since the effect is always very small, because the charge is small, it can only be made apparent by moving the charge with great speed, so as to increase correspondingly the aggregate equivalent electric quantity passing per second, and by placing a sensitive electromagnetic needle in the most advantageous position to be acted upon by the magnetic force expected. In the experimental case described by Mr. Adams there were 16 brass balls, about 1in. in diameter, mounted at equal radial distances (about 8in.), from a revolving shaft so as to magnify the effect of one charge 16 times. Each ball was charged to a potential of approximately 19 kilovolts, and the speed of the balls in their path was between two and three miles per minute. The result was to produce the equivalent of a current of a few microamperes circulating in a single turn. A similar set of balls was rotated in the neighbourhood with opposite electric charges, for the purpose of obtaining a more definite distribution of the revolv-

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ing electric field. A delicately suspended and sheltered set of astatic magnetic needles showed a distinct deviation under the influence of the rotating balls, and the magnetic force exerted was apparently of about the right magnitude. The pressure of 19 kilovolts, or 63 electrostatic C.G.S. units of potential—a fearful rhodomontade of description rendered necessary owing to the absence of a name for this unit—was produced by a storage battery of 10,000 cells. Assuming that the results are as reliable as they seem, the conclusions are that just as a moving magnetic charge is the known equivalent for a magnetic current, or time rate of flow of magnetism, so a moving electric charge is the equivalent of an electric current, or a time rate of flow of electricity.

The Electrolytic Cleansing of Metallic Surfaces. The following is a translation of a short article, by M. F. Loppé, which appeared some time ago in the columns of our contemporary, *L'Electricien:* "In ordinary practice metallic surfaces are cleansed by immersion in either alkaline or acid solutions. Acid solutions are employed for cleansing the surface of iron, copper, and alloys of copper, whilst alkaline solutions are used to clean aluminium or zinc. These methods of cleaning metallic surfaces by simple immersion are lengthy and costly; the solutions used gradually become saturated with metal and lose their cleansing power; and if, as in the case of copper, the metal dissolved in the cleansing process is valuable, it is necessary to recover it from solution, a recovery which is not always easily carried out. Moreover, the liquids employed are corrosive, and therefore, if their action is not carefully checked, the metal surfaces may be damaged, or the workpeople may be affected by their corrosive or poisonous nature, whilst, finally, there is often considerable difficulty in getting rid of the waste pickling solutions owing to local regulations concerning drain and water contamination Attempts have been made to overcome some one or more of the above-mentioned difficulties by employing electrolytic methods of cleaning, such as that used by Cowper-Coles. These methods have been applied to the cleaning of iron surfaces, such as boiler tubes, etc., but the employment of an acid solution has always been advocated. Recently, however, the Vereinigte Electrizitäts Aktiengesellschaft, of Vienna and Budapest, have patented a process for the electrolytic cleansing of metallic surfaces which has yielded remarkably satisfactory results, both from the point of view of rapidity and of economy. This new process may be applied to any kind of metallic surface, and the cleansing solutions employed do not become deteriorated in their properties by use. Any metal removed from the surfaces which are under treatment may be readily recovered if the value of the metal renders such recovery desirable, and, further, the solution being neutral and practically harmless, it may, when necessary, be run off into the drains, etc., without creating a nuisance. The electrolyte used consists of an aqueous solution of an alkaline salt, and one of the electrodes is formed of the metal whose surface it is desired to clean, whilst the other is formed of carbon, or of some metal which is not acted upon by the solution (or, as will be pointed out later, both electrodes may consist of the metal whose surface is under treatment). In the case of iron or copper, or alloys of copper, the metal surface is made the anode, and the metallic oxide which is dissolved from the anodes is reprecipitated from the solution by the alkali which is generated at the cathode. The electrolyte is thus continuously regenerated. When it is wished to clean zinc and aluminium surfaces, these metals are employed as the cathodes, and alkaline aluminates and zincates are formed, from which, however, the zinc and aluminium oxides are subsequently precipitated by the acid liberated at the anode. This form of electrolytic cleansing process may, moreover, also be used for the cleaning of metallic surfaces from greasy and fatty matters, and for this purpose the metal must always be used as the cathode, the alkaline hydrate liberated at this electrode saponifying and dissolving the grease on the metallic surface. If it is wished to use the process for the preparation of iron plates, etc., which are to be subsequently tinned or electro-galvanised, it is carried out as follows The electrolyte employed consists of an aqueous solution containing 20 per cent. of sodium sulphate, such as is produced as a waste product in some factories, and both of the electrodes are formed of the iron whose surface is to be cleaned. The current is first of all passed in one direction during a certain period, and the plates acting as anodes are cleaned of metallic oxide by the acid set free at their surface, whilst the plates acting as cathodes are cleansed from grease by the alkali. The anode plates are then removed and replaced by fresh uncleaned plates, and the current is then reversed so that the plates which were previously cleansed from grease as cathodes in the first operation are now cleansed from oxide as anodes, and the freshly introduced plates now acting as cathodes are in their turn freed from grease. When this operation is completed the current is again stopped, and the anode plates are replaced by fresh plates, and the current is once more started in the reverse direction. The process is then continued in this way, the plates being successively cathodes and cleansed from grease and then anodes and cleansed from oxide, and are finally removed from the cleaning vats. The duration of the process naturally depends upon the current density employed. With a current of 60 to 120 amperes per square metre—*i.e.*, rather under 6 to 12 amperes per square foot—of the metallic surface, each operation lasts about half an hour, and as each surface undergoes a double treatment, first as cathode and then as anode, the complete treatment requires from 60 to 120 ampere-hours per square metre of surface. The mean voltage required is about four volts, and the energy required per square metre of surface cleaned is therefore from 240 to 480 watt-hours, which is a very small expenditure. When the articles cleaned are iron plates they are slipped into frames made of lead-covered iron wire, which are not attacked by the solution. The space inside the frames is about 2cm. wide, and the sheets are slipped in either through an opening at the top or at the side, and are so adjusted that they come into contact with the frames at several points, thus obtaining a good electric contact. The frames are arranged parallel to each other, but are insulated from one another by wood separators. At one side of the vat the alternate frames are connected together to one conductor, whilst the intermediate ones forming the second electrode are connected together to the other conductor. The electrolytic vats are usually made of concrete, and the whole of the frames can be lifted from the vats together in order to remove and replace the plates. When the current is passed there is a considerable evolution of gas, and the solution becomes turbid. The solution also becomes heated, and a flocculent precipitate of the reddish-brown ferric hydrate is formed, which partly falls to the bottom of the vats and partly floats at the surface. The electrolyte is circulated by a pump, which forces it through a filter, from whence it returns to the vat. Each vat requires a voltage of about four volts, but if a higher voltage is available several vats may be arranged in series with advantage. The process has been employed at the large plate factory at Teplitz, in Bohemia, and a still larger installation is now being erected."

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GLASGOW CORPORATION TELEPHONE EXCHANGE.

(Concluded from page 309.)

The central exchange premises are in a new block of buildings known as Castle-chambers, which was in course of construction last year in Renfield-street, in the very centre of the business part of Glasgow. The lease is for 28 years, and the building has been fitted up to suit the requirements of the department. The exchange is situated in the upper portion of the Castle-chambers, which, being high above the adjoining houses, affords admirable lighting and ventilation, while access is easy by the electric elevator, which runs throughout the day. The public office and the private rooms of the officials occupy half of the fifth floor; the switch-room, a spacious apartment, and also a large airy room for the recreation of the operators, are on the sixth floor; the apartments of the assistant engineers and clerks, also those containing the testing jacks and the high-voltage guards and the lightning arresters, are on the seventh floor, while overhead is a room used by the instrument fitters.

All the wires from the Glasgow municipal telephone exchange are laid underground in the main streets of the town. It is only when the outlying districts are reached that the distribution is sometimes completed by means of overhead wires. The underground cables used are all of the paper and air insulated type. In the main cables 312 pairs of wires are usual contained within the one lead sheath. Where the underground cables reach the exchange there are 22 of these cables already laid. These are conducted to the top of the building through an iron cableway, which gives the required support. Owing to the

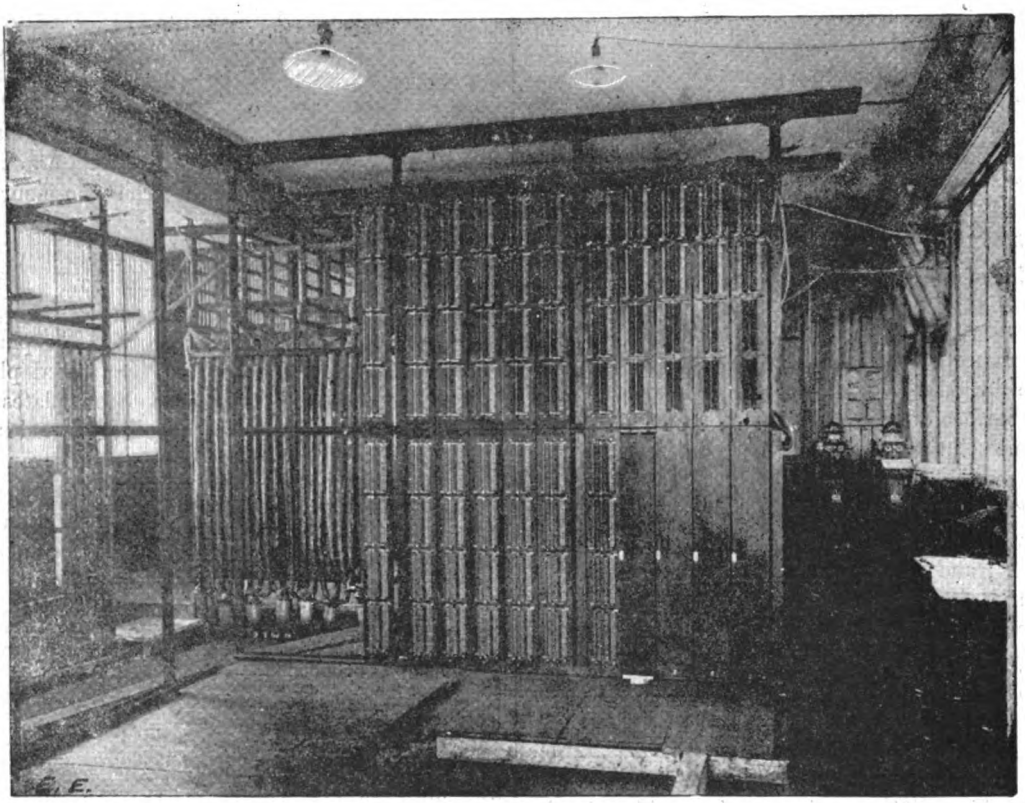

FIG. 1.—Test Room, showing High-Voltage Guards and Lightning Arresters.

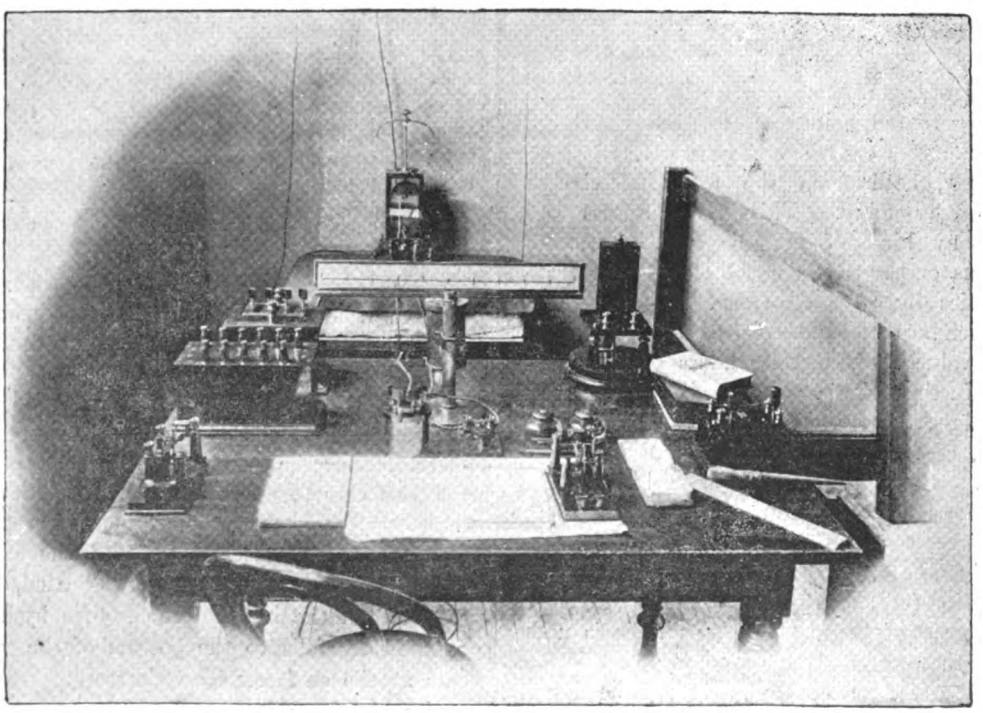

FIG. 2.—Testing Instruments in Test Room.

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great weight of the lead covering, the architect of the building insisted that the cables should be supported independently of the building. The engineer accordingly arranged the iron cable-way, to which the cables are secured at about every 10ft. in the vertical run. The total height of this cable-way is about 100ft. At the top of the faulty section is removed and the air pressure applied at the nozzle at the other end of the faulty section. As the air is forced into the cable it is dried by means of calcium chloride. It is also proposed to have an air-pump worked by means of an electric motor in the exchange so that it can be conveniently applied to dry up

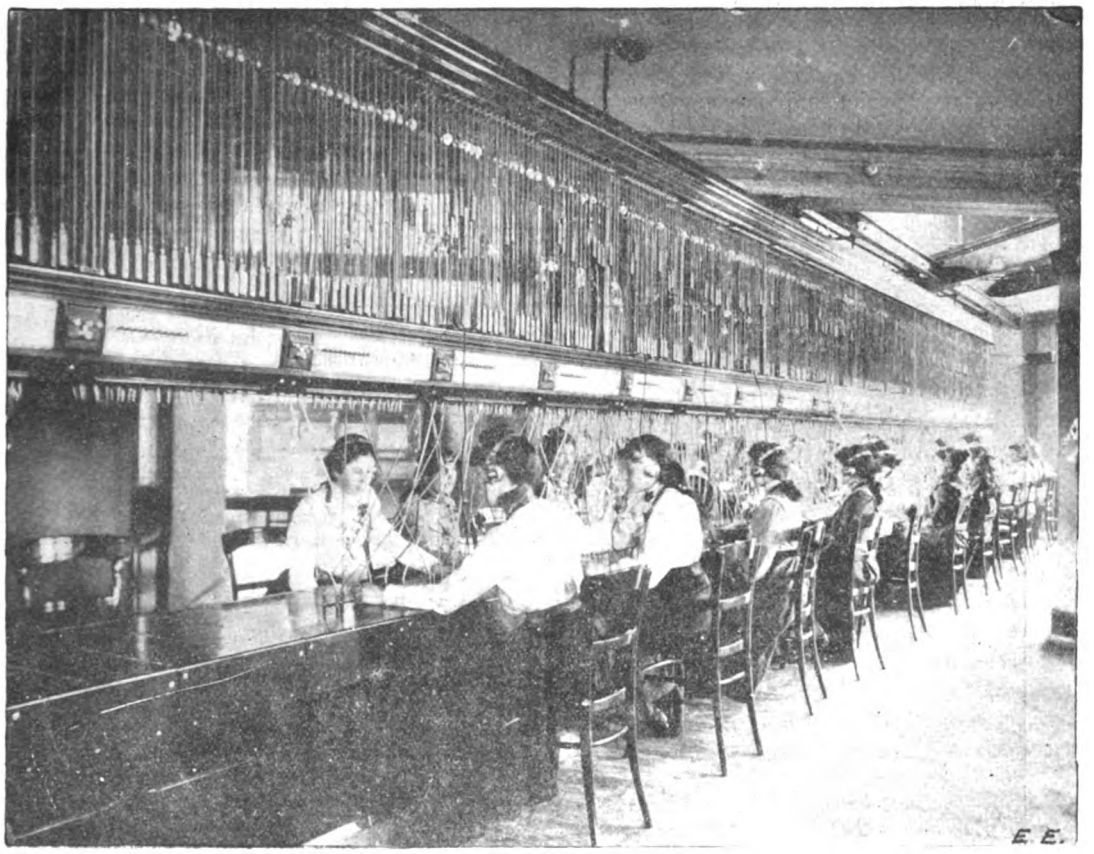

FIG. 3.—Central Switch Room.

the lead-covered cables are taken under the floors to the main terminal and testing board, which is seen in Fig. 1. As the insulation of these cables depends on the air-tightness of the lead sheath, any leakage of air soon makes itself

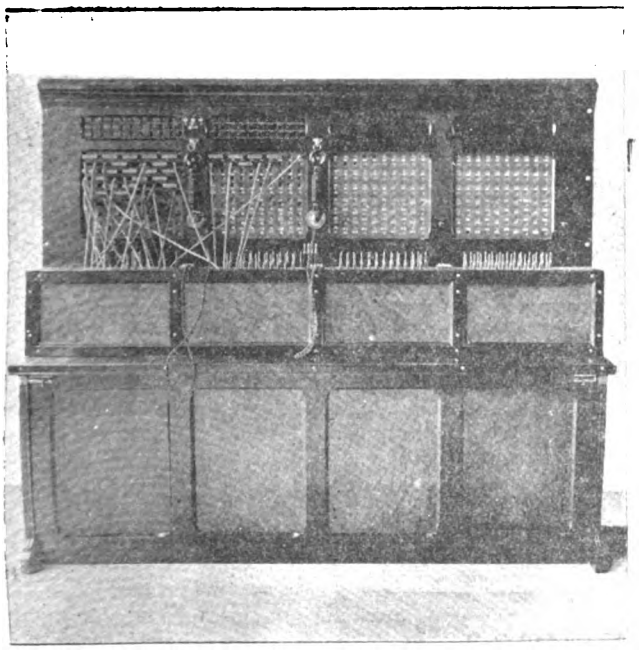

FIG. 4. Call-Wire Distributing Board

felt by introducing moisture, which lowers the insulation. The operator in the testroom having located the division of the cable in which the low insulation occurs, the moisture is dried up by means of air, which is forced through the cable with a pressure of about 10lb. per square inch. In order to give the air free course, the nozzle at the one end of the last sections of the cables. The ends of the paper cables are taken to the bottom of the terminal and testing board, as is seen in Fig. 1. In the way in which the cable is connected on to this board a new departure has been made in Glasgow. The wires with the paper insulation are

FIG. 5. Table Instrument.

actually connected on to the springs of the terminal board. In order to prevent moisture creeping back along the paper, the ends are impregnated with a bituminous compound and varnished. This procedure largely reduces the total number of joints which have previously had to be made at this point, and there has been no loss of insulation found.

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The two connecting springs in each circuit wire on the terminal board are made much more flexible than is usually the case. This has the advantage that every movement of the same when introducing testing plugs tends to clean the connecting surfaces, whereas in the older type with a stiff spring the opposite is the case. On the terminal board already provided provision is made for 5,000 subscribers. Over this board a new system of grids (Fig. 1) has been arranged, through which the wires on to the lightning arrester board are laid. Each of the grids has 50 openings, and they are all arranged symmetrically along the top of the board. Each of the openings provides ample room for 300 wires, so that the grids will ultimately take 15,000 wires without crowding. Each division of the grid is used for wires of a definite series of numbers, so that the testing engineers are able to trace any wire at any point without difficulty, and the arrangement is also such that any wire can be removed individually without causing any tangling

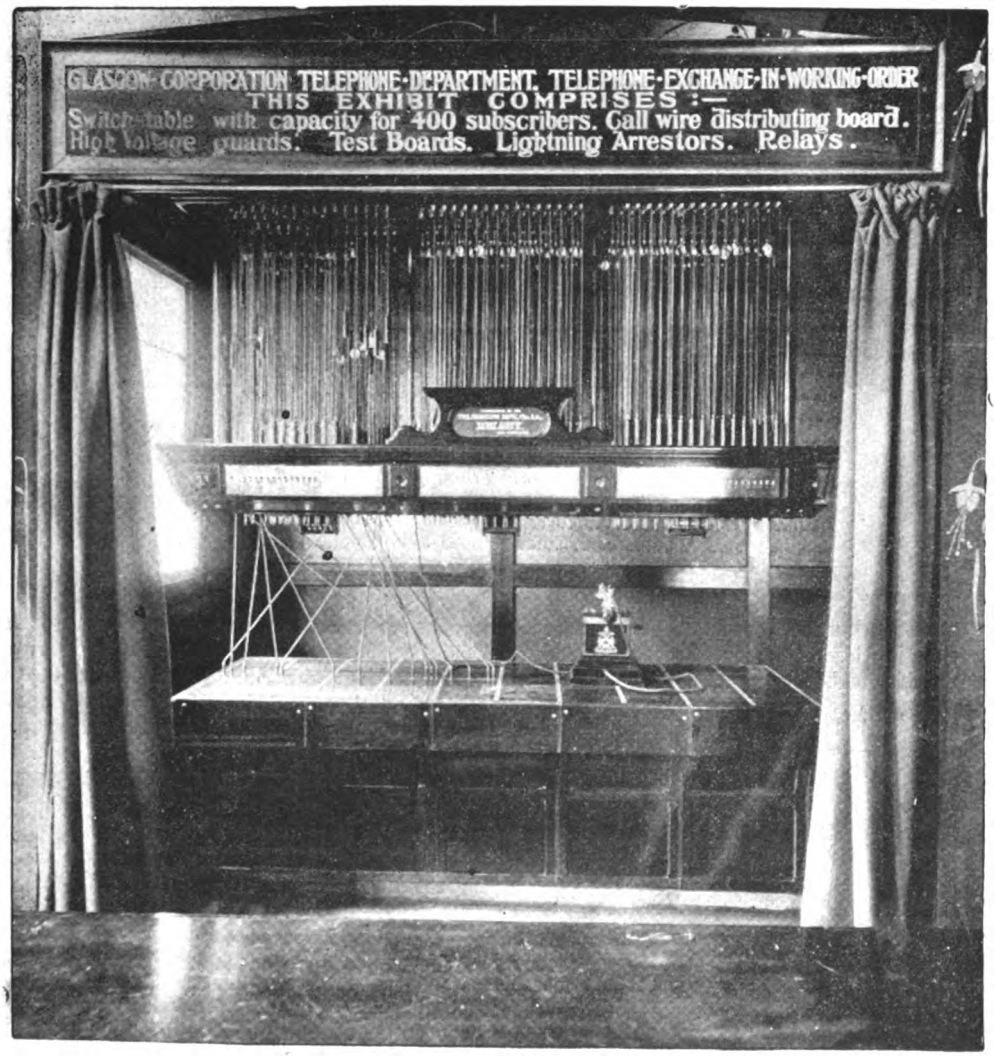
GLASGOW CORPORATION TELEPHONE-DEPARTMENT. TELEPHONE-EXCHANGE-IN-WORKING-ORDER
THIS EXHIBIT COMPRISES :—
Switchboard with capacity for 400 subscribers. Call wire distributing board.
High voltage guards. Test Boards. Lightning Arrestors. Relays.

FIG. 6.—Switchboard, Sub-Exchange.

of the remaining conductors. In this respect the grids are a great convenience over the ordinary method of binding up the cross connecting wires into cables. Near to this terminal board is placed the test board, at which the inspectors make a preliminary investigation as to the nature of a fault on any subscribers' line. The testing plug on being inserted at once divides the circuit inside the station from the subscribers' line outside the exchange. The inspector can then see on which of the two parts the fault occurs, and also if there is an earth connection on either side. This enables the character of the fault to be quickly determined, and greatly reduces the labour in locating the same. The testing instruments are shown in Fig. 2.

On the next board (Fig. 1) are grouped the heat coils and lightning arresters. The heat coils are arranged to disconnect the line if a stray current of any magnitude is in it. The arrangement is that of a spring which, in the normal way, is compressed and held in position by means of a bead of fusible alloy. If the current through this fuse exceeds that which would be given by, say, half a dozen primary batteries, the alloy melts, and the spring expands and disconnects the circuit. At the same time it releases a group relay, which rings a bell and warns the operator that either the electric light or tramway current has obtained access to a given group of his lines, and then an inspection shows which heat coil in the group has gone. These heat coils and also the lightning arresters are provided on each pole of the telephone circuit. They are also placed at the subscriber's end of the line, so that there is perfect safeguard against both high-voltage current and lightning. From this board the wires are laid down through the main board of the exchange, which is shown in Fig. 3. These wires are made up into cables of a rectangular form, which can be conveniently stored under the floors, where they are easily got at. The design of the main board has been carefully worked out by Mr. A. R. Bennett. It allows for the wires coming in from below the floor, and for any line of plugs to be removed individually without dismantling those around it. The board will ultimately provide for 10,400 subscribers, any one of which will be within the reach of any operator without her having to rise from her chair. This main board is 60ft. in length, and each subscriber is connected to 11 different plugs along the line. This means that there will be 10,400 plugs in a length of 5ft. 5in. In this way it will be seen that considerably less space is taken up than is usually the case. All the jack cords are overhead, where they are easy of access.

Coming now to the system on which the connections are made, the whole of the exchange is carried on on the call-wire system. When the subscriber wishes to obtain a connection, he depresses a red key on his instrument and asks the operator to put his number on to the number required,

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He would say, for instance, "364 on to 152." The operators are always listening, and hence there is no time wasted in asking an individual subscriber which number he wishes to

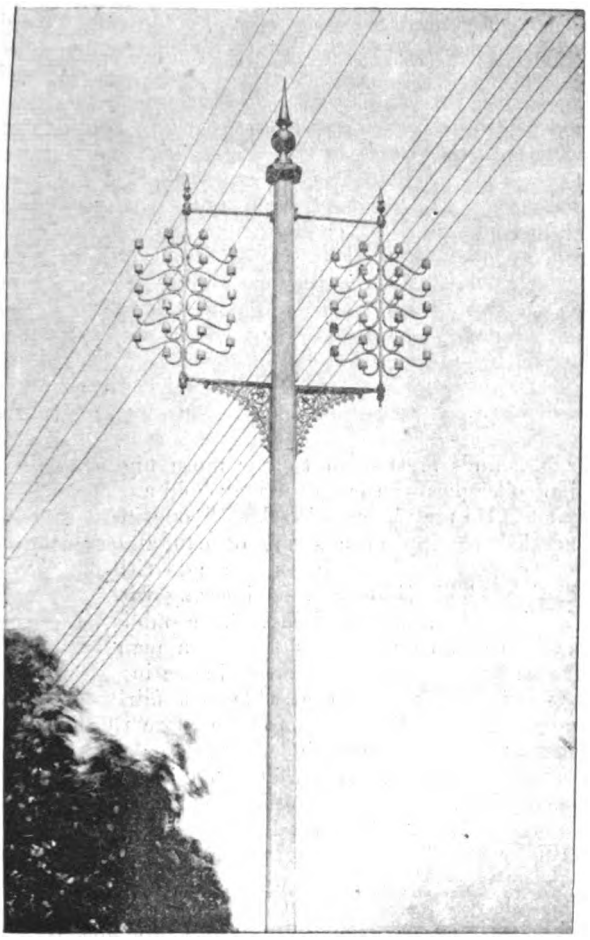

FIG. 7.—Ornamental Pole.

be connected to. In order to arrange that each operator shall have about the right number of subscribers on which to attend, the call wires are led to an individual board (Fig. 4) in charge of the lady superintendent. On this board the call wires can be grouped together on to any operator, or, again, an operator can be relieved if it is found at one time of the day she is receiving more calls for connection than she can quickly attend to. When the conversation is completed, the subscriber has again to ask to be disconnected. The maximum number of subscribers to be connected to any call wire will be 30.

Two types of instruments are used by subscribers—one fixed, the other (Fig. 5) portable. These embody the latest improvements. The call is made by simply pressing a button and stating what number is wanted. On Sundays and during the night, when the operators are not sitting with the receivers at their ears, the pressing of the button causes the indicator to fall and a bell to ring, whereupon the operator on duty asks what number is wanted, and gives the desired connection. The instruments were supplied by the Ericsson Bell Company, Glasgow, and the General Electric Company, London; the switchboards were provided by the Telegraph Manufacturing Company, Helsby; and the electrical apparatus, high voltage guards, and lightning arresters by the International Electric Company, London. Although the formal opening of the system only took place yesterday week, operating service began in the central switch-room on March 28, and since then sub-exchanges have been opened in the International Exhibition (Fig. 6) and in the Hillhead and Bridgeton districts of the city, while premises have also been secured for sub-exchanges in Springburn, Maryhill, Strathbungo, Kinning Park, and Govan. Communication with the Government trunk lines began on June 2. Fig. 7 shows an ornamental pole used in the outlying districts, and Fig. 8 a typical manhole.

We are indebted to Mr. A. R. Bennett, the consulting engineer to the Corporation, for facilities granted in preparing the above description and also for the illustrations. Mr. Bennett has his hands full in completing the work of connections, as the contentment of the 1,400 subscribers now connected is as nothing compared with the discontent of the 3,600 would-be subscribers. The magnitude of the work and the early date of opening renders instant completion impossible, and the citizens of Glasgow are now, as always, clamouring for the *best*. The work which has been done is good, and the completion of the connections will soon make the municipal exchange the most useful one in Glasgow. We have also to thank Mr. F. W. Shorrocks, the inside superintendent, for showing us round and explaining what otherwise would have not been clear in the equipment. Mr. John Macfee

FIG. 8.—Manhole.

M.I.E.E., has the arduous post of assistant manager to Mr. Bennett, and Mr. J. L. Chambers has charge of all outside work.

The following is a brief *résumé* of the opening which

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reached us just too late for our last week's issue: The LORD PROVOST, in performing the opening ceremony in the telephone exchange, congratulated the community on having, after a nine years' struggle for what they considered their rights, at last received from a somewhat unwilling Parliament those powers which they had that day put in operation. They were not animated by the slightest shadow of hostility to the National Telephone Company, who, as pioneers in that important enterprise, were heartily entitled to receive the due reward of all their efforts and their public spirit when they had achieved success, but no company could expect to retain a monopoly which interfered with commercial freedom unless it realised that its own individual interest must ever go hand in hand with the public convenience and the public service. It was no secret that in telephony this country was lagging very far behind other countries, a state of matters which, they believed, was largely caused through the telephone service being in the hands of one company; therefore, the Corporation felt it their duty to ask Parliament to give them powers to do what the company were unable to do.

Mr. HANBURY, speaking afterwards in the Merchants' House, in acknowledgement of receiving the freedom of the city, said that the Treasury, the Post Office, and the Corporation of Glasgow, working side by side, found that a great means of intercommunication, a great civilising agency, was the telephone service, which even in this rich country was far behind that of many smaller countries of Europe. The National Telephone Company did a great work in starting this system throughout the country. Unfortunately, the task was too gigantic for any company. Its life was too short and its powers too small. It was impossible to allow any company to tear up streets at its pleasure, and it would have become necessary, even if the service had been ideally perfect, to find means for extending it and for dealing with the question of wayleaves. There was another reason which weighed with him. He did not like private monopolies especially when contrary to the intention of those who gave it the license originally. The National Telephone Company having bought up all the other companies, had become practically one huge monopoly. In the case of that company there undoubtedly was special danger, because as its life was short there was always a risk that as the desire for telephonic communication increased, if that service was not efficient, the cry might suddenly arise for the Government to buy up the whole service, and it was possible that the price the Government would have to pay would be out of all proportion to the value of the service obtained. As the Post Office had already sufficient to do, they fell back upon the most enterprising municipalities. He believed that the examples of Glasgow and Tunbridge Wells would soon be followed by other municipalities.

Mr. Hanbury was afterwards entertained to luncheon by the Corporation, and spoke in similar terms.

THE GLASGOW INTERNATIONAL ENGINEERING CONGRESS.

The President's Address.

BY J. MANSERGH, F.R.S., PRES.M.I.C.E.

Standing here, in virtue of my position as president of the Institution of Civil Engineers, to open the first General International Engineering Congress held in Great Britain, I am conscious of owing my elevation to this eminence to the accident of office, and not to personal desert. I feel very keenly myself—and I am sure the feeling must be shared by many present—that it is an act of the greatest presumption on my part to occupy this position in the presence of the Grand Old Man of Glasgow's ancient university. I desire, therefore, to explain that the position has been forced upon me, notwithstanding my very earnest remonstrance, and by the desire of Lord Kelvin himself. My words will therefore be few, and will be restricted to tendering a very cordial welcome to all engineers—especially to those hailing from foreign and distant lands; to thanking the authors of the papers contributed to the various sections; and to making the briefest reference to certain matters of interest to us as engineers working under modern conditions.

It has long been impossible for any individual to give adequate expression to the fulness of the combination of contemporary science, art, knowledge, and practice which we recognise for engineering Engineers constitute more than a profession: they amount to a "race," and it is upon them, more than upon any other class of the civil population of the world, that falls the heaviest share of the "white man's burden." There have been framed many definitions of engineering and of the engineer, but none that I can esteem adequate and at the same time sufficiently exact and exclusive. My reason for holding this opinion is based on two considerations. The first is the persistence of much popular ignorance of the nature of our work, and some lack of appreciation of our class; and the second is the stubborn refusal of the English spirit to admit the necessity of any formal qualification on the part of those who claim to be of the profession. With us—odd as such a state of things must seem to our more highly organised foreign colleagues—an engineer may hold a diploma, or he may not. He may be associated with our institution, and be entitled to append a string of capital letters to his name, or he may not possess a single title to nominal distinction. This is because engineering with us does not consist in being, but in doing. The public's unformed, vague idea of an engineer is that of a man who can do things—a great and constantly increasing number of things—all falling within a wide but fairly recognised category. His quality seems to lean more to the side of invention than to that of scholarship. For my part, I am content to have it so. Not that an engineer can ever be too deeply instructed, or too well trained in all the elements of knowledge and skill required for the effective pursuit of his calling; but the really great engineer is born, not made. So subtle is the influence of words upon thought, that I could wish the name of our avocation were spelt in English, as it is in languages of more pronounced Latin derivation, with a capital "I" instead of "E"—"Ingeniering," say, in place of "Engineering." Thus the nature of our work would be better recognised among the people, who are careless of etymologies. The suggestion of the name would be removed from association with the word "engine" (a good enough word in its degree, and one that once had a wider significance than is now left to it), and would be placed where it rightly belongs, with the root idea which gives us the words "ingenious," "ingenuity," etc.

We must, however, go no further in this direction for the missing definition of engineering, or we shall get into the clouds, where, although I am not sure but that we might find some colleges of engineering, we should miss the substance of the thing itself. For engineering is the only high art which depends as much on its cheapness for its excellence as upon any other item in the sum of achievement. All other things being equal—adaptability, soundness, efficiency—the engineering work which costs the least money is the best. I do not know of any other product of man's creative and adaptive powers of which the same can be so truly said. The "cash" basis is the real foundation upon which the engineer builds, and this consideration draws us at once from judging engineering as merely something cleverly done by an ingenious person. It also very often serves to distinguish between college, text-book, or rule-of-thumb engineering and the real thing There is an American definition of an engineer which states that "he is a man who can do well for one dollar things that anybody could do somehow for double the money." This is getting very near the truth. It is not the whole truth, of course, but that, for reasons I have already indicated, is unattainable. At any rate, it places in due prominence a quality which those who regard engineering studies from the college standpoint are apt to ignore. I have heard a legend of a professor of applied mechanics who was shocked at the thought of steam engines being made for money to sell—like cakes. A good deal of wasted ingenuity would be saved if those who engage in every kind of engineering work would remember

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to use the money standard, as well as the foot-rule and the higher mathematics.

Real engineering must be mastered as it is realised on works in progress. It has no authoritative text-book. The working engineer's library is sometimes largely composed of ephemeral manufacturers' catalogues and lists of prices current of materials. Like the perfect artist described by Longfellow, the engineer must learn to work with the means that lie readiest to his hand. He must cherish his ideals, or he will sink into the routineer, but he, of all men, cannot afford to indulge in hobby-riding. He leaves as little as possible to chance, and, if he is wise, he will not rely upon his best mathematics any further than he can see them. If he starts with aptitude, plods on with patience, observes with insight, records with careful exactitude, and adapts with wisdom, in the fulness of time he will find himself, almost to his surprise, in possession of judgment, and that is the glory of an engineer, fitting him for his highest employ as man-of-all-work to civilisation. Material civilisation owes much to this faithful servant. Others may plot, scheme, invent, discover wants and their proper supplies; the engineer, as a rule, does chiefly what he is told wants doing. By strict attention to his own business he helps to make the crooked ways straight and the rough places plain for all. The engineer must have great power of concentration. His solicitude is to make every job a little better than the last. The newest steam-engine shows a fractional economy of steam; the latest steamship carries her freight with a scarcely distinguishable saving in coal consumption per ton; the selected railway metal lasts a little longer than the previous purchase; the main line is straightened here and there; and, incidentally, as it were, the remote ends of the earth are brought closer together, and plague, pestilence, and famine are driven back. The wiseacres who declare on political platforms that the effect of modern civilisation is to make the rich richer and the poor poorer forget all about engineering. The engineer is the chief of the modern democratic civil service.

Civilisation is admitted to have had its birth with the Romans, and they were the first to recognise a change of purpose in engineering from the idle aims of Egyptian pyramid builders to the useful purposes of roadmaking and the provision of ample supplies of pure water to their cities. Down to the dawn of the century that has just closed civil engineering did not surpass the works of the Romans, which, indeed, in some respects remained unequalled. It may be said with respect to the elemental need of the modern world for improved means of transportation that the new civil engineering first broke out its own line with the notable discovery of the Scotsman, Macadam, that good roads could be made with stones broken small. The distinguishing note of modern engineering is that it subserves in the main the interests of the mass of the people. The greater comfort, better feeding, higher healthfulness, freer movement of the people to outside the congested urban areas to-day, as contrasted with the state of the populace of this and other countries a century ago, are chiefly attributable to the triumphs of our professional work. An alarm has been sounded in our ears of late warning us that we, the inhabitants of the United Kingdom of Great Britain and Ireland, have touched our high-water mark in respect to the prosperity derivable from the prosecution of those manufacturing industries which are based upon engineering, or served by it with the means of transport and communication. This may be so. Our nation has no royal secret for arresting the revolution of Fortune's wheel. When merchants first sought our shores to trade with the aborigines, their attraction was the native tin. The development of the country, however, was not arrested by the substitution of iron for bronze implements and weapons. Wool became in turn the staple product of the land, and carried its diversified fortunes bravely down almost to within living memory. We have long ceased to produce enough wool, or corn, or meat for our teeming population It is almost as much as we can do to find enough water to drink. The wisest man that graced the court of the British Solomon who first united the kingdoms of Scotland and England would be sorely puzzled—if he were to revisit this realm—to understand how we all contrive to live. The industrial development of the world has proceeded along the lines that the profoundest mind of the nineteenth century—Charles Darwin—traced for the life history of the planet.

The course of economic progress is from the simple to the complex, from oneness to infinite differentiation. In the history of Britain, the mining of a semi-precious metal for exportation was succeeded by pastoral pursuits, and these, again, were followed by agriculture and manufacturing enterprises. Good government kept order in the land, and saved it from devastating invasions. Margins realised over the cost of living formed capital, which went into fresh enterprises at home, and eventually overflowed into adventures for the conquest of markets abroad. All the time engineering dogged the way, making roads and inland waterways and harbours, and supplying tools and mechanical motive powers. A vast multiplication and diversification of employments for money, ingenuity, and toil has resulted from the free play of the national genius, and been carried to such a height by the indomitable spirit of the race that now the waxing and waning of particular trades and interests from accidental influences does not alter the balance of the great account which the nation has opened with Fate. An illustration in point is spread before our eyes. Mark the difference of the conditions governing the prosperity of, say, a mining camp and those prevailing over a vast and varied emporium, a manufacturing centre, such as this noble city. Glasgow flourishes, not by reason of the vogue of any particular trade that finds specially favourable situation on the banks of the Clyde, but because it is a microcosm of the universal activities which yield wealth. Its engineers can point with pardonable pride to the material framework and setting of this community—the artificially improved river, the systems of railways, the magnificent water supply, which have given Glasgow elbow room for its expansion, as the gains of engineering; but it is the peculiar diversity of Glasgow's energies that have won for her the rating of "second city of the Empire."

The question of moment to Britishers is, Shall we maintain our ground—to say nothing of increasing our lead? I cannot tell; but this I do believe, that the character of the future of the country, and the fruitfulness of our common calling, depends chiefly upon the preservation of that freedom for the play of all the talents, all the energies, all the force of human initiative for the subjugation of the powers of nature, and their direction in the service of mankind, which has enabled us to do so much in this regard in the past. Favoured simply by secured peace at home and the confidence of the masters of accumulated capital, engineering has showered its firstfruits over our land. To-day these advantages have become internationalised. Gold flows daily to and from the capital cities of the earth for the smallest balance of gain, or, as engineers would describe the movement, of a mobile fluid under the slightest head of an evershifting pressure. Brains are no peculiar possession of our nationality. The cosmic forces are the same everywhere. Economic conditions tend to wear down to a uniform level. Science knows no frontiers. The engineer is the truest freetrader. He goes whithersoever he is wanted and finds most to do. Will he in future flourish best in Britain, or abroad? One hears much talk nowadays about the British need for more technical education for workers, and of better instruction in the art of living for the people generally, and I am not disposed to disparage this desire for more light. There cannot be too much of it. Nevertheless, I hold liberty to be more precious than learning. The fullest freedom for the exercise of the inborn spirit of initiative, enterprise, and adventure is the next essential to the occurrence of this spirit in the individual members of a race, for the whole to make headway in the universal struggle for life and a leading position. I fear that only too good a case could be made out for the allegation that a mistaken statutory system has discouraged in this country—for the time being, at least—the naturalisation and development of electrical engineering on the largest scale. In other words, the Electric Lighting Acts had the broad result of chopping up the business of electricity supply in this favoured land into morsels reduced to the parochial needs of local authori-

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ties. There was no freedom in the business. Instead of the electrical and mechanical development of lighting and power plant being undertaken in this country upon a scale proportional to its early promise, the work had to be done by "sample"—every small specimen differing from the others. Long years passed before any English engineer was in a position to give out an electrical power contract amounting to £100,000. Meanwhile our friends in America and on the Continent of Europe were forging fast ahead. So we lost our chance, and shall probably have to take other people's electrical plant for some time, instead of striking out our own leading line, as our less governed forefathers did in railway work and shipbuilding years ago.

I should like to remark here, in parenthesis, how much of the real essence of economical engineering is contained in the work of settling standard sections of important constructive materials. This matter has been taken in hand by a joint committee of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Iron and Steel Institute. It is my privilege to be *ex officio* chairman of this committee, and we have already taken the evidence of representative men among makers, merchants, and users of steel and iron bars of all shapes and scantlings, and received many written communications, all of which go to prove the great desirability of doing very thoroughly the work of standardising which the committee have taken up. Sir Benjamin Baker, with a specially selected sub-committee, has charge of bridge and general building construction; Sir John Barry, with similar assistance, of railways; Colonel Denny of shipbuilding; and Sir Douglas Fox of rolling stock. In the hands of these eminent engineers you may rest assured the work will be well handled; but we desire very earnestly the active and cordial assistance and co-operation of all our brethren interested in this important matter.

In all the various sections to which you will now go to perform the real work of the congress, you will, I think, find something that will serve to focus your attention upon the great engineering problems of our time. I have no wish to discriminate among the papers, but it is plain that in Section I. Prof. Carus-Wilson has undertaken the treatment of a matter of extreme interest in writing of the "Economy of Electricity as a Motive Power on Railways at Present Driven by Steam." Some very important papers are to be read in Section II., and it is a matter of peculiar gratification that we have been able to enlist the help of so distinguished a band of engineers from the United States of America and the European Continent to give true international importance to the deliberations of this section. I am pleased to find that one of the most interesting of all inventions since the age of Watt in the domain of prime movers—the steam turbine—is to be discussed in Section III. It is impossible to overrate the value of the section of metallurgy, and the number of papers promised testifies to the technical interest of the questions which await answers in this sphere of engineering energy. In Section VII., two of the most pressing problems of municipal engineering—the disposal of sewage and the housing of the poor—will, I am sure, be adequately treated. In Section VIII.—gas engineering—sufficient proof will be given of the influence on the industry of that invaluable invention of incandescent lighting, to which the exhibition (of which our hosts may justly be very proud) owes so much of its evening brilliancy. The applications of electricity to various purposes will be described by Section IX., among them the wonderful "three-phase" system of power transmission, which promises so much in this connection. Time forbids my going further into the various matters that crowd one's mind on such an occasion as the present. I can, therefore, only commend you heartily and sincerely to the dispatch of the important business you have undertaken, and trust that the fruit of increased knowledge that may be gathered from interchange of ideas will amply repay your trouble in coming here at the invitation of our Glasgow friends and *confrères*.

Doncaster.—Mr. W. Wild, of Wednesbury, has been appointed electrical engineer to the Corporation; his duties will include the lighting station and the tramways. There were over 50 applicants

THE GLASGOW ENGINEERING CONGRESS.

Electrical Section.

The work of the Electrical Section of the Glasgow Engineering Congress was commenced on Tuesday immediately after the reception of the foreign delegates and the delivery of the inaugural address by the president, Mr. James Mansergh, F.R.S., in the Bute Hall of the Glasgow University.

The proceedings were opened by the following address from the chairman of the section.

Introductory Address to the Electrical Section.

BY W. LANGDON, PRES.I.E.E., CHAIRMAN OF THE SECTION.

Inasmuch as, within a very short time, it will be my privilege to deliver before the members of the Institution of Electrical Engineers my inaugural address, it was not my intention on this occasion to have encroached upon your time by anything in the shape of an address; but other sections of the congress having elected to follow that course, I fear I may be thought wanting in courtesy if I fail to comply with that which has proved so generally acceptable with others. I therefore propose to approach you, very shortly, upon a subject which, at the present juncture, I feel to be one of the highest importance.

Just 50 years since London, under the auspices of the nation's lamented Prince Albert, gave birth to the first International Exhibition. Followed by numerous others, at home and abroad, none, it is pleasing to note, have proved more successful financially, or more fully met the object for which they were established, than those inaugurated by the enterprise of Glasgow's citizens—the last and most successful of which forms one of the attractions incidental to the assemblage of this congress and of the inauguration of the new century. There can be no question that the result of these great undertakings has been for good; that they have been a stimulus to manufacture and trade; and that—greatly beyond all else—they have been a means making for peace. Whether we, as a nation, have been the gainer or the loser, the world has richly reaped. Exhibitions, railways, steamboats, education, the ready intercourse between peoples have told, and are daily telling, their tale. Few articles remain the privileged product of any one place. Manufacture has become cosmopolitan, and the rivalry of the future between the most advanced nations of the earth will be that of manufacture—the power to apply the products of the earth to the exigencies of life at the least cost, and with the least loss of time. The supremacy of a nation may be attained by force of arms, but war cannot be carried on without the sinews of war, and the sinews of war means the wealth of the nation. Whence comes this national wealth? Surely by the industry and intelligence of its people—the power to observe, to apply, and to produce. Lord Rosebery, when speaking recently at the Mansion House, remarked, "We are coming to a time of stress and competition for which it is necessary that we should be prepared," and later on he observes, "It is necessary for a nation in these days to train itself by every valuable method to meet the stress and the competition that is before us." The question whether England, in comparison with other nations, is becoming retrograde in her industrial achievements must prove one of peculiar interest to all who seek this country's welfare. There are grave reasons to fear that in some paths, especially in the more modern applications of science, and notably in that development with which this Institution is so closely allied, we have not retained that prominent position which has characterised this country for so long a period. Twenty years back British manufacture stood on level ground with other countries in the production of electrical machinery, yet, if we may judge by the following figures, for which I am indebted to Mr. Philip Dawson, member of this Institution, it would appear that we have from some cause failed to meet even our home demands. From these figures, which are approximate, it appears that of some 300,000 i.h.p. of steam-engines laid down for lighting and traction, 73,000 have been imported from the United States of America; and that of some 200,000 kw. capacity

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of generators, 71,000 were derived from the same source. It will be understood that this does not mean that the residue was British production. It is not my intention, nor would the time at my disposal admit of my attempting, to enter into details why this is so. I take the bald fact as illustrated by the figures I have quoted. England did not meet the demand. Can it be that the British manufacturer lacked confidence in the permanency of this new electrical development? I quote again from Mr. Dawson. The capital invested in European countries and the United States in electric lighting, power, and traction works, amounts to £367,000,000. Of this sum the United States contribute £200,000,000 and Great Britain £35,000,000. The number of miles of single track equipped for electric traction in the two countries is, relatively, 21,000 and 900. Of motorcars, 68,000 and 2,600. Germany, where the power employed for lighting work approaches closely that of England, has 2,300 miles of track and 5,400 cars, although the invested capital is but 29 millions, as against England's 35 millions for an enormously less mileage and smaller equipment. The population of Great Britain is approximately 40,000,000 as against 70,000,000, that of the United States. The area in square miles is, relatively, 121,115 and 3,581,885. Too much stress must not be laid upon territorial comparison, although it would seem an evident corollary that the more dense the population the greater must be the demand for means of locomotion. These figures should, at all events, prove effectual in disposing of any doubt that electrical development is staple. That it is only at the beginning of its era, and that an enormous field lies before it in almost every path of commercial and social life, must be evident to every observant person. It is not, however, with its utility that I desire to deal so much as with the means for its production: the production by our own country of all that is needed to meet not merely the wants of our home demand, but that of our colonies as well.

Two important factors—cost and promptitude of delivery—attend successful competition in manufacture. Inspired with confidence in the future of electrical work, with, as it were, a prescience of those demands which must arise, and unencumbered with many of those restrictions and regulations which attend similar undertakings in England, other nations have seen and have seized their opportunity, gained experience, standardising their productions, and have thus, in advance of this country, prepared to meet any ordinary demand that may arise. Cost depends much upon our labour conditions. Within a very short period rivalry in manufacture will be far more acute than is even now the case, and in it labour will play the chief part. America, as well as England, has her labour troubles. Trade unions exist there as well as here, but the principles which govern them differ from those which prevail here. There the man works unrestricted with all his might. Of what avail is education to the child if manhood fails to take full advantage of it? In the following comment of the New York *Sun* we have an expression of opinion that may well be laid to heart: "When the British workman is willing really to work for his wages, then, and not till then, Great Britain may hope to survive in the great revolution which has begun to sweep through the modern economic world. There is no indication that that willingness will be shown until the bitterness of dire adversity has wrung it from the misguided labour unions of Great Britain." The artisan should not lose site of the fact that this question of cost is one which affects the employé as well as the employer. In the long run the master may be thrust to the wall. He may spend his last penny in keeping his works going, but when he closes those works the workman's means of livelihood are also, so far as the industry there dealt with affects him, closed. Unhappily, identity of interest, so necessary to both master and man, is more frequently marked by its absence than its presence. Until the employé can be induced to recognise in a practical manner the fact that his employer's interest is also his interest, those labour regulations which have been fruitful of so much harm to the manufacturing interests of this country, and which must in the end prove disastrous to the workman, will continue. So long as the production of a certain commodity is peculiar to a given locality, the question of cost is not so material; but where its production is world-wide, labour conditions must subscribe to those attaining elsewhere, otherwise the market for that commodity will be lost. We are speedily approaching a condition in the industrial progress of the world that will test to the utmost, not merely our means of production and our skill, but our position as a nation; for the pre-eminence of a nation will in future be largely determined by its progress in manufacture, and from it mainly shall we have to look for the means by which the nation's power will be maintained. A people may trade. Articles may be bought and sold, but food for the worker lies not there. The wealth of a land is to be found in that which it produces—whether from the soil or by the handicraft of its citizens. In such a rivalry—however friendly and generous that rivalry may be—it behoves us to consider how our manufacturing industry is placed in relation to that of other countries with which we have to compete; whether the conditions of production—labour, legislative enactments, or other restrictions, are such as give our rivals an initial advantage. The question is one of unexampled importance. We see and feel that the manufacture of any one article is no longer the privilege of any one country. The ready means of intercourse between nations—the feverish haste to exploit that which is new—all tend towards the establishment of a common knowledge of the productions of the day. Certain advantages remain to the locality from which the natural product is derived, but if this is submerged, lost in other directions—lost, for instance, in the cost of production—wherein is that country the richer? We have seen that England, once the chief source of iron and steel rails, has in that industry met with serious rivalry. How long will our position in textile fabrics remain even as at present? Is it not time we should look within ourselves and ask, Why is this so? To what is it due? Are our means of production at fault; are they too costly, too much restricted; or where are we to look for the reason?

Gentlemen, I plead no excuse for having ventured to address you upon a subject which might, perhaps, more properly have been approached through the medium of some other branch of science, for the reason that it is one which so materially affects the future prosperity of this country, and amongst other industries none perhaps more so than that embracing electrical development, that I have felt impelled to avail myself of this opportunity to urge the importance of its consideration. We see other countries prepared and preparing to take advantage of every new development in industrial progress. We see vast sums of money embarked in it, and especially in the use and advancement of electricity in its various modes of application, and we see that here in England—the pioneer of mechanical power and progress—we are indebted to a foreign source to meet a great portion of our wants. There is a cause, and if our country is to retain her rank as a nation it is necessary that this cause, whatever it may be, should be ascertained, and, if possible, removed ere it is too late. Are we sacrificing the substance for the shadow? Are we, in our recognition of the liberty of the subject in making provision for his welfare, so handicapping the source of his livelihood as to reduce its power of affording him that support? Are we, on the other hand, fostering manufacture and that which leads to manufacture? We have sternly to face the fact that manufacture is daily becoming cosmopolitan: that the production of a land must form its staple source of revenue, and in this sense to emphasise the need to consider those liabilities to which the British manufacturer has, in relation to the conditions attaining in other countries, to subscribe. The subject is one which may, I humbly and earnestly submit, claim the most careful consideration of every branch of our legislative administration, our labour organisations, and of every citizen of the British Empire.

Mr. W. B. SAYERS, M.I.E.E., then gave a brief but extremely useful description of the principal objects of interest to electrical engineers, with the object of enabling members of the section to avoid waste of time and to devote their attention to the features of greatest novelty in the Exhibition.

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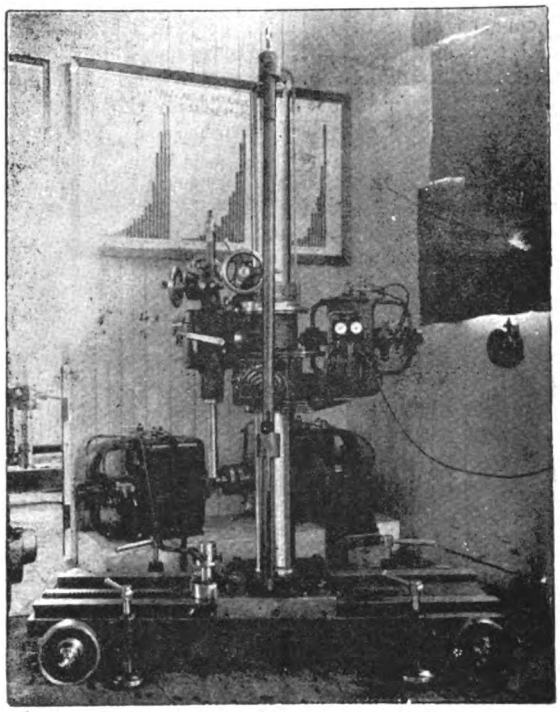
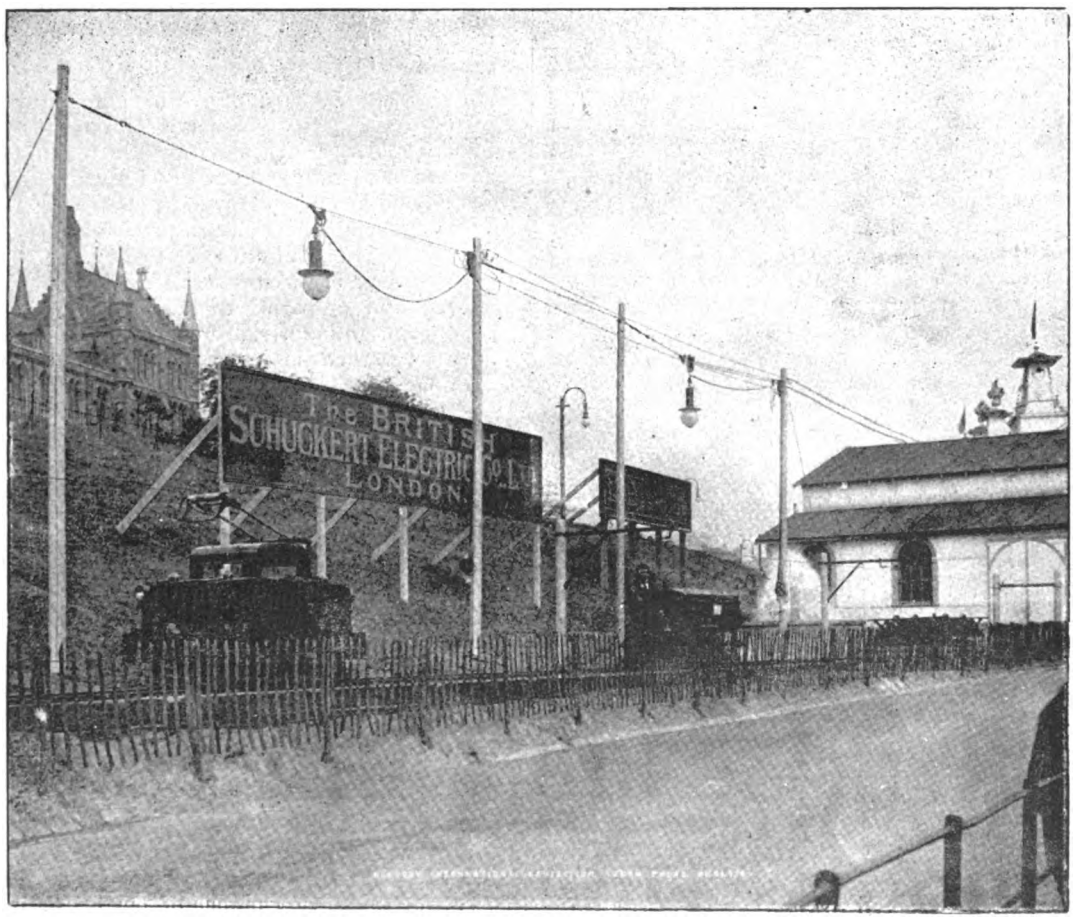
Mr. Sayers's paper was followed by an announcement by the PRESIDENT that Prof. Gray, in whose lecture-room the meetings of the section are held, had made arrangements for his assistants to show and explain to members the apparatus of his department, which includes many valuable instruments of great historic interest, among them being some of Lord Kelvin's earliest electrometers. This announcement was very warmly received, and it appeared that Prof. Gray's offer would be accepted by very many.

The meeting then dispersed into groups, who, under the kind and patient leadership of various members of the local committee, made a tour of the exhibition with a view to gaining familiarity with the position of the most striking exhibits of interest to electrical engineers. The organisation of this tour, following the description given just previously by Mr. Sayers, was, in its time-saving value, characteristic of the hospitality and energy of the local section, through whose untiring efforts so much has been done to enhance the value of the brief period of the congress and to render the visit a memorable one.

Among the exhibits which chiefly attracted our notice were a high-tension switch of excellent design and a novel synchroniser, both by the British Schuckert Company. The switch is a three-pole one designed for 50 amperes at 20,000 volts, and its chief feature was the means adopted for disposing of the arc. The whole switch is built up on a framework of angle iron, all conducting parts being carried on porcelain insulators. Referring to any one pole of the switch, the two ends of the circuit to be closed are brought to two horn-shaped conductors, placed and shaped like the horns of a lightning arrester. Each of these conductors is made of a copper rod, some 4ft. to 5ft. long, that has been doubled back upon itself in the middle like a very long lady's hairpin, and the double conductor then bent into a horn shape. The two limbs of this horn fail to touch by about half the diameter of the rod forming the horn, and when a pair of these horns is placed in position opposite one another, the circuit is closed by a bent rod, each end of which presses into the crevices left between the limbs of each horn, thus closing the circuit. As this is pressed home the circuit is further closed by a knife switch of the ordinary type, thus relieving the above device of the full current. When current is broken, the knife switch breaks first, then the circuit breaks at the base of the horns, and the arc is driven up to the tips and is broken just as in a lightning arrester. The synchroniser referred to is in the form of a large disc of 4ft. 6in. diameter, carrying three concentric rings of lamps and one vertical row in a diametral position. The machines are connected to the lamps so that they glow successively in such a way that two diametrically opposite patches of light circle



Portable Electric Drill—British Schuckert Company.



Electric Mining Locomotive—British Schuckert Company.

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round the rings of lamps, and the straight row alternately glows and becomes dark. When the machines are ready to be synchronised, the patches of light—*i.e.*, of glowing lamps—are stationary at the ends of a horizontal diameter and the vertical row is bright. This firm also shows an excellent portable drill, which we illustrate, and is also showing a mining locomotive running on a temporary track in the exhibition grounds. This, too, we illustrate here.

THE RATING AND TESTING OF ELECTRICAL MACHINERY.*

BY GISBERT KAPP, OF BERLIN.

Electrical engineering enters into so many industries, and has modified the conditions of modern life to so large an extent, that the sale of electrical apparatus has become an important factor in the commerce of every civilised country. To place this commerce on a safe basis it is, however, necessary to arrive at a clear understanding as regards the properties of the different articles bought and sold. This necessity becomes the greater the more the international character of the trade in electrical apparatus is developed, and for this reason the subject of this paper may be considered as specially suited for the consideration of an international engineering congress.

At first sight it may perhaps be thought that the determination of the power, efficiency, and other qualities of electric machines is a simple matter. Electric measurements can be made with so great a degree of accuracy that two experts, if they test the same apparatus under the same working conditions independently of each other, must arrive at the same results. Hence if one expert acts for the seller and the other for the buyer of the apparatus, no difference could seemingly arise. Yet we see it daily that such differences do arise, and the reason for this state of things is that the tests are not made under the same working conditions, and that no general understanding exists as to what shall be tested and how. As an illustration, the case of a tramway motor may be taken. The manufacturer designates it as capable of developing a certain horse-power. According to his method of rating this does not mean that the motor is capable of giving off hour after hour and all day long this horse-power. It only means that the motor can, in the usual way of working tramways, give off that power whenever it is required. Now, as a rule, the periods during which this full power is required form only a small fraction of the time during which the motor is in service. In such cases it would obviously be bad economy to put in a motor capable of giving off the full power permanently. Yet in other cases this may be necessary. Thus if the line contain a moderate grade many miles long, it will require larger motors than a line having very stiff but short grades, yet in the former case the maximum horse-power required is less than in the latter. We thus see that the mere statement of horse-power is not sufficient to decide the question, whether the motor will be suitable for service on a line on which this horse-power is demanded of it. We have here an element of uncertainty in the rating which may cause great trouble to buyer and seller. Another source of difficulties and differences is the question of efficiency, especially in direct-coupled generators. The engine builder guarantees a certain efficiency for the steam-engine, and the dynamo builder does the same for his dynamo. When the two are coupled, it is easy enough to determine the combined efficiency, but it is by no means easy to find out whether each guarantee has been separately fulfilled. Should the combined efficiency fall short of the product of the two guaranted efficiencies, then the separate determination must be made, and each expert will use a different method giving different results. Now to protect buyer and seller alike, it is necessary that the method of testing should be agreed upon beforehand. If the dynamo builder knows how his machine will be tested, he can, in framing his guarantee, allow for inaccuracies of the method. The buyer gets his tenders all worked out on the same basis, and can compare them, and the expert who may be called in to test the machinery has no need to invent new methods, but will be simply requested to carry out the tests as agreed beforehand. Such rules for testing efficiency should be simple and capable of being carried out without entailing great expense or disturbance to the regular working of the plant, and they should give the efficiency with a fair degree of accuracy. Absolute accuracy can, of course, not be expected, and is not required. The important point is, that by such rules there should be established beforehand a clear understanding between buyer and seller, and that there should be no possibility of either being unfairly treated. It would be easy to multiply examples to show that a general, and, if possible, international understanding as to the proper way of rating and testing electrical machinery is very desirable. As, however, on this point there will probably be no difference of opinion, the author does not propose to take up the time of the congress by giving further examples, but he prefers to put before the congress an account of what has recently been done in Germany in the direction of establishing standards for the rating and testing of electrical machinery.

The Association of German Electrical Engineers, of which the author has the honour of being secretary, appointed last year a committee for investigating the question of rating and testing electrical machinery. The report of this committee was presented to the annual meeting of the association this year and accepted by it provisionally. As is usual with rules and regulations issued by the association, their definite adoption is only decided upon after they have been provisionally in use for a year or two, the object being to provide an opportunity for testing the rules in practical work and for amending or altering them, if the necessity arises, before final adoption, which takes place at some future annual meeting of the association. Thus the "Standards for Rating and Testing Electrical Machinery" are still subject to revision. The committee has been reappointed with instructions to collect information as to how the standards work in practice, and to bring up a second report next year. In the appendix is given a translation of these standards. They do not relate to all electrical apparatus, but only to that kind which is generally understood by the term machines and transformers. Thus, generators, motors, rotary converters, motor-generators, and static transformers are provided for by these standards, but not switches, switch gear, measuring instruments, fuses, automatic circuit breakers, and other apparatus. It is not intended that these standards should interfere with any special conditions which buyer and seller may agree upon; but if there are no special conditions previously arranged between the parties, then they shall both be bound by the standards of the association. As regards the rating of apparatus a distinction is made according to the time during which it is used. Three classes are provided—namely, for (*a*) intermittent use, (*b*) short-time use, (*c*) continuous use. The same piece of apparatus may be used under all three conditions, but then its rating would be different. Thus a motor which under (*c*) would be rated at 12 h.p. may be rated under (*b*) as 20 h.p., and under (*a*) as 25 h.p. The power is to be stated on the name plate and tne test is to be made according to the power stated. Thus if the motor is rated at 25 h.p. for intermittent use, it shall be tested at 25 h.p. for one hour. If the name-plate bears the inscription 20 h.p. for two hours (condition *b*) then the motor shall be tested for two hours under a load of 20 h.p. If the name-plate bears the inscription 12 h.p. continuous, then the motor shall be tested with that load during 10 hours or a shorter time, if that suffices to bring it to the final temperature. In all three cases the temperature rise must remain within the limits prescribed. These are for cotton-covered wire, 50deg. C.; for paper-covered wires, 60deg. C.; and for wires insulated with mica, asbestos, etc., 80deg. C. For tramway motors somewhat higher limits are allowed—namely, 70deg., 80deg. and 100deg. C. respectively. The conditions as to overload are not very rigorous. As far as generators are concerned, the capacity to give an increased output is generally limited by the prime mover, and to demand an excess of output beyond that which the prime mover can deal with would uselessly increase the cost of the electrical part of the plant. In motors, transformers, and converters somewhat larger overloads are possible, but then only momentarily, and for this reason the standards only require the overload test to be made during three minutes. The measurement of insulation resistance is not prescribed, but a breakdown test at high voltage. Also this test has been advisedly kept within reasonable limits, since a breakdown test at extremely high voltage may, even if the machine stands it, injure it just as the cold-water test of a boiler, if made under excessive pressure, may permanently weaken the plates. The most difficult task of the committee was the framing of rules for testing efficiency. In all eight methods are given, and the maker of the apparatus has the right to specify which method shall be used in testing the efficiency. In framing the methods, the committee was guided by considerations of expediency. It would, perhaps, have been possible to devise methods which from a theoretical point of view promise a greater degree of accuracy, but there was the danger that such very perfect methods would entail so large an expenditure of time and money, and would cause so much disturbance to the regular working of the plant, that they would not be used. Efficiency tests are ordinarily carried out only after the plant has been at work some time. Any test which causes considerable disturbance to the regular use of the plant is therefore inadmissible, and although it would in the interest of science be very desirable to make efficiency tests with the highest possible degree of accuracy, practical considerations must lead us to be satisfied with approximate methods which can be easily carried out. The danger that either the maker of the apparatus or the buyer of it may suffer through the inaccuracy of the efficiency test, is provided against by the stipulation that the method under which the efficiency shall be tested must be stated in the tender. Both parties know therefore beforehand what sources of error may arise, and the maker of the apparatus can frame his guarantee accordingly.

APPENDIX.

STANDARDS FOR RATING AND TESTING ELECTRICAL MACHINERY, PROVISIONALLY ADOPTED BY THE GERMAN ASSOCIATION OF ELECTRICAL ENGINEERS AT THE MEETING IN DRESDEN ON JUNE 28, 1901.

Definitions.—"Dynamo" or "generator" is a rotatory machine for the conversion of mechanical into electrical power. "Motor" is a rotatory machine for converting electrical into mechanical power. "Motor-generator" is a duplex machine consisting of motor and generator directly coupled. "Converter" is a machine in which the conversion of current takes place in one armature. The word "machine" used hereunder shall mean either of the above articles according to the context. "Armature" in a machine is the part in which by the action of a magnetic flux E.M.F.'s are developed. "Transformer" is an alternating-current apparatus without moving parts for the conversion of electric power into electric power. "Pressure" in three-phase current is the pressure between any two of the three main conductors. "Ratio" in transformers is the voltage ratio at no load. "Frequency" is the number of complete periods per second. Rules given for single-phase current apply also, as far as is compatible with the context, to polyphase current.

General.—1. The following rules shall only apply as far as they are not changed or superseded by conditions of delivery specially agreed upon. The Sections 4, 5, 6 concerning the name-plates are, however, always to be observed. Machines or transformers without name-plates,

* Paper read in Section III. of the Glasgow International Engineering Congress.

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or with name-plates not in accordance with those required, will be deemed not to comply with these standards.

Power.—2. The power of all machines and transformers is to be defined according to the output. It must be stated for continuous current in kilowatts (kw.), and for alternating current in kilowatts, with the addition of the power factor. Motors are to be rated according to the output of mechanical power expressed in horse-power (h.p.). In addition to the output there must be stated on the name-plate, or a special plate, the normal values of speed frequency, pressure and current.

As regards the output the following working conditions are to be distinguished: (*a*) intermittent use, in which periods of work and rest each lasting only a few minutes alternate (motors for cranes, hoists, tramcars, etc.); (*b*) short-time use, in which the period of work is shorter than necessary to reach the final temperature, and the period of rest is long enough to permit the temperature to drop approximately to that of the air; (*c*) continuous use, in which the period of work is long enough for the final temperature to be reached.

4. The power of machines and transformers for intermittent use is to be rated as that power which can be given off during one hour without the temperature rising above the limits stated below. This power is to be stated on a plate with the designation "intermittent."

5. The power of machines and transformers for short-time use is to be rated as that power which can be given off during the working time agreed upon without the temperature rising above the limits stated below. This power is to be stated on a plate with the designation "for . . . hours."

6. The power of machines and transformers for continuous use is to be rated as that power which can be given off during any length of time without the temperature rising above the limits stated below. This power is to be stated on a plate with the designation "continuous."

7. It is permitted to state the power for different working conditions on the same plate.

8. For generators and converters for variable pressure, the plate need only contain the normal values of pressure, current, and speed; the limiting values belonging together must, however, be stated in the conditions of delivery.

9. Machines with commutator must, if the brushes are shifted into the best positions, run at any load within the prescribed limits so far sparklessly that no treatment of the commutator with glass-paper, etc., is necessary until after at least 24 hours' working.

Rise of Temperature.—10. The temperarure rise shall be measured at normal load as defined by the above working conditions—namely: (1) For intermittent use after working one hour. (2) For short-time use after working uninterruptedly during the time stated on the plate. (3) For continuous use—(*a*) for machines after working 10 hours; (*b*) for transformers after working long enough to reach the final temperature.

11. If with small machines there is no doubt that the final temperature is reached under 10 hours, then the temperature rise may be measured after a correspondingly shorter working time.

12. For testing the temperature rise the various casings or coverings provided for normal working must not be taken away, opened, or considerably altered. If for normal work special provision is made for cooling, this may be provided for also during the test, but it is not permitted when testing tramway motors to artificially produce a current of air as an equivalent for the motion of the car.

13. As external temperature is to be taken that of the incoming current of air, or if no current is observable, the mean temperature of the surrounding air about 1m. distant on all sides and at the level of the centre of the machine. The temperature of the air is to be measured in regular intervals during the last quarter of the time of test, and the average of all these readings is to be taken.

14. If a thermometer is used, care must be taken to provide for an efficient transmission of heat between the part to be tested and the bulk of the thermometer by using a bedding of tinfoil. To prevent radiation, the bulb and the part to be measured are to be protected by a covering of a bad conductor, such as dry wadding or waste. The reading must be taken after the mercury has ceased to rise.

15. With the exception of continuous-current field coils all parts of generators and motors are to be tested for temperature rise by means of a thermometer. As far as possible the points of maximum temperature are to be ascertained, and the readings for these points are to be considered in determining the temperature rise.

16. The temperature of continuous-current field coils is to be determined from the increase of resistance. Unless the temperature coefficient is specially determined it is to be taken as 0·004 per degree C.

17. For transformers, the highest temperature indicated by the thermometer at any point of the windings is to be taken. If oil be used, the temperature is measured in the upper strata of the oil.

18. For ordinary cases, and if the air temperature does not exceed 35deg. C. (95deg. F.), the temperature rise of insulated conductors, commutators, and slip rings shall not exceed the following values: with cotton insulation, 50deg. C. (122deg. F.); with paper insulation, 60deg. C. (140deg. F.); with insulation, consisting of mica, asbestos, or preparations containing these materials, 80deg. C. (176deg. F.). For windings which are not in motion, these values may be exceeded by 10deg. C. (50deg. F.).

19. In tramway motors, when tested in the testing-room in the workshop after one hour's continuous work, the rise of temperature should not exceed the following values: with cotton insulation, 70deg. C. (158deg. F.); with paper insulation, 80deg. C. (176deg. F.); with insulation consisting of mica, asbestos, or preparations containing these materials, 100deg. C. (212deg. F.).

20. For combined insulation the lower limit must be taken.

21. In windings which are permanently short-circuited the above limits may be exceeded.

Overload.—22. In practical working overload should only occur for a short time or under such temperature conditions that the permissible temperature rise is not exceeded. With this limitation machines and transformers must be capable of overload within the following limits: generators, motors, converters—25 per cent. for half an hour, on condition that in the case of alternators the power factor is not lower than marked on the plate; motors, converters, transformers—40 per cent. during three minutes, on condition that for motors the normal pressure at the terminals is kept up. The commutator of continuous-current machines and converters must not be injured by the test for overload to such an extent that it fails to comply with Section 9.

23. If tested at constant speed the pressure of generators must be capable of being kept constant up to 15 per cent. overload, provided that when testing alternators the power factor is not kept lower than stated on the plate.

24. The test is intended to prove the mechanical and electrical capacity to take an overload without regard to heating. For this reason the test is to be begun under such temperature conditions that the permissible temperature rise is thereby not exceeded.

25. These regulations also apply to generators for variable pressure in which the variation of pressure is attained by approximately proportional changes in the speed. In generators with approximately constant speed (which work at normal pressure with a weakened field) the overload test is not to be made. The same applies to motors if they work with a weakened field.

Insulation.—26. A measurement of insulation resistance is not prescribed, but a test of dielectric strength which has to be made at the makers, and with larger apparatus also on the site before starting the plant. Machines and transformers must be capable of withstanding the test for an half an hour with a pressure exceeding the normal pressure by the amount stated below. The test is to be made when the apparatus is warm and shall be repeated only in exceptional cases, the object of this restriction being to avoid damage. Machines and transformers up to 5,000 volts shall be tested for dielectric strength with double their working pressure, but not with a smaller pressure than 100 volts. If the working pressures lies between 5,000 and 10,000 volts, the test pressure must exceed it by 5,000 volts. If the working pressure is above 10,000 volts, the test pressure should exceed it by 50 per cent.

27. The test pressure is to be applied between winding and frame, and for bodily contiguous but electrically separated windings between those windings. In the latter case the test pressure is to be determined with reference to the winding of higher pressure.

28. Two electrically-connected windings of different pressure are to be tested to frame with the test pressure corresponding to the winding of higher pressure.

29. If machines or transformers are connected in series, then in addition to the above tests the connected windings are to be tested to frame with a test pressure determined with reference to the pressure in the whole system.

30. The above regulations apply to cases where the testing current is of the same kind as the working current. If continuous-current apparatus is to be tested with an alternating E.M.F., then the effective test pressure need only be 70 per cent. of the value as above defined. If, on the other hand, alternating-current apparatus is to be tested with a continuous E.M.F., then the test pressure must be by 40 per cent. greater than above defined.

31. If a winding is normally connected to frame the connection must be severed during the test. In this case the test pressure is determined with reference to the highest pressure which obtains normally between any point of the winding and the frame.

32. Magnet coils excited from an independent source of E.M.F. shall be tested with three times the normal working pressure, but not less than 100 volts.

33. The winding on the secondary armature of an induction motor is to be tested with twice the working pressure occurring at starting, but not less than 100 volts. Squirrel-cage armatures need not be tested.

Efficiency.—34. The efficiency is the ratio of power given out to power put in. It may be determined by direct measurement of output and input or indirectly by measurement of losses. The indirect methods are more easily carried out, less influenced by errors of observation, and for these reasons to be preferred as a rule. In stating the efficiency the method according to which it shall be or has been tested must be also stated, for which purpose a reference to the corresponding paragraph of these standards is sufficient. The efficiency must be stated for the temperature condition corresponding to normal working. The efficiency is to be stated with regard to the working condition (compare Sections 4, 5, 6). If the efficiency is stated without reference to load, then it shall be deemed to refer to normal load. The power required for excitation or loss in the field rheostat is to be calculated as a loss when determining the efficiency.

35. For generators, synchronous motors, and transformers the efficiency is to be stated on the supposition of equality of phase between current and pressure.

36. When machines have separate exciters the efficiency of both machines must be given separately.

Methods for the Determination of Efficiency.—37. *Direct Electrical Method.*—This method can be employed with motor-generators, converters, and transformers by measuring electrically the power put in and given out. In order to employ similar measuring instruments, it is desirable in this method to test similar machines or transformers in pairs.

38. *Indirect Electrical Method.*—If two similar machines are obtainable, they are mechanically and electrically coupled so that one runs as generator and the other as motor. The system is driven by means of current from an external source in such a way that only the power required to cover the losses is supplied and measured. The arrangement is to be regulated so that the mean between the power given to the

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motor and given out by the generator is as nearly as possible the normal output of the single machine, this average value being determined by measurement. The power supplied to cover the losses can also be applied mechanically and measured electrically. If belt gearing cannot be avoided in this measurement, the losses occasioned by it are to be taken account of. The method above described can also be employed with transformers if the latter are identical so far as output, pressure, and frequency are concerned. The loss occurring in any auxiliary apparatus is to be taken account of.

39. *The Direct Brake Method.*—This method is generally employed for small motors, but can also be employed for a small generator which is being driven as a motor, in which case the conditions must be so chosen that the magnetic and mechanical stresses, speed, and output differ as little as possible from what they would be if the machine were used as a generator.

40. *Indirect Brake Method.*—If a generator or motor of corresponding output is obtainable whose efficiency at various loads is accurately known, this can be employed as a brake or as a driving motor. If a brake is employed, the loss in it must be taken account of.

41. *No-Load Method.*—The machine is run light as a motor, and the loss at normal speed and field strength is determined. This represents the losses due to air, bearing and brush friction, hysteresis and eddy currents whose variation with the load is not taken account of. By electrical measurements and calculations, the C^2R loss in the field, armature, brushes, and contact resistances at the corresponding load is determined when the machine is warm. In the case of asynchronous motors, the losses in the secondary armature may be determined by measurements of slip instead of by measurements of resistance. The losses in regulating resistances in series with the field windings are to be taken account of. This method may also be applied for transformers. The sum of the losses determined as above is called the "measured loss." The efficiency is to be considered as the ratio of output to the sum of output and measured loss.

42. *Auxiliary Motor Method.*—If there are difficulties in the way of direct determination of the friction losses, as well as of the hysteresis and eddy currents, or if a suitable source of current cannot be obtained for driving the machine, the frictional, hysteresis, and eddy-current losses may be determined by means of an auxiliary motor. The machine to be tested is given its normal excitation, and the power required to drive the auxiliary motor is determined. The losses in the auxiliary motor (and if a belt drive be employed the losses in this) are then deducted, having been obtained by measurements and calculations as in Section 41. A steam-engine can be employed in place of the auxiliary motor if it can be disconnected from the dynamo. In this case the steam-engine is indicated when driving the generator at light load at normal speed and excitation, and then the steam-engine is indicated again after the dynamo has been uncoupled. The difference between the two indicated horse-powers may be taken as the light-load losses of the generator. This method must be used with great care on account of the inaccuracy of light-load diagrams.

43. *Indicator Method.*—If the generator is driven directly by a steam-engine and cannot be uncoupled, the efficiency may be determined without regard to friction. The hysteresis and eddy-current losses occurring at no load at the normal speed and pressure are determined, by taking indicator diagrams with the machine excited and not excited. If the excitation is provided from the same steam-engine, the power required for it is to be subtracted. The difference is regarded as loss due to hysteresis and eddy currents, and no account is taken of its variation with load. By means of electrical measurements and calculations the ohmic loss in field, armature, and brushes is then determined. Account is to be taken of the fact that the contact resistance of the brushes varies with the speed and current density, and that the ohmic losses of the windings must be calculated for the working temperature. Losses occurring in normal working in field rheostats are to be included in the calculation. The sum of the losses as above determined is called the "measured loss." The efficiency is to be considered as the ratio of output to the sum of output and measured loss. This method must be used with great care on account of the inaccuracy of light-load diagrams.

44. *Separation Method.*—For machines which have no bearings of their own the efficiency shall be determined without regard to friction in the following manner. The loss due to eddy currents and hysteresis is to be determined in similar manner as prescribed for the "no load method" by running the machine light as a motor. In order to separate the loss due to air, brush, and journal friction from the loss due to eddy currents and hysteresis, proceed as follows: The machine is to be run without load at different pressure but normal speed. It is advisable to reduce the pressure as far as possible after having taken readings at normal pressure, and, if possible, at 25 per cent. excess pressure. The readings are to be plotted graphically, and the curve prolonged backwards to the point of zero pressure. The corresponding value is the loss due to friction, and is to be deducted from the loss determined at normal pressure. The rest is to be considered as loss due to eddy currents and hysteresis, and no account is taken of its variation with load. The other losses are to be determined as in Section 41. The sum of the losses due to eddy currents, hysteresis, resistance of field, armature, and brush contacts is called the "measured loss." The efficiency is to be considered as the ratio of output to the sum of output and measured loss. The determination of the losses due to eddy currents and hysteresis can also be made by means of an auxiliary motor.

Change of Pressure.—45. The change of pressure in alternators is to be stated for normal armature current when the load is non-inductive, and for one-third of normal armature current when the load is inductive with a power factor not exceeding 0·3.

46. The change of pressure at non-inductive load is that variation of pressure which is observed on removing the full working load (power factor = 1) whilst not altering the speed and full load excitation.

47. The change of pressure at inductive load is the variation of pressure which is observed if the armature current is switched off whilst speed and excitation remain unaltered. Before switching off, the machine must be loaded to a third of normal armature current, the power factor not exceeding 0·3, and the excitation must be such as to produce at that load normal terminal pressure.

48. Machines for inductionless load need not be tested as described in Section 47, and machines for inductive load need not be tested as described in Section 46.

49. If continuous-current machines are to be tested for variations in pressure, the following is to be observed: Continuous-current machines with shunt, compound, or separate excitation are tested at four different approximately equidistant loads from full load at normal pressure to no load, without the excitation being adjusted. The difference between the greatest and smallest observed pressure is to be taken as the pressure variation As regards the position of brushes during this test, the same practice as agreed on for ordinary working shall be adhered to.

50. For transformers, the ohmic loss of pressure and the short-circuit pressure with the normal secondary current has to be given, both for the secondary circuit. The ohmic loss is taken to be the pressure variation for inductionless load; the short-circuit pressure as the pressure variation for inductive load. It is permissible to make the test with a current differing slightly from the normal, in which cases the variations in pressure must be calculated proportionately for normal current.

NEW COMPANIES.

The following new companies have been registered since our last issue:

Lancashire and Grand Trunk Electric Tramways, Limited.—Capital, £100. Objects: to carry on the business of constructors of light railways, producers, and suppliers of electricity, for the purposes of light, heat and power, rubber manufacturers, etc.

Buenos Ayres Electric Tramways (1901), Limited.—Capital, £250,000. Objects: to adopt an agreement made by this company with the South American Syndicate, Limited, to construct in the Argentine Republic or elsewhere in South America tramways, railways, light railways, cars, omnibuses, engines, rolling stock, electrical and other plant, etc.

Astar Company, Limited.—Capital, £2,000. Objects: to acquire as a going concern the businesses of the German Electrical Company and Kroning and Co., now carried on by P. Stern and E. F. H. Kroning, at 11 and 13, St. Bride's-street, E.C., and to carry on the business of importers, exporters, and dealers in and manufacturers of articles of every description.

Wrexham and District Electric Tramways, Limited.—Capital, £50,0000. Objects: to carry on in the United Kingdom or elsewhere the business of carriers of passengers and goods, electrical engineers and contractors, manufacturers of and dealers in rail, tramway, and electrical apparatus, mechanical and chemical engineers, producers of gas, electricity, etc.

Electric and Ordnance Accessories Company, Limited.—Capital, £50,000. Objects: to carry on the business of manufacturers of and dealers in omnibuses, motorcars and other vehicles, electricians, engineers, etc.

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Foreman, for switch department of a large electrical engineering works. Details in our advertisement columns.

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Assistant Engineer, county borough of Burnley, £2 per week, Sept. 14. Full particulars in our advertisement columns.

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Junior Meter-Room Assistant, must have had experience in calibrating meters and demand indicators, and in general testing; 25s. per week. Full particulars in our advertisement columns.

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ENGINEERING CONGRESS.

The International Engineering Congress at Glasgow has been the means of a very large number of engineers from all nations meeting together in order to discuss papers illustrating the most recent advancements in engineering science. The presidential address of Mr. James Mansergh drew attention to the qualifications which an engineer has to possess in order to attain eminence in his profession. In doing so he explained that engineers might also be looked upon as an individual race, including representatives from all nations, and that engineers had to bear the heaviest share of the White Man's Burden. The fact that British engineers refused to admit the necessity of any formal qualification for entrance to the profession, is a sign that strong individuality is required in order to obtain success in any branch of engineering. In his address the president made it clear that while he advocated the extension of education for engineering students, it was in no case possible that education could replace the natural aptitude for "doing" which characterises successful men. Another item in his address, which we would commend to all young men who wish to become engineers, and who are looking up the theoretical side of their profession, is that the element of cash enters into all engineering problems. As the president stated, "an engineer is a man who can do well for one dollar what most people are able to do in some way for two." The presidential address in the electrical engineering division of the congress was devoted largely to the question of our position in the British Isles as compared with countries abroad as far as electrical manufactures were concerned. A number of useful statistics were brought together in this address, but the conclusions which could be drawn might be somewhat incorrect, because Mr. Langdon neglected to take into account the question of the protection duties in the various countries of the world. Perhaps, after all, the most information as regards the right way to obtain a lasting progress in engineering matters is to be derived from the paper which was read on Wednesday last in the electrical section by Mr. Lasche, of Berlin, on "High-Speed Railways." We are informed by this, as, without doubt, certain of our readers knew before, that some large manufacturing firms in Berlin have joined together in order to investigate practically the equipment of high-speed railways with electric motors. These manufacturing works have been greatly assisted in their experimental work by the kindly approval and encouragement given to them by the German Emperor. In consequence of his active co-operation the experiments are to be carried out on a line made by the Government for military purposes. The straightness of this line is, of course, of great advantage, especially when high speeds up to at least one hundred and twenty five miles per hour are to be experimented with. On this line the whole question of the correct way in which to convert the main lines of railways for electrical working will be thrashed out at the cost of the manufacturing firms. Amongst the points which are already recognised as being essential to success is the conclusion that long and heavy main-line trains, which we are now so used to, will have to give way to motor vehicles, or at the most a train composed of two or three such vehicles connected together. In this way a more frequent service of trains at very high speeds will be possible, and the proportion of the deadweight of the train to the useful weight carried will be reduced. The author of the above paper remarked on the fact that in the problem they had under consideration, the question of the actual cost was not of supreme importance. The convenience which such a service would have would be quite likely to make it a financial success, even if the actual

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cost of transport was increased. The paper, however, showed that the whole details of electrical vehicles suitable for such high-speed work on main lines were being most carefully gone into from every aspect, and that in the design the question of weight and cost had equal consideration with the smoothness and efficiency of working. We were also told that in order to make the results which will be obtained during the next year from the line in question more complete, steam locomotives are to be tried working at the same speed and under similar conditions as the electrically-propelled vehicles. Investigations are also to be made on the track over which these high-speed vehicles run, in order to see what alterations would have to be made in standard railway practice. The alteration and the cost of upkeep of the track in consequence of the replacement of the steam locomotive, with its reciprocating parts, by the electric locomotive, with its even turning moment, will be noted. At first one is surprised to find that the association carrying on such extensive and costly experimental work is willing to give an engineering congress the detailed information contained in Mr. Lasche's paper. The answer to this was freely given by Director Rathenau in his contribution to the discussion. The firms making these experiments will know exactly what to do in order to successfully convert main railways into electric ones, and such work is really of international importance. They, therefore, think that the work of conversion will be hurried forward by their present labours, and that the firms associated with the successful experiments will obtain the large orders which will have to be given in the near future. We should like to hear that an association of English manufacturers were looking at the matter in the same broad light, and that they were about to spend their brains, experience, and money on original investigations of this kind in order to acquire knowledge which will mean the acquirement of the supremacy in electrical railway working.

HIGH-SPEED RAILWAY CAR OF THE ALLGEMEINE ELEKTRICITATS-GESELLSCHAFT, BERLIN.*

BY O. LASCHE, BERLIN.

The German Association for the Study of Electrical High-Speed Railways (Studiengesellschaft für elektrische Schnellbahnen) has been formed with the object of gaining experimental knowledge of the electrical working of long-distance railways, and as to the construction of the cars, the consumption of power, and the wear and tear of the permanent way, as well as of the limits within which railways can be run by electricity on a sound technical and economical basis. The theoretical study of the question, and the experiments resulting therefrom, have up to the present time been of a general character only, and have had no reference to the planning of any special track. The first trials will be commenced shortly on the military railway from Berlin to Zossen, which the Imperial Military Railway Board of Administration has placed at the disposal of the association.

A speed of 200 km. (124 miles) per hour has been assumed as the maximum for the present construction of car, but this does not imply either, on the one hand, that the main object of the experimental line will be the attainment of this speed, or, on the other hand, that there may not be a possibility of running at still higher velocities. The trial has for its special object the establishment of a sound basis for the projection, construction, and working of lines at the usual (or at higher) speeds. In certain technical journals and newspapers the attainment of a speed of 200 km. per hour has been ridiculed as being impossible, whilst in others it has been repeatedly asserted that this speed can be attained by steam locomotives. Indeed, the Americans claim to be able to travel at still higher velocities, and it is much to be desired that efforts should still be made in this direction with steam railways. In view of the present requirements of traffic, efforts must, of course, be made to travel more quickly; but special attention must be devoted to making travelling more convenient for the public, and electric traction is the best for this purpose. Naturally the object of the present experiments, and of those conducted during the next few years, will be to compare the economy of the electrical systems with those in which steam driving is employed, and to ascertain the total cost of each system when running at different speeds, and especially at the higher speeds. It must be remembered that money was not treated as the main consideration when electric light and electric power were introduced. Indeed, even at the present day electric light is often much more expensive than gas-light, and yet it is very extensively used. In the same way the electric working of railways is likely at first to be largely adopted in cases in which the higher cost (if, indeed, the cost should prove to be higher) may be disregarded on account of the greater convenience afforded by the system. In this way the introduction of electric long-distance traffic should be easily developed and universalised.

The ability to run separate motorcars in rapid succession is a great advantage in favour of electric driving, and such a service of motorcars has been proposed for use on suburban and long-distance lines. With this in view the experimental cars of the association have been built in the form of passenger cars rather than as locomotives. This method of working with single cars, running without producing smoke and at short intervals, is already required by the public, and should therefore be remunerative. Another advantage attendant on electrical driving is that on lines on which the traffic is increasing, the existing permanent way, bridges, etc., may be retained, because in place of heavier locomotives and longer trains light and separately running motorcars will be used. The permanent way and its maintenance are, of course, very important considerations in connection with the electric system, and further considerable improvements are necessary; but the trials about to be made by the association should show to what extent the wear produced by electric locomotives is less than that caused by steam locomotives.

The experiments will, it is hoped, establish a basis for the calculation of the working expenses of electric main lines, and also of the outputs of motors for the various speeds and the increasing influence of air resistance, at well as for the determination of the size of power stations necessary. The lower limit of speed at which electrical may be more economical than steam traction is about as little known as is the higher limit. All that is known is that with steam locomotives the consumption both of steam and (more especially) of coal is very greatly increased with increasing speed. But by centralising the generation of power the circumstances will, of course, be entirely different. Large steam-engines of the best construction may then be used with boilers provided with super-heating and feed-water heating apparatus. This centralisation (and, consequently, the attainment of a practically uniform load) is now possible for very long distances. Three-phase alternating current can be generated at a pressure of 40,000 or 50,000 volts, so that electrical energy can now be transmitted for very great distances without serious loss; and all the railway lines over a large area can be supplied with current from a central station placed in a favourable position.

Nature of Current Used.—As the problem to be solved is that of long-distance transmission, the current to be adopted should be three-phase alternating current of high voltage. For the experiments to be described a current of only 10,000-12,000 volts was necessary; it was supplied by the Oberspree central station of the Berliner Elektricitäts-Werke, the distance from the central station to the nearest point on the trolley wire being about 15 km. (9·3 miles). At present, the current supplied to this wire is at a pressure of 10,000-12,000 volts, and the transformers are mounted in the car itself, a low voltage—435—being used for the motors. With regard to future developments, it is still an open question whether it will be advisable to keep the heavy weight of the transformers within the car, or whether it may not be preferable to reduce the high pressure (about 50,000 volts) by transformers alongside the track, to a medium pressure of about 3,000 volts, and to wind the motors for this latter voltage. The conversion of three-phase into continuous current is not practicable for the service of long-distance railways, because it requires the use of rotating machinery, and consequently necessitates attendance, whilst transformers for varying the potential of three-phase current have no moving parts. Moreover, continuous current demands the employment of a very low voltage, and, therefore, of short distances between the transforming stations. It might, however, be necessary to use continuous current for long-distance cars while passing through a large town, the three overhead wires of the three-phase system being inconvenient for points and crossings; a slow-speed locomotive could then be coupled temporarily in front of the car.

Investigations.—The problem set to the Allgemeine Elektricitäts-Gesellschaft was as follows: To construct a motorcar to run at a speed of 200 km. per hour and to accommodate 50 persons. The car to have two bogies with three axles each, and the motors to be adapted for a total output of 1,100 h.p. normal and 3,000 h.p. maximum. The electric current provided to be three-phase at 12,000 volts, and at a frequency of 50 complete cycles. The weight of the cars to be as small as possible, but on no account to exceed eight tons per wheel; and the shape to be such that the car is within the standard structure gauge necessary to allow it to pass over the lines of the State Railway. The second part of the present paper contains the description of the car and its electrical arrangement. In the first part, some of the preliminary experiments and investigations are described, as they are of special interest in view of the novelty of the whole system. The description of these investigations shows in the clearest possible way the results which it sought to attain.

Although primarily experimental, the car has been constructed to run permanently at any speed decided upon after the trials have been completed. It must not, of course, be compared with the ordinary tramcar or with the low-speed locomotive, for the motors, the transformers, and the starting and regulating apparatus are of an entirely new type. In this paper an account is given of the attempts made to attain the lightest possible weight both for the car and for the electrical equipment—*i.e.*, transformers, motors, and apparatus (Section 1). In view of the high speed desired, the company thought it necessary to find means to relieve the axles from the heavy weight of the motors, or at least to prevent the axle from being directly burdened thereby (Section 2). The starting and regulating apparatus for a 3,000-h.p. car could not be constructed of the same type as that used for the ordinary controllers for cars taking hardly 100 h.p. Experiments on a very

* Paper read in Section IX. of the Glasgow International Engineering Congress.

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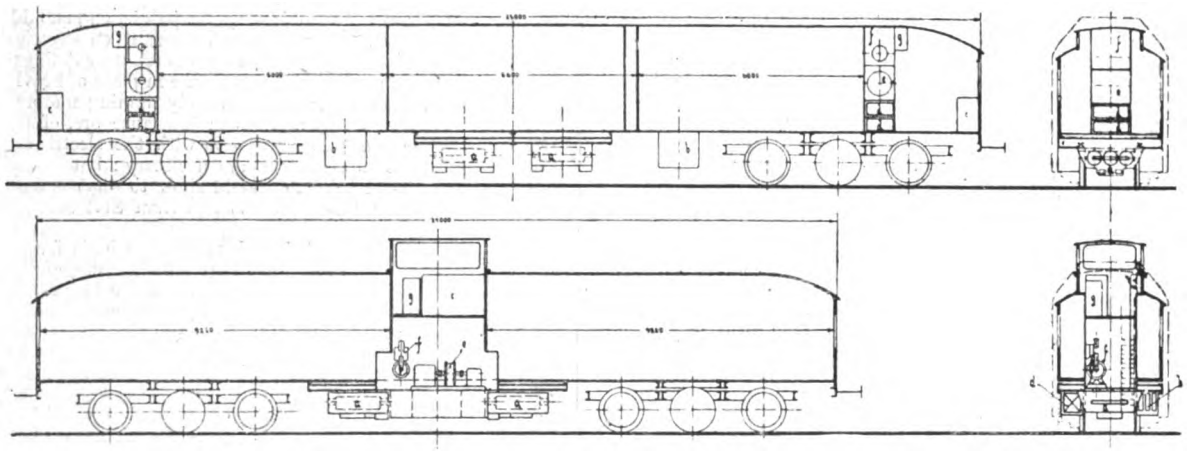
large scale were therefore necessary in order to test the novel arrangements (Section 3). Braking at a speed of 200 km. per hour by means of friction brakes—that is, at a peripheral speed of 56m. (184ft.) per second—was found to be unsatisfactory, and it was therefore necessary to provide means for braking electrically (Section 4). A large number of other new details had also to be designed. The motor bearings have to work at a surface speed of about 14m. (46ft.) per second, the collecting rings of the armatures at a speed of about 40m. (131ft.). The trolleys required special consideration, and presented one of the most difficult of the problems to be solved. The preliminary steps that were necessary in this connection are described in Section 5.

1. *Weight of the Electrical Equipment.*—Figs. 1, 2, and 3 show the changes made in the main design of the car, and especially in that of the comfort and safety of the passengers—led to the development of the last design (Fig. 3). The whole of the apparatus, cable, and safety devices are arranged in the middle compartment, which, with the transformers below it, is separated from the passenger compartments by air shafts with double iron walls. The driver always stands at the front of the car, separated from the passengers, in a compartment in which there are no connections at high electrical pressure. The control is effected from the driver's platform by mechanical transmission.

It has already been stated that the transformers had to be mounted in the car itself, although they add much to the total weight of the car. In making the calculations for the transformers and determining the cross-sections necessary for the iron, the question of the heating and cooling of the iron and of the copper coils is of the greatest import-



FIGS. 1 AND 2.

the body of the car, at the beginning of the trials. At first, in view of the condition that the car must be able to run either forwards or backwards, it was proposed to construct a driver's platform, containing the necessary starting apparatus, at each end. The construction was such as to enable the driver to control the whole car, including the motors of the rear bogie, by means of the front starting device. The arrangement of cables required for this purpose proved, however, to be impracticable for the 3,000 h.p. which was to be used. Matters were facilitated by dividing the electrical apparatus into two circuits, and operating the rear starting device at a distance, either by means of an electromotor, or by compressed air, or by water pressure, or the like. Fig. 2 shows the two driver's platforms combined in one, with a single compartment for the apparatus, in which, however, the two circuits were kept separate. This compartment had two divisions, the lower for the necessary apparatus and machinery, and the upper for the driver and the starting and regulating apparatus. Although on account of the high speed, the observation and inspection of the last 30m. of the track is impossible, the arrangement was again altered and the driver's platforms were placed at the two ends of the car. Efforts were made to leave the front and rear windows of the car unobscured for the benefit of the passengers, as a view in these directions is specially desired. These three main conditions—the stationing of the driver at the front of the car, the placing of the apparatus at the place which calls for the shortest cable connections, and the devotion of every consideration to ance. The cooling of the transformers by air taken from below the car is impossible, on account of the large amount of dust produced when travelling at a high speed. On the other hand, the designs showed that a great gain in weight is possible if air is passed through the cores of the transformers, and the insignificant amount of cooling possible from the surface of the casing is not alone depended upon. Two air-shafts led from the roof (Fig. 4) to the transformers in such a manner that the front shaft was used for the admission of fresh air, and that in the rear for its emission after it has become heated. Special care was taken to withdraw the moisture from the air in rainy weather and to ensure that it is dried and filtered before it enters the channels of the transformers, although the actual contact of the cooling air with live conductors is avoided. Further economy resulted from the use of a liquid starting device of an entirely new construction, instead of the metal starting device with coils or plates of resistance material at first provided (Section 3). The following summarised statement shows how the weights varied in the different investigations:

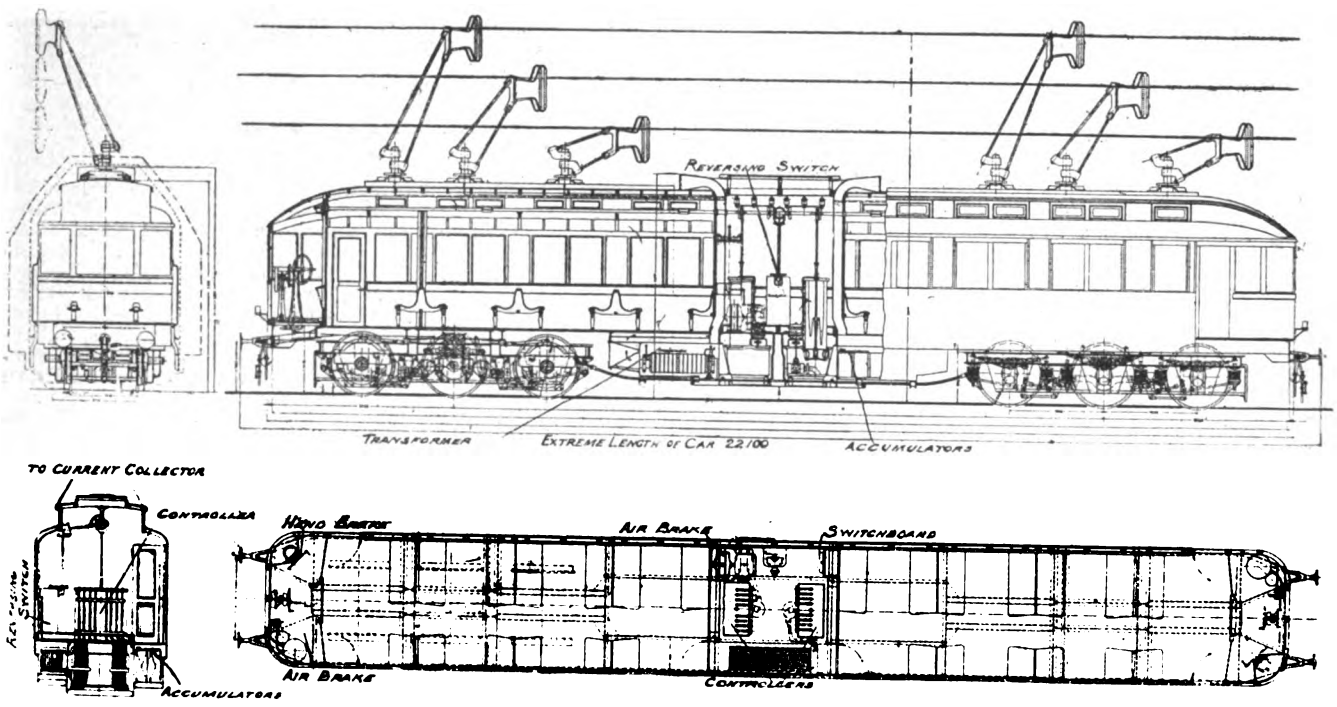


FIG. 3.

Weights.	I.	II.	III.
	Kg.	Kg.	Kg.
Four motors	16,000	16,000	12,800
(*a*) Two transformers	13,000	13,000	6,500
(*b*) Starting resistance, with casing (*c*) Controllers, with driving mechanism	9,000	9,000	4,750
(*d*) Braking and lighting batteries	2,600	2,600	2,600

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(*e*) Motor, with compressor	800	800	800
(*f*) Oil-pump	200	200	—
(*g*) Oil-tank	600	600	—
Total weight of cable	4,000	1,000	1,000
Trolley poles	1,400	1,400	1,400
Total	47,600	44,600	29,850

The final weight for the transformers was 6·5 kg. (14·3lb.) per kilowatt; and for the motors 13 kg. (28·7lb.) per horse-power of the normal output, and 4½ kg. (9·5lb.) per horse-power of the maximum output. The table shows the saving which resulted from the construction of the unenclosed motors (Fig. 5). Like the new alternating-current dynamos and the stationary motors, the laminated iron magnets are not encased, but are directly exposed to the cooling influence of the air, the external surfaces of the motors being increased in area by the ribbed design adopted. Surface cooling was thus ensured in a convenient way. It was found to be fully sufficient even when the motors were running continuously. No provision was made for the admission of air into the motor, as on account of the dust below the car it was not possible to take the air from below, and there was no convenient way of supplying it from above.

2. *The Motors Spring-Mounted against the Axle or Rigidly Secured to the Axle.*—Between the two extremes—(*a*) the body of the car mounted without springs directly on the axles, and (*b*) every part being practically mounted on springs, as in an automobile with pneumatic tyres—a large number of different combinations is possible. Electric locomotives of very small dimensions have been constructed with the upper part in rigid (not spring-mounted) connection with the sets of wheels (Fig. 6). On the Central London (Underground) Railway, notwithstanding that a speed of 30 km. per hour is attained, the bogies of the locomotives are not mounted on springs; hence the severe vibration which has caused so many complaints. Others have adopted

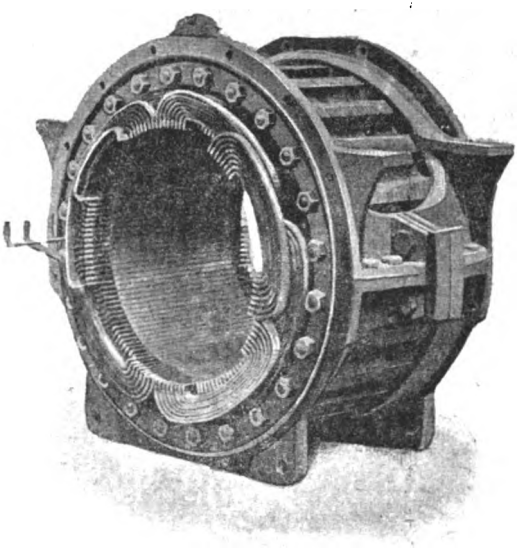

Fig. 5.

different constructions. Some have placed the motors directly on the axles (Fig. 7), whilst others have fixed them to the spring-mounted body of the car or to the bogie (Fig. 8). The motors carried by the bogie have the same range of movement (due to the deflection of the spring) relatively to the wheel axles as the frame itself has—*i.e.*, up to a maximum of 60mm. (2·3in.) in one direction. Figs. 6, 7, and 8 show these three fundamentally different constructions for a set of wheels of 1,000mm. (3ft. 3in.) in diameter. The principal dimensions inscribed (in millimetres) on the figures give an idea of the space available, and also show how much of the valuable space in Figs. 7 and 8 is absorbed by the bearings of the motor. The simplest construction is, of course, the rigid mounting of the axle on the bogie (Fig. 6). In this case the axle and motor have no motion relatively to the other parts of the construction; but, unfortunately, the axle boxes have here to ensure the central position of the revolving armature within

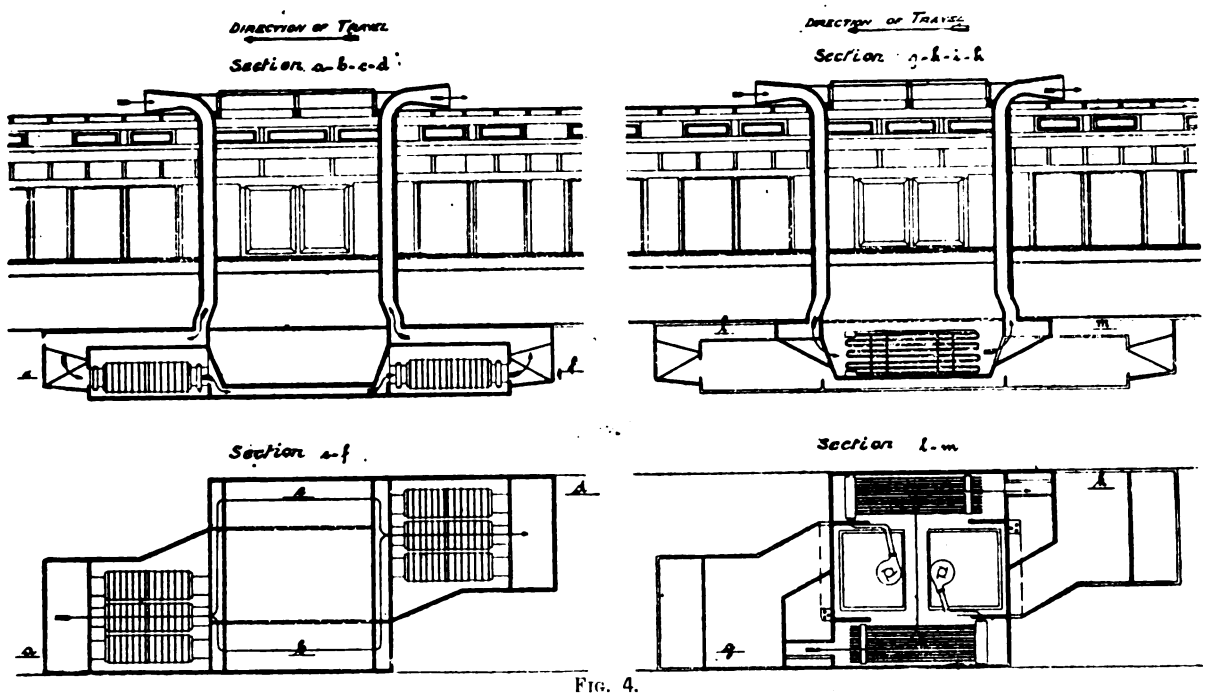

Fig. 4.

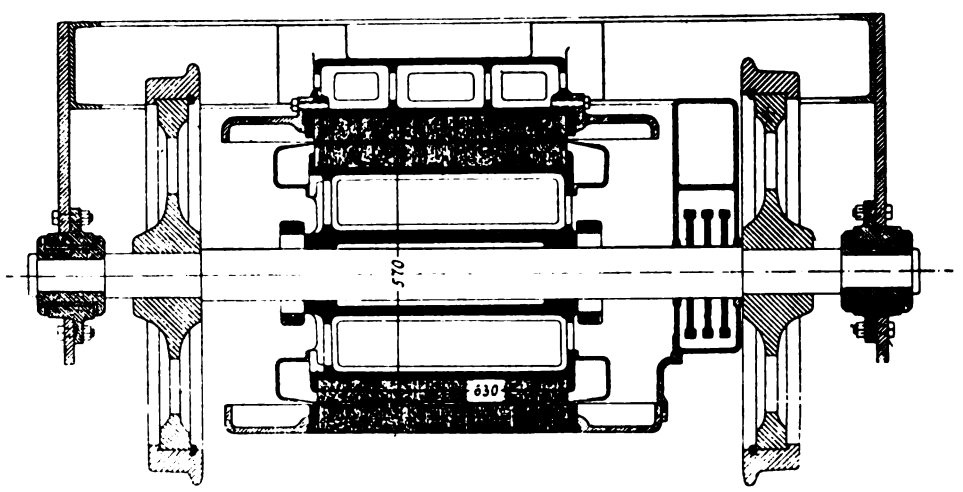

Fig. 6.

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the fixed stator. In the construction shown in Fig. 7, the stator is kept concentric with the rotor by being mounted on the same axle, which thus carries the weight of both, and the power is transmitted from the axle to the wheels. The stator must be so connected to the frame that it is prevented from rotating. In Fig. 8 the motor is shown rigidly connected to the bogie, which is spring-mounted on the axle. The indirect use of springs in supporting the motor (by attaching the stator to the frame of the bogie) necessitates the use of a hollow shaft surrounding the axle at a suitable distance. This construction may be possible when the springs between the frame and the axles are not subject to such deflection as they are liable to in the high-speed car, where the play may amount to 60mm. or more. In this car there is a peripheral speed in the bearings of not less than 18m. per second (3,540ft. per minute). As no previous records were known of the use of white-metal bearings at these extraordinarily high speeds, a series of experiments was undertaken in this connection, quite independently of the other investigations. The material at first used for the hollow shaft was cast steel, due regard being paid to cooling; but this was subsequently abandoned, and wrought nickel steel was substituted, because its surface is capable of taking a very high polish.

From the attempt to relieve the axle of the wheel from the very great additional weight of the motor, there resulted another difficult problem—namely, the designing of an elastic coupling to transmit the power from the hollow shaft to the axle and the wheels. The coupling first designed is shown in Fig. 9, photographed from an experimental arrangement tried in combination with an electromotor and a dynamo used for braking purposes. This coupling in its essential features resembles a double-crank system; but as high speed (about 1,000 revolutions per minute) was to be employed, the combination of links and rods here indicated did not appear to be sufficiently safe. This design was followed by numerous others of various kinds, and the advisability of mounting the motor directly on the axle was again considered. The extraordinary deflection of the spring was the greatest obstacle to the construction of a safe coupling. Attempts were therefore made to find means to overcome it. A screw attachment of the motor to the bogie was dispensed with, and the springs were caused to bear against either the wheels or the axle. A movement of a few millimetres was deemed sufficient, especially in the former case, to protect the motor and its windings from shocks, such as might be produced by the hammering of the shaft on the axle, and to prevent undue strain to the axle and wheel hubs. The annexed sketches (Fig. 10) show the springs which carry the motor. The springs and rods which transmit the torque have been omitted in the sketches. The springs shown in sketch *a*, bearing against the rim of the wheel, were subjected to a considerable strain by the action of their own centrifugual force. Design *b* was not much better. Design *c* is superior with regard to the action of centrifugal force, but the space occupied by the coupling was considerably greater than before. Sketch *d* shows the motor supported by springs bearing upon the hub of the wheel, as in design *e*, but in the latter case the support is effected by the cylindrical surfaces of a large number of spiral springs. Sketch *f* finally shows the possibility of transmitting the weight of the motor to the axle in a very simple manner by means of a spiral spring with an eccentric arrangement of very many windings. These couplings, however, did not give promise of being sufficiently safe in use.

(To be continued.)

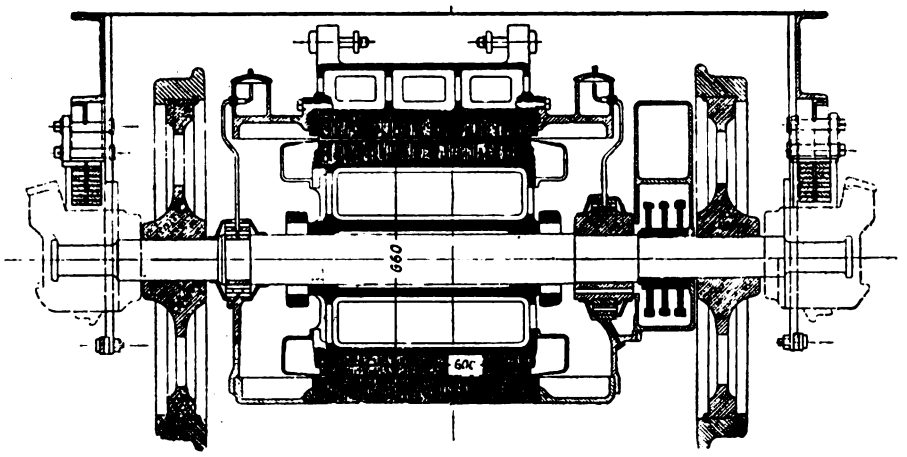

FIG. 7.

DISCUSSION.

The following discussion took place on Mr Lasche's paper, of which we give the first portion above:

Sir W. H. Preece said that the electrical world of both hemispheres would be most deeply indebted to Mr. Rathenau and the author for the invaluable information which was given in the paper. They all admired the care, openness, and magnanimity with which the facts and experiments had been given. There was a great contrast between the way such things were done in Germany and in England. The German Emperor had certainly taken a most active part in helping forward the success of such work, and his foresight would be of great assistance to the electrical profession in Germany for years to come. The experiments were being carried out at a very great expense. In England, on the other hand, a large amount of money had been spent in trying to prevent such experiments being tried at all. He referred to the proposed electrical railway between Liverpool and Manchester, which had only got through Parliament this year after fighting a most costly opposition before two parliamentary committees. Those who had heard the paper would agree with him now that the three-phase system was the only one to be used for high-speed railways and for long lines. Sir Wm. Preece then made some remarks as to the continuity of the energy in a three-phase system. He added that when the three-phase currents were used directly on the locomotives the plant required in the sub-station was much less costly and required less space. In fact, some 40 per cent. in prime cost could be saved in consequence. He had recently had the honour to witness the first trials on a three-phase line in Italy which had been equipped by Messrs. Ganz and Co. In that case, however, high speeds were not sought. He hoped that as the experiments in Germany were progressing they might be allowed to hear the conclusions arrived at in the same way that the details of the apparatus to be first experimented with had been given them that day.

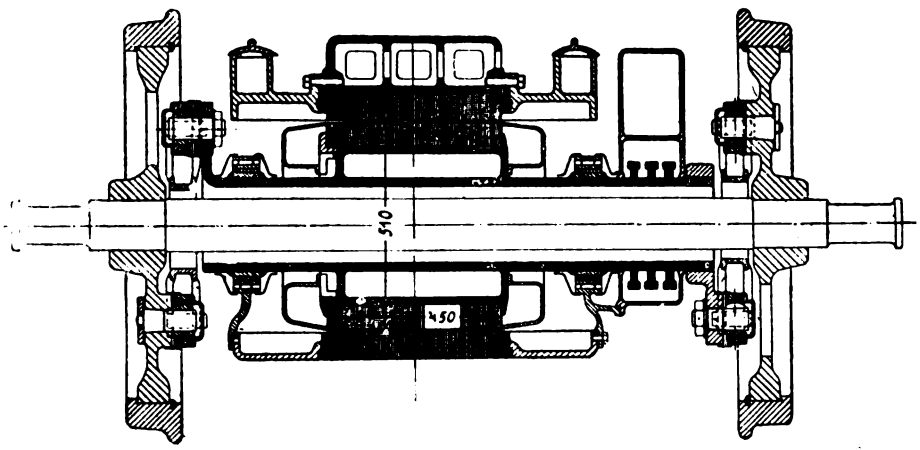

FIG. 8.

Director Rathenau (of the Allgemeine Elektricitäts-Gesellschaft) thanked those present for the kind way in which they had received the paper, and for the expression of thanks which he had received. When the Electrical Engineers came to Berlin this year his firm had shown all that they possessed, and he should be only too pleased to still further assist the profession by giving the results of their experiments on high-speed railways as they were completed. What they wanted was more

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work to fill their workshops, and he believed that the electrification of the main-line railways would provide quite sufficient work for the century. The question arose as to where the first main line was to be equipped electrically. Owing to the railway monopoly in Germany, he thought it was quite likely that it would not be in that country, while the competition between the English railway companies made England a likely field.

Prof. S. P. Thompson said that Sir Wm. Preece had lamented that in England the experimental work on electric railways had not been allowed. He would remind that speaker that, besides the two courses of either spending or not spending money on experiments, there was a third course—*i.e.*, the spending of a great deal of money on useless experiments. He (the speaker) classed the trial which had been made at Earl's Court under this latter head. It was perfectly well known that trains could be hauled by means of direct current at the time these experiments were undertaken. He thought that Sir Wm. Preece's contention, that the experiments would convince the directors of the line, was no excuse for the neglect to obtain experience with three-phase motors. He agreed with the last speaker that the conversion of railways was the most important field for electrical research at the present time. The problem of the best way of doing this should be solved as quickly as possible, and there was ample work for a number of independent researches. He believed that the days of commutators had gone by, and was surprised to find that there were two papers to be read before the Electrical Section of the congress as to the best way of commutating alternating currents. He believed the solution was to get rid of the commutator altogether. Another fact brought forward in the paper was that a continuous variation of resistance would have to succeed the usual step-by-step method of introducing resistance into circuits. The use of liquid resistance for this purpose when suggested years ago had been laughed at, but it was now recognised by several firms as the correct thing. He hoped that English manufacturers would recognise the importance of the subject now before them, and equip practical research departments on the same lines as those in which the author had conducted his experiments.

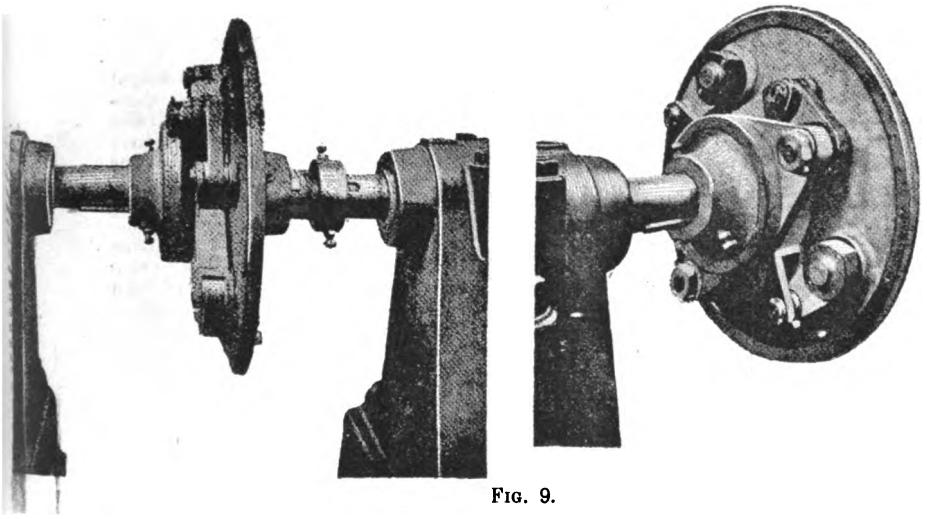

FIG. 9.

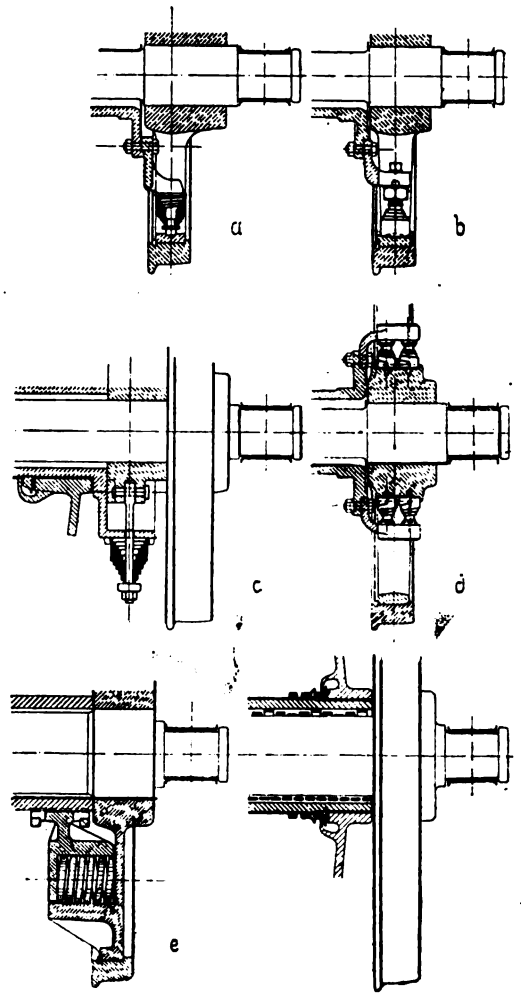

FIG. 10.

Mr. Alexander Siemens desired to express, as the leader of the party who went to Berlin in June, the thanks of the Institution to Director Rathenau for the kindness then shown to them. He would remind those present that the firm of Siemens and Halske were also connected with the syndicate for experimenting with high-speed railways, and that a motorcar manufactured by them was about to be tried on the same lines as that described by the author. The last speaker had flogged the continuous-current motor, but it had its proper place as well as the three-phase motor. If large and continuous changes of speed were required, the continuous-current motor had the advantage. He thought that the author's statement on the second page of his paper could not be accepted without a warning. It was quite true that electric light had succeeded, although when it was introduced it was more expensive than gas. This success was due to the indirect advantages of electric lighting, and these must always be taken into account when making any comparisons between a new system and an old one. Another point was that the present main lines of railways could not be converted to higher speeds even with the use of electric motors. For these higher speeds a straighter line would be required.

Mr. Zipernowski said that 10 years ago he had exhibited at the Frankfort Exhibition the plans of a three-phase motor carriage, and it had taken all the time up to now to get the same a trial on railways. He believed, however, that the success of the system was assured. He also wished to congratulate the author on his paper.

Mr. E. Kolben said that the use of resistance when starting up three-phase motors in the way the author had described seemed to involve a great waste of energy. This waste could be reduced by an arrangement by which the winding of the motors could be altered. For instance, by increasing the number of poles it was easy to reduce the synchronous speed to one-half, and it was not a difficult matter to make other variations in the winding to get even lower speeds without the introduction of resistance.

Mr. Gisbert Kapp gave those present some information respecting the first motorcar to be worked with 10,000 volts, which was tried some 18 months ago by the firm of Siemens and Halske. He confessed that when he was invited to inspect the same he felt some qualms as to the safety of the public, and also his own safety when entering a car to which electricity was delivered at 10,000 volts. He found that everything in the driver's cabin could be touched without danger, being of metal, and earthed, and that his objections on the score of security were groundless. The other objection urged against the use of three-phase motors was that they were not economical in starting or when running at slow speed. This objection also was faulty because the object of a high-speed railway was to run at high speed, and the driver would not be required to run slow for any length of time. The journey would be run at an even high speed for the greater proportion of the time, and the short time occupied in starting up would be a very small proportion of the total time spent in the journey. In other words, the high-speed lines would be built with that special object.

Prof. Carhart said that the United States manufacturers had not up to the present paid much attention or, as far as he knew, carried out experiments on the construction of high-speed electric railways. They were, however, exceedingly busy in converting low-speed lines. He himself recognised that some new system would have to be introduced for the long routes which would not involve the use of rotary converters. He knew of one such system which was shortly to be tried in Michigan, the details of which he was unable to disclose owing to the patent not being completed. He could say, however, that current would be collected at 11,000 volts, and that single-phase currents would be used. He thought, also, he was at liberty to inform the meeting that on this system the electric motors would not be stopped when the train was pulled up.

Mr. Carus-Wilson also referred to the valuable detailed information contained in the paper. He was surprised to learn that the same only represented nine months' work on the part of the author. It was a remarkable proof of the author's skill in organising the experimental department of the Berlin firm with which he was connected. He would remind those present that the experiments were to be carried out on a straight line of railway, whereas such straight lines would not, as a rule, be constructed in this country. The experiments referred to by Sir W. Preece as about to be carried out between Liverpool and Manchester would be on a system which it was claimed would allow of high speeds even on a curved line. His own opinion was that it would be better to get successful experiments carried out on a new system before applying for parliamentary powers to put the same into practical use.

This closed the discussion on the paper, but **Mr. Langdon** intimated that any further contributions on the subject should be sent to the secretary of the Institution of Electrical Engineers. He also expressed the hope that some of our large railway companies would join with electrical manufacturers in this country in carrying out experiments on the electrical working at high speeds of long railway routes.

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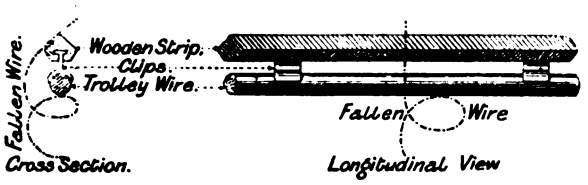
DANGERS FROM TROLLEY WIRES AND THEIR PREVENTION.*

BY PROF. ANDREW JAMIESON, M.I.E.E., M.I.C.E., F.R.S.E., ETC.

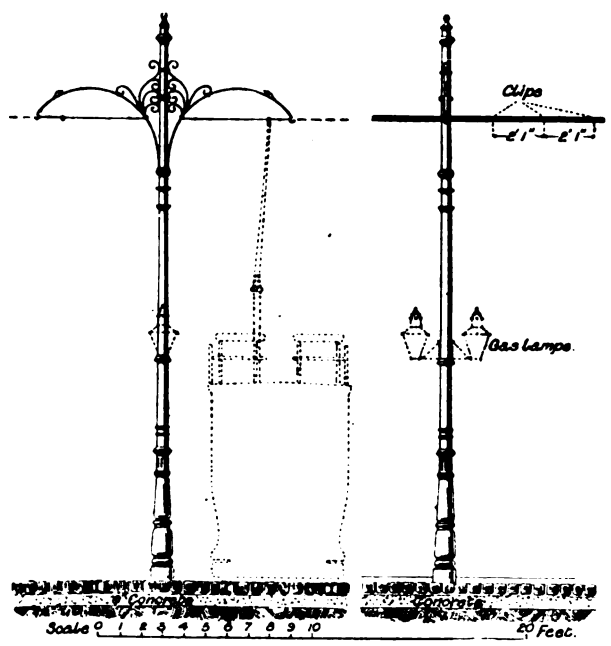
I. *Recent Accidents and the Necessity for the Proper Protection of Trolley Wires from Contact with other Overhead Conductors.*—Scarcely a week or even a day passes that we do not notice in the public and the technical Press an account of one or more accidents, arising from the contact of overhead conductors with trolley wires. These accidents prove that so long as telephone, telegraph, and electric light wires are permitted to cross over electric tramway routes, there is a liability to their occurrence; and further, that we still lack a perfect system of guarding trolley wires from accidental contact with other conductors. There is also the danger arising from the fracture of the trolley wire and its contact with persons or animals. It will be still fresh in the memory of everyone present that about 7 p.m. on Feb. 4 of this year, a large number of telephone wires in Liverpool fell upon a trolley line and resulted in the electrocution of two men and two



FIGS. 1A.—Guard System Hitherto Adopted at Liverpool and Leeds, etc.

horses, as well as the electrification and injury of a dozen persons. Further, on Feb. 7 "a cluster of electric light wires in Princes-road, Liverpool, lodged on the tramway trolley wire, causing the breakage of the electric lamps in the vicinity." "On Feb. 9 (in the same city) a trolley head fouled a span wire and broke it, so that it came into contact with the trolley wire and with the ground, thus causing alarm to the passengers and pedestrians, due to the heavy sparking and arcing." It is needless for me to multiply these examples. Suffice it to say that we have had in this city of Glasgow several instances of broken telephone and guard wires coming into contact with live trolley lines and producing alarming scintillations; although, fortunately, no fatal electrocutions have, so far, occurred from these causes. Many other electric tramway installations, however, both at home and abroad, supply sad instances of injury and even death.

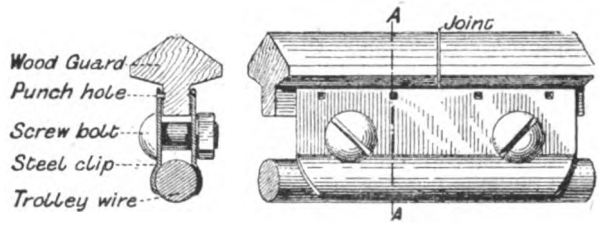
II. *Methods which have been Adopted and Proposed for Protection against Contacts with Trolley Wires.*—The form of guard adopted at Liverpool, Leeds, etc., with the view of preventing contact between



FIGS. 1B.—Rails, Poles, Trolley and Guard Wires, with Outline of Lamps, Cars and their Special Road Fenders as Adopted at Liverpool.

the trolley wires and other broken or sagging conductors is illustrated by Figs. 1A. It consists of strips of wood machined to the shape shown by the cross-section and supported by brass distance pieces or clips, which are soldered to the upper surface of the trolley wire at convenient intervals. Although one of the cheapest, and perhaps one of the least unsightly forms in use, its inefficiency as a safeguard against fallen springy bronze telephone wires was demonstrated by the Liverpool catastrophe. The dotted lines in the cross-section and longitudinal view of the previous figures serve to indicate how the telephone wires curl and make contact with the trolley wire; or they may be dragged into connection therewith by a passing vehicle or car. In fact, to prevent the trolley wire current entering any of the fallen overhead conductors, the insulation resistance of the wooden strips would require to be great under all atmospheric conditions; the broken wires must clear the trolley wire and remain free until repaired. But such assumptions are most unlikely of fulfilment in stormy or snowy weather and where there is considerable traffic.

(Since writing the foregoing part of this paper, I have received from Mr. C. R. Bellamy, the general manager of the Liverpool Corporation tramways, a description and drawings of the latest plan of supporting their *wooden guard strips*. His drawings are reproduced in Figs. 1B and 1C, which are self-explanatory. The following is an extract from his letter of Aug. 12, 1901: "I have now the pleasure of sending you a drawing showing the details and method of protecting the trolley wires in Liverpool by means of guard strips. In addition, I am sending you samples, *one* with a brass spring clip carrying a T-grooved *wood strip*, and the *other*, which is the latest and best form, with a *steel clip piece*. In dealing with the subject, you will be pleased to know that following the trouble we had in February last we arranged with the Telephone Company to cable the whole of their wires crossing our trolley wires and to place them underground by September, 1902. At this moment a great number of telephone wires

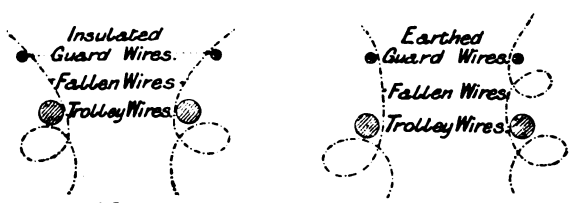


FIGS 1C.—Guard System Now being Adopted at Liverpool.

have been placed underground, and none cross our trolley wires except by aerial cables. We have not yet finally arranged the matter with the postal authorities, but we are on the verge of a settlement. As a result of our experience during the past two years, we are strongly of opinion that overhead wires crossing trolley wires must always be a source of danger whatever may be the protective methods. We have, therefore, determined (as far as possible) to have them all cleared away.")

Figs. 2 and 3 show the two methods of arranging the guard wires which have been tried in Glasgow and many other installations. Wherever telephone or other wires are suspended above and across the trolley wires, each of the latter is guarded by *one* No. 7 S.W.G. galvanised steel wire, carried parallel to and about 2ft. above the live car wires. At first these guard wires were insulated from earth and placed from 8in. to 1ft. to the left and right of the respective trolley wires. Now, however, they are earthed at the feeder pole of each half-mile section, and placed for the most part vertically above the trolley wires which they are intended to protect, as in Fig. 3. But, as has been proved in actual practice, and as is shown by the dotted lines in Figs. 2 and 3, the fallen springy telephone wires do make contact, not only with the guard, but also with the trolley wires. When the former were insulated, the current from the latter entered the fallen wires, and was therefore not only a great source of danger to passing human beings and animals, but has been known to set fire to telephone stations, wherein there were either no protecting fuses or inefficient ones. When the guard wires are earthed, the short piece of contact-making fallen wire is expected to melt almost simultaneously, and the street end thereof to fall harmlessly to the ground. This may happen without affecting the fuses or the automatic cut-out switches at the tramway sub or main stations. In the case of a large number of overhead conductors simultaneously making contact with the guard and the trolley wires, these safety devices are expected to act, and thus render the trolley wire of the section neutral and harmless. Telegraph and tramway engineers hold somewhat opposite views in regard to the advantages and safety arising from the insulating *versus* the earthing of guard wires, which will be referred to later in the paper.

III. *Board of Trade and Post Office Regulations.*—In the Board of Trade "Electric Tramway Rules," which were issued in March, 1894, there are no regulations as to guard wires. In form No. 2, revised and published by the Board of Trade in 1896, we find in Clause 22 the



FIGS. 2 and 3.—Guard Wires as Adopted at Glasgow and elsewhere.

following statement regarding crossing wires: "Where an aerial line crosses, or is in proximity to any metallic substance, precautions shall be taken by the undertakers against the possibility of the line coming into contact with the metallic substance, or of the metallic substance coming into contact with the line by breakage or otherwise." (Combined recent inspections have been made by the Post Office and the Board of Trade electrical engineers with the view of formulating a joint set of rules. I have been promised copies of these before the reading of this paper. It is, therefore, likely that these special rules will be printed here in the *Proceedings* of this Institution.)

The regulations by the Post Office authorities for telegraph and telephone wires crossing above trolley wires prior to August, 1901, have been as follows: "(1) when there is only a single trolley wire or two trolley wires not more than 12in. apart, two guard wires should be erected, as shown in Figs. 4 and 5; (2) when trolley wires are more than 12in. apart and do not exceed 3ft., the guard wires should be increased to *three* in number, as shown by Fig. 6; (3) when the distance separating the trolley wires exceeds 3ft., each wire should be separately guarded

* Paper read in Section IX. of the Glasgow International Engineering Congress.

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by two wires, as shown by Fig. 7." If these Post Office regulations were faithfully and carefully carried out, there can be no doubt that the chances of broken telegraph or telephone wires coming into contact with the tramway trolley wires would be minimised. But tramway contractors and companies or corporations, as well as the general public, may be expected to object to the multiplicity of such wires so near the roadway, their liability to become inextricably mixed up in the case of an accident to one or more of them, and also on æsthetic grounds. I understand, however, that these regulations have been adopted in Bradford and other places. I am not aware of any place where cross-lacing or hammock-netting guard wires have been introduced, as proposed by the Post Office, where the erection of telegraph or telephone wires are so close to the trolley wires as to render the aforementioned protections inadequate. (The author has to thank Mr. J. Gavey, assistant engineer-in-chief of the postal telegraphs, and Mr. W. A. Valentine, Glasgow district manager of the National Telephone Company, for the specimens of telegraph and telephone wires and cables submitted to the meeting.)

IV. *Contacts between and the Breaking of Guard and Trolley Wires.*—The chief and the primary causes of such contacts and breakages arise from: (1) The omission to turn the trolley pole at the end of a tramcar line in the proper slanting direction for the return journey, or whenever the direction of the propulsion of a car has to be reversed. The neglect of this precaution often unships the trolley pole from the trolley wire, and permits the former to foul the guard wire or its cross street span wire, thus severing the binding between the latter two wires or breaking the guard wire. (2) Unshipment of the trolley pulley at street corners where the hangers are too short, or the frogs and the cast bronze (Y) or (+) brackets at crossings are badly adjusted. (3) Disconnection between the trolley wire from hangers, splicing ears, or sectional insulators due to their imperfect soldering and clipping. Or, due to the breaking of ears, and of the trolley wire at the pinching pins of bracket crossings. (See specimen.) (4) Fusing of the trolley wire due to intermittent contact and arcing between it and a disconnected arc or span wire. (See Appendix, Table I., for sizes and tests of these wires. The tables were kindly supplied to the author through Mr. John Young, the general manager of the Glasgow Corporation tramways. The author has also to thank Mr. Young and Mr. Clark, the chief engineer of the Glasgow tramways, for the numerous specimens of trolley, guard, span, and pull-off wires, as well as ears, insulators, and other overhead fittings, which are now placed before the members.)

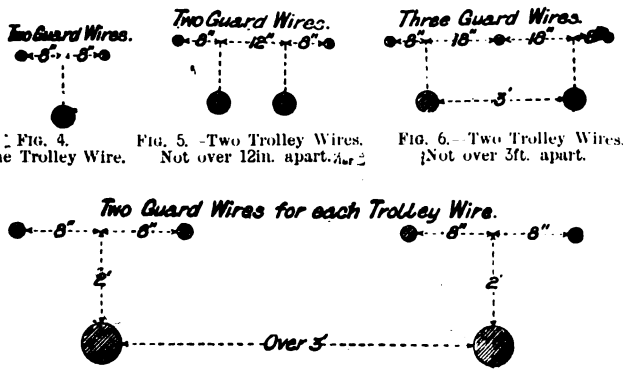

FIG. 4. One Trolley Wire.

FIG. 5.—Two Trolley Wires. Not over 12in. apart.

FIG. 6.—Two Trolley Wires. Not over 3ft. apart.

FIG. 7.—Two Trolley Wires. Over 3ft. apart.

FIGS. 4 TO 7.—Illustrating Post Office Regulations for Guard Wires.

Since the guard wires are generally made of but *one* No. 7 S.W.G. galvanised steel wire (of ·18in. diameter, having a breaking stress of less than 2,000lb.), whereas the cross street spans for the guard wires are composed of seven-strand galvanised steel wires (each wire of which is No. 14 S.W.G. of ·08in. diameter, with a combined breaking stress of over 3,500lb. for the complete strand), the chances are that either the guard wire or its weak binding to the span wire is broken. Then the guard wire falls into contact with the trolley wire. If the former be insulated and originally fixed about 2ft. above and some 8in. to 1ft. to the right or left of the trolley wire, it has the chance of falling clear of the same. The current may then be switched off at the nearest street pillar-box from the half-mile section in which the mishap took place, and the guard wire refixed without causing any damage. If, however, the guard wire should be earthed, either at the centre, or the ends of its half-mile section, or preferably at several pole-points along the same, and if it be originally supported vertically above its trolley wire, then it naturally falls upon the latter, and the current therefrom enters the former and causes delay and trouble. (See specimens.) When the guard wire is only earthed at each end of a half-mile section, and contact takes place between it and the trolley wire (say, about the centre of this section), then the joint resistance of the contact and the two quarter-mile lengths of guard wire may be so great, that the current passing through the contact does not increase the normal trolley wire current by an amount sufficient to blow the nearest station fuses (if there are any), or to free the automatic cut-out. I am of the opinion that guard wires and their bindings should be made of silicon bronze, instead of the usual galvanised steel. These would be stronger for the same size, and would not only have greater conductivity, but they should withstand the rapid corrosive effect which grimy chemical-laden atmosperes have upon galvanised steel wires. (See specimen.) It is seldom that the trolley wires break from over-tension arising from mal-erection, or even from fouling the trolley poles. They are usually composed of the very best hard-drawn 98 per cent. conductivity copper, having a diameter of ·37in., which is equivalent to No. 3/0 S.W.G. or fully 00 B. & S. gauge. The initial stress which this wire will withstand before beginning to stretch is over 54,000lb., or 24 tons per square inch of the full section. But when subjected to a continuous steady pull, the very small elongation of 4 per cent. is accompanied by a gradual diminution of the original cross area of fully 40 per cent. (See appendix, Table I., and specimen.) In any case there is comparatively little chance of the trolley wire being broken by an accidental stress, except where it becomes rapidly worn at sharp street curves. Special watchfulness is therefore necessary at such curves, in order that the copper wires may be renewed before they become unduly reduced in size.

V. *Feeding, Earthing, and other Safety Devices.*—Even assuming that the trolley and guard wires are made of the best materials and have been erected in the most substantial manner; further, that the former is divided into separate half-mile sections, of which as few as may be practicable are supplied with current from the power-house or sub-station by any single "feeder," it is, nevertheless, necessary to be able to render any section inoperative or "dead" as soon as possible after any one or other of the previously mentioned faults occur therein. Many devices have been proposed and adopted with this object in view, of which the following may be mentioned:

1. Fuses and automatic cut-out switches at the supply stations. But, as we have already stated, these do not always act unless an abnormal current is demanded by a "short-circuit" to "earth," or to the "return" conductor.

2. Fuses or automatic cut-out switches, or simply hand-switches, in each of the half-mile street pillar switch-boxes. There should also be a telephone, or a connection for one, in each of these boxes in order to be able to communicate direct to the current supply stations and the engineer's office. It is unusual to place either fuses or even automatic switches in these pillar boxes, for most tramway engineers object to multiplying such devices. They therefore simply insert therein a main feeder hand-switch and a trolley wire section hand-switch for each car line, plus a telephone wire connection. Moreover, keys for opening these boxes are, as a rule, only given to the engineering staff, and consequently neither the car driver, nor the conductor, nor the car inspectors can operate these switches in case of an accident to any particular section. All that they can do under the circumstances is to use their insulating gloves and pliers, or earth a fallen wire to the rails and communicate with the head office from the nearest special telephone pillar. This roundabout proceeding causes an unnecessary waste of time and blocking of the traffic, as well as a possible cause of danger to passengers. Why not supply these employés with keys, and give each of them clear printed instructions how to act under certain circumstances? (See the *Light Railway and Tramway Journal* of July 5, 1901, pp. 32, 33, and 42, for descriptions and illustrations of Quin's safety switch; also the *Railway and Tramway World* of July 11, 1901, for Mr. Manville's paper on this subject. A specimen of Quin's safety switch gear, together with drawings, were placed before the members. These switches and drawings were sent by the British Insulated Wire Company, Limited, who are the sole makers.)

3. Blackwell and Co.'s earthing device is attached to either a bracket arm or a trolley wire suspension, and it acts when the trolley wire breaks by mechanically short-circuiting it to the rails. (For illustrations and descriptions see the periodicals referred to previously. Specimens of Blackwell and Co.'s "earthing devices" were placed before the members.)

4. Placing an earthing switch in each car. In the case of the severance or disconnection of a trolley wire, or a serious downfall of overhead conductors, all that the driver or the guard has to do is to break the glass front of a special box and turn a switch or insert a plug into a metal hole, thus immediately earthing the trolley wire to the tramway rails through the trolley pole and car wheels. This operation instantly causes an abnormal current to flow in the feeder to the section in which the car happens to be at the time, and consequently blows its safety fuse or frees its automatic switch at the station. This device, which is being tried in Leeds, seems to me to be one of the simplest and most direct methods of rendering a section neutral in the case of an emergency. The attendant at the station should be authorised to close the freed automatic circuit breaker three successive times, when, should it persistently and immediately fly out again, he must attend to the telephone for instructions before again closing the switch.

VI. *Aerial Telephone and Telegraph Cables versus Underground Wires or Cables.*—In Glasgow there are now three authorities dealing with these important matters—viz.: (1) the Government Postal Engineering Department, who have placed their principal telegraph and telephone city wires underground, but who have still a large number of aerial wires. (See specimen.) (2) The National Telephone Company, who have hitherto carried their fine bronze wires overhead, and who, being prevented from opening the streets, are now running aerial telephone cables. These consist of about 100 paper-insulated wires twisted together, and then insulated as a whole with canvas and vulcanised indiarubber, protected by waterproof matting and strong woven tape. These cables are suspended by hooks hung from strong stranded steel span wires, attached to brackets fixed to the walls or the roofs of buildings. Two conductors are used for each closed telephone circuit to avoid induction, etc. Such cables and their suspension spans are not likely to interfere with tramway trolley wires; and even if they did come down in the case of a fire, they are so large, well insulated, and strong that they could be more readily dealt with than a similar number of bare bronze springy wires. (See specimens.) (3) We have the Corporation of Glasgow, who have just started a telephone exchange, and who, having full authority in regard to the streets, have very properly taken the precaution to place all their city wires and cables in underground cast-iron pipes where they approach the tramway lines. (See specimen). There cannot be the slightest doubt that the only sure and safe plan is to place all non-tramway electrical conductors, of whatever, kind, underground. If this were done, then there would be no necessity for guard wires, thereby leaving the trolley wires free from extraneous contacts, and minimising the afore mentioned dangers.

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APPENDIX.

TABLE I.—Tests of Trolley, Span, and Guard Wires for Glasgow Corporation Tramways by the Steel Company of Scotland, Limited. Hallside Works, Aug. 30, 1900.

Samples.	Diam., inches.	Actual stress.			Breaking stress.	Initial stress.	Exten. per cent. in 8in.	Size of fracture.		Per cent.
		Area, sq. in.	Tons.	Lbs.	Tons per sq. in.	Lbs. per sq. in.		Diam., in.	Area, sq. in.	
Cold-drawn copper trolley wire 3/0 S.W.G. ...	·37	·1075	2·6	5,824	24·2	54,200	4·0	·24	·0452	57·9
Trolley span wire, galvanised steel of 7 strands, each wire No. 12 S.W.G.	·105	·0606	2·15	4,816	35·5	79,500	—	—	—	—
Guard span wire, galvanised steel of 7 strands, each wire No. 14 S.W.G. ...	·085	·0397	1·60	3,584	40·3	90,200	—	—	—	—
Guard wire, one No. 7 S.W.G. galvanised steel	·180	·0253	0·85	1,904	33·6	75,200	15·0	·12	·0113	55·3

TABLE II.—Analysis of Three Samples of Copper Alloy* for "Ears" and "Pull Offs." Chemical Department, Oct. 5, 1900.

	Straight line ear.	Guard double pull off.	Trolley single pull off.
Copper	88·54	85·84	85·84 per cent.
Tin	7·79	4·57	8·73 ,, ,,
Lead	0·75	2·86	0·72 ,, ,,
Zinc	—	6·24	4·13 ,, ,,

* These fittings are generally made of "Admiralty mixture."

Test III.: Tensile Test of "Dirigs" Globe Strain. (Insulation Green Colour).—The first perceptible extension was noticed when the tensile stress reached 2·5 *tons* (5,600*lb.*), while the composition slightly cracked. The specimen broke through bottom eye at the maximum stress of 2·9 *tons* (6,496*lb.*), while the original crack in the composition widened.

Test IV.: Tensile Tests of Two Brooklyn Strain Insulators. (Composition Red Colour).—The large one broke through large eye after a stress of 3·3 *tons* (7,392*lb.*) was reached. *The small one* broke through large eye after a strain of 2·2 tons (4,928lb.) was reached. The composition did not show signs of cracking in either case.

Test V.: Tensile Test of Double Pull-Off. (Composition Green Colour).—First perceptible extension observed when the tensile strain reached ·07 ton (156·8lb.). Insulated bolt became fast at 1·1 tons (2,464lb.), ruptured through one arm at a stress of 1·9 tons (4,256lb.). Original distance between centres of eye-holes 6in., extended 3in. to 4in. when bolt became fast. Total extension at rupture, 2in. Composition intact.

Test VI.: Tensile Test of Single Pull-Off. (Composition Green Colour).—The first perceptible extension showed at a stress of ·09 ton (2,016lb.). Insulated bolt began to bend at 1·2 tons (2,688lb.), and centre of bolt to centre of eye-hole extended 1in. Final rupture at 1·9 tons (4,256lb.).

Test VII.: Compression Test on Single Pull-Off Insulated Bolt. (Red Colour).—Original diameter 1·18in., slightly tapered. At 4 tons (8,960lb.) very slight cracks observable in composition. At 6 tons (13,440lb.) diameter or deflection stood at 1·17in. At 10 tons (22,400lb.) diameter or deflection stood at 1·165in. At 11 tons (24,640lb.) diameter or deflection stood at 1·15in. At 11½ tons (25,760lb.) badly cracked.

Test VIII.: Compression Test on Single Pull-Off Insulated Bolt. (Green Colour).—Original diameter, 1·18in., slightly tapered. At 4 tons (8,960lb.) showed very slight cracks. At 6 tons (13,440lb.) diameter or deflection was 1·17in. At 8 tons (17,920lb.) diameter or deflection was 1·16in. Cracks in composition gradually extended as weight was applied, until at 8 tons (17,920lb.) it was badly cracked.

Test IX.: Tensile Test of Ear with Insulated Bolt Screwed in. (Green Colour).—After gradually applying the stress up to 2 tons (4,480lb.) the composition came off head of bolt. The ear collapsed on both sides of screwed neck when the stress reached 4·6 tons (10,304lb.).

THE RUBBER INDUSTRY OF RHODESIA.

From a report on species of rubber indigenous to North-West Rhodesia, by Mr. Harding, the Acting Administrator, it appears that the distinct species are three in number—viz., Landolphia florida, Capodinus lanceolatus, and Kickxia elastica. The first named is a kind of vine rubber, usually found growing in marshy tropical localities. It grows in close proximity to a small tributary of the Zambesi, north-west of Nyakatoro, and also on an east bank tributary of the Kabompo River, called the Mumbasi. No doubt this species may be found in considerable quantities in the basins of the numerous tributaries of these two rivers, as quantities of the prepared rubber have been found in possession of the natives inhabiting these districts. The Landolphia florida is collected and prepared by the natives. The cutting of the vine is accompanied by great waste, for it is promiscuously hacked, the best and largest branches being selected for subsequent preparation, while the smaller ones, which would attain maturity in another year, are left to rot on the ground. The juice of the plant cannot be extracted by incision, and so the preparation of the rubber is conducted as follows: The selected material in lengths of 3ft. to 4ft. is soaked in water for 48 hours, and then hammered to remove the bark. The "blanket," as the rubber is termed at this stage, is then immersed in water, and boiled, for three or four days, until the bark is completely removed. While the rubber is still warm it is rolled into sticks about 6in. long, called matallas, which are hung up to dry and subsequently made into what are known as "chetotes," which are sold to the Mombari traders. The price of this class of rubber at Benguella would be from 2s. 9d. to 3s. 6d. per pound. Kickxia elastica is a true rubber found in close proximity to the Landolphia florida; it has been noticed in the possession of natives north-west of the Zambesi, near the Kasai River. The rubber is procured by making an incision in the tree, and is of better quality than either of the products obtained from the two other species. It is free from dirt and bark, and the only objectionable ingredient present is grease, which is introduced into the material at the time of collecting, and also when moulding it into various shapes. This kind of rubber is often used by the natives to mix with inferior samples, thereby improving their market value. Capodinus lanceolatus is found in considerable quantities between the Kwando and Kwito Rivers, and is generally met with throughout the Barotse country west of East Lunga River. This plant is also a species of vine rubber, and although admittedly of inferior quality, still it will thrive in very poor soil and should eventually prove a very valuable asset to Western Barotseland. To substantiate this statement it is pointed out that both east and west of the Kwito River the Portuguese have erected stations with the object of collecting this rubber. Capodinus is a phanerogamous plant, and grows from 6in. to 8in. in height; the roots are found 4in. beneath the surface of the soil, and they extend evenly and uniformly over a considerable area. The process of preparation of this root is the same as that described under Landolphia florida. There is little doubt, continues the report, that North-West Rhodesia is a rubbber-producing country, and only an early settlement of the internal conditions of the country is necessary to secure a successful future for the development of this industry.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

409. Two steam alternators of same type and size are running fully loaded in parallel on the 'bus bars. The cut-offs of the engines are set the same, and the field of both are taking the same exciting current. There is an appreciable motor current between the two. What is the best way to stop this?—A. C. J. R.

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410. What tools and testing instruments would be required to equip an electrical repair shop for a factory installation comprising telephones, dynamos, arc lights, and about 40 small motors?—A. R.

ANSWERS.

Question No. 403.—When in a continuous-current drum-wound motor one armature connection is disconnected from its commutator bar, why is it that not only that bar is marked by sparking, but also a bar opposite to it? Would the same thing occur were the sparking caused by one coil being short-circuited?

Best Answer to No. 403 (*awarded* 10*s.*).—Supposing the motor to be a two-pole one, the marking of the opposite commutator bar is probably due to an inductive action between neighbouring coils undergoing commutation at the same time. The two sections short-circuited by the two sets of brushes are situated close together on the armature core, either side by side (as in Fig. 1), on top of one another, or, in the case of a slotted armature, in one and the same slot. The position given to the brushes when working without any fault in the armature is such that the combined effect of the reversing field under the trailing horn and the inductive action of one commutator section on the other, gives sparkless commutation. If, however, one of the commutator connections is broken, not only does

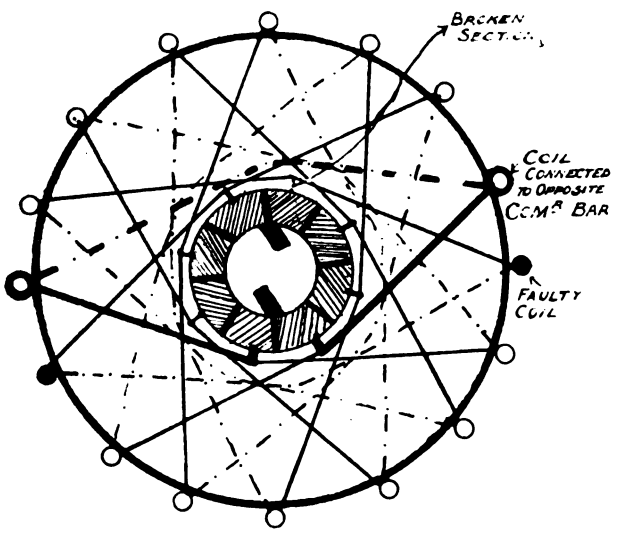

FIG. 1.

a spark occur every time that bar passes a brush, due to the failure to short-circuit that particular coil, but also a spark occurs at the opposite section due to the absence of the usual inductive action between the coil with the broken connection and the coil connected to the opposite commutator bar. In the case of a short-circuited coil these will again be sparking at the opposite segment as well as at the faulty one, due to the abnormal inductive effect of the large current in the short-circuited coil. In this case, however, it is quite likely that several of the sections nearly opposite the faulty one will be found marked by sparking, as the short-circuited coil will probably affect a number of other coils close by.—Q.

Answer to No. 403 (*awarded* 5*s.*).—A reference to Fig. 1, which shows an end view of an armature and commutator, will make it fairly clear why the disconnected commutator bar should show the effects of sparking. Assuming that the brushes are at the top and bottom of the commutator, the supply current would divide itself in two halves, one going through coils A, B, C, D, and the other half going through coils H, G, F, E. This division of the current continues as the armature and commutator revolve; but, of course, other coils take the places of those mentioned, and so the disconnected commutator segment gets to one of the brushes, and then the circuit is suddenly broken. We must now remember that the self-induction of such a circuit as the armature, with its mass of iron, is great, and therefore there is a very considerable E.M.F. generated at the moment of breaking the circuit—*i.e.*, when the last connected segment leaves the brush. This E.M.F. is sufficient to leap across the insulation between the last connected segment and the disconnected segment whilst it is in contact with the brush, but the rapidly increasing distance between the last connected segment and the brush soons stops the arc, and, of course, the draught of air assists to put out the arc thus formed. Such sparks are really miniature arcs, and are intensely hot, so that every spark can easily and does effectually oxidise and remove a particle of copper both from the commutator and from the brush, hence the marking. As the current is interrupted at the fault in the armature connection, and the effect of the self-induction of the armature may be said to run in two directions—viz., towards each brush—and the contact between the brushes and the commutator is never perfect, it follows that a spark is very likely to occur at the other brush also, more especially as the sudden break in the current must interrupt the smooth running of the machine.

Fig. 2 represents the same view of the same armature but with coil, C, short-circuited, instead of the disconnection as in Fig. 1. Obviously the circumstances are very different, and coil C is virtually cut out of the armature circuit whilst two segments of the commutator are joined together. Although the machine is running as a motor, it is really a dynamo, and, consequently, the revolving armature between the field magnets produces an E.M.F., but as this E.M.E. opposes the supply (or driving) current, it is called the back E.M.F. of the motor. As one of the coils of the armature is short-circuited it cannot produce any effect, or add to the back E.M.F. produced by the armature, consequently the back E.M.F. on one side of the armature will be greater than that on the other, and so a current will flow from the stronger to the weaker side of the armature except when the short-circuited coil happens to be in the air-gaps. The back E.M.F. of the armature will, therefore, vary a good deal with any revolution, and consequently the amount of current received by the armature from the brushes will also vary. This uneven current would, of course, tend to prevent even speed in the machine, and so the proper place for the brushes would change with each revolution, and sparking would be certain to result on each side of the two connected segments, but there would be excessive sparking here rather than at the opposite side. A short-circuit would have to be large enough to carry an appreciable current to produce these effects, and then probably it would carry enough current across the short-circuited coil to damage it by heat.—F. G. A.

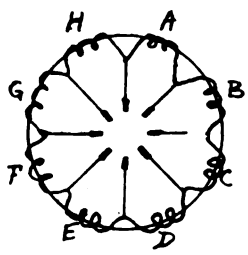

FIG. 1.

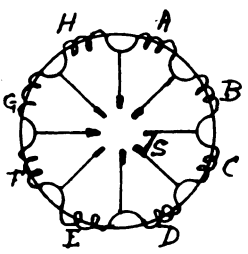

FIG. 2.

Answer to No. 403 (*awarded* 5*s.*).—In a two-pole motor the current has two paths through the armature to the opposite brush. If one wire of the armature becomes disconnected from the commutator, the current can only flow round one half of the winding, no matter where the disconnection is, except at the moment that the brush is short-circuiting the faulty segment and the next to it. The half winding, therefore, has to carry twice the current that it was designed for if the motor has the full load on. At the moment that the faulty segment passes under the brush, the current is normal in the two halves, but the instant it passes from under the brush there is a spark due to opening the circuit of the one half, and also a spark at the other brush opposite due to the rush of current to the one half. In event of a short-circuited segment, there will be sparking at the opposite segments due to the rush of current caused by the out of balance of the armature, and the half in which the short-circuit is will give a smaller back E.M.F., and therefore, a greater current will flow through. The particular coil will get very hot, and in time burn out, or, if the short is in the commutator, the wires will melt the solder where it is soldered into the armature and become disconnected.—C. L. E. S.

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Question No. 404.—What is the most likely cause of a growing temperature rise in the disc armature of a 125-kw. Ferranti alternator, and how can the balance of the two halves of the armature be best tested with the ordinary station instruments?

Best Answer to No. 404 (*awarded* 10*s.*).—It is rather difficult to exactly know what is meant by a growing temperature rise in the Ferranti armature. Of course, there will be a rise in temperature depending upon the load, but evidently something abnormal is meant. If the heating is greatest in one or two coils, it is most likely caused by the paper insulation between the strip winding charring and partially short-circuiting a few turns. This will cause the two halves to get out of balance, and cause all the other coils to warm up as well, due to the out-of-balance current from one half of the armature to the other, in addition to the load current. If, however, the overheating is the same all round, this must be caused by the halves being widely out of balance, probably by a burnt-out coil being replaced and the new coil being put in the wrong way about, so that it is subtracting instead of adding its E.M.F. to the rest on that half. Run the machine fully excited on open circuit for, say, an hour, and feel all round the coils. If it has warmed up much, it must be unbalanced. To make sure, break the strip winding on one of the coils and fasten the ends down so as to open circuit that half, and run as before. If it runs cool this time, it may be taken as granted that one of the coils is in wrong. To find the faulty coil, take off collecting brushes and send fairly heavy continuous current round (having joined up broken strip) armature by feeding on to collecting rings, and hold compass needle to each coil. This will show directly if there is a coil not connected up right. An alternative way is to feed an alternating current on to collecting rings, and put an ammeter in circuit on each half, by cutting winding on each side and noting current taken by each half.—F. A. G.

Answer to No. 404 (*awarded* 5*s.*).—An undue heating of the armature may be caused in many ways. I cannot say which one would be the correct fault (if I may use the expression) as you do not give your system of distribution, or state if your alternator has always heated, or if this

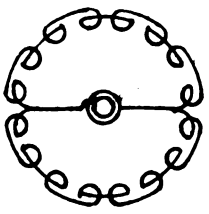

Fig. 1.

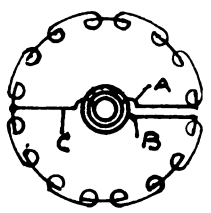

Fig. 2.

heating is local. If it is general, may be the current is out of phase with the voltage to a great extent, caused by an inductive load (transformers and motors) or by capacity (long concentric cable and no transformers or motors). The above causes, however, would cause very little difference of temperature. Local heating would be caused by one or two of the convolutions of a coil or coils being shorted by the vulcanised fibre giving out, or the convolutions being spanned by dirt, etc. This would reduce the voltage of the faulty side (the shorted coils giving a voltage, effective, of 0) and throw the greater part of the load on to the "other side," thus making it heat up, and deceiving the poor station engineer into believing that it was the faulty side. Another cause would be that at some time (since leaving the shop's charge) the coils have been taken out and not put back to their proper pitch, thus causing the ones that are out of pitch to give a voltage out of phase with their neighbours, and so totalling for one side a reduced voltage, and causing a similar effect to the above. To discover whether the armature is out of balance may be done in a very simple way. In a Ferranti alternator the armature revolves and is connected up in parallel (see Fig. 1). Divide the armature, and place an ampere-meter in circuit. If the halves are not balanced, a deflection will be given on the meter in proportion to the amount out of balance. To do this, a third ring had better be fixed (see Fig. 2). Then an alternative arrangement may be used; a voltmeter, one terminal being connected to the common collecting ring, the other to first one of the two spare ones and then the other. This will give the voltage of the two halves. The half that gives the lower voltage is the faulty one.—F. W. S. H.

Answer to No. 404 (*awarded* 5*s.*).—There are several reasons for the growing temperature rise in alternators of the disc armature type, as unless the temperature rise is stipulated in the specification, manufacturers do not give the question much consideration for this type of machine. In some cases the fault is in the design of the plant, as an alternator that is fixed on the shaft between the high and low pressure engines will always when running maintain a higher temperature than an alternator coupled on the extremity of shaft, on account of the engine beds taking up (what would be on an alternator coupled on at extremity of shaft) ventilating space; also, the atmosphere surrounding the centrally fixed alternator is subject to radiation from cylinders, etc. Another most likely cause for the high temperature is due to painting the armature coils with shellac varnish, which, in my opinion, is quite unnecessary, as it acts as a covering to the windings, and so prevents them from getting proper ventilation, and it is often used as a covering for dirt and grease. A perforated guard, in place of the ordinary sheet-iron guard generally used, has on an alternator under my charge reduced the temperature considerably. In passing, I may mention another cause, the responsibility of which rests on the engineer in charge—that is, having too much exciting current, which keeps the speed of plant low. When parallel running, of course this is not possible unless the exciting current is increased on the other plant. The most satisfactory proceeding to obtain the balance of the two halves of armature with the ordinary station instruments is to disconnect one half of the armature by uncoupling the copper bar connectors at bottom of coils, run the plant up to ordinary speed, taking voltage off synchronising voltmeter. If considered, necessary it can be put on artificial load, and readings taken; then connect up the disconnected half of armature (disconnecting the half already tested), and run the plant again, keeping speed and exciting current as in the first test. Comparing the readings will then show the balance or out of balance of the two halves of armature.—W. C. F.

COMPANIES' MEETINGS AND REPORTS.

CARDIFF TRAMWAYS.

A meeting of the directors of the Cardiff Tramways Company was held at the Royal Hotel, Cardiff, on Friday. As a rule, the directors meet in London, and it is presumed that the change of place is not unconnected with the negotiations which are now taking place between the Corporation and the Company for the purchase of the lines. The Town Council at their last meeting passed a resolution offering £40,000 for the 9¼ miles of permanent way, such sum to include engineering commission and an allowance for compulsory purchase goodwill, and profits in respect of about three miles of line constructed under the powers of the Cardiff tramways orders, 1884 and 1885, but not the actual parliamentary expenses for obtaining the orders, estimated at £1,600. At the close of the meeting of directors Mr. J. Barber Glenn, managing director and secretary, admitted that the letter of the town clerk enclosing the above resolution had been considered, but refused to state what action the Board decided to take. It would, he said, be unfair to the Town Council to disclose any information until the reply to the Town Council's offer had been put before that body.—*The Weekly Mail.*

MATHER AND PLATT, LIMITED.

The yearly meeting of this firm of engineers was held in Manchester on Tuesday. Mr. Wm. Mather, M.P., presided. The accounts showed a net profit of £77,621, and there was a balance of £6,925 from last year. A dividend of 7 per cent. on the ordinary shares was declared, £30,000 being added to the reserve fund, and £10,295 carried forward.

The **Chairman** said they might have increased the dividend, but they preferred to enhance the security of the shareholders—preference and ordinary alike. Developments of engineering science led to rapid change in all branches of the profession, therefore it was desirable to husband the resources of their industry.

INDIA RUBBER (MEXICO).

An extraordinary general meeting of the shareholders of the India Rubber (Mexico), Limited, was held on the 30th ult. at the Guildhall Tavern, Gresham-street, E.C., Mr. Anthony Stephen Wehner presiding. After some discussion, a resolution for voluntary liquidation was agreed to, and Mr. J. F. Lovering was appointed liquidator.

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LEGAL INTELLIGENCE.

LIVERPOOL TRAMWAYS.

At the Chancery Conrt of Lancashire held at the offices, Cook-street, on Tuesday, an application of the Liverpool Corporation came before the registrar, Mr. F. Willis Taylor, for the continuance of an interim injunction obtained on Aug. 30 against Mr. M'Cullough, until recently assistant manager of the Liverpool tramways department, restraining him from dealing with letters and reports relating to the conduct of tramway matters. Pending the filing of affidavits the motion was ordered to stand over until Tuesday next, the interim injunction being continued.

BLACKPOOL ELECTRIC TRAMWAYS (SOUTH).

An application was made in the Chancery Court on Wednesday on behalf of the secretary of this company, that the time for the registration of a trust deed of July 11, 1901, might be extended. The application was made under the Companies Acts of 1900, which require the registration of such deeds within 21 days from the date of execution; but in this case it had been intended to register at the time of the issue of the debentures. The debentures, however, were not then printed, and they were not signed and sealed until July 31. As the Court has power to extend the time on application made to it, the company now sought that indulgence. Mr. Justice Joyce granted 21 days from Sept. 4.

ISLE OF MAN TRAMWAYS.

At the Manx Chancery Court on Wednesday a petition was presented by Wm. Henderson Walker, liquidator and receiver of the Isle of Man Tramways and Electric Power Company, for the appointment of trustees for debenture holders in place of Frederick George Callow and John Shimmon, who desired to relinquish the trust. William Frederick Price and Mr. Cookson were appointed.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Erivan (Russia).—The Municipality invite tenders for 2½ miles of electric tramways by Sept. 14.

Paris.—Post and Telegraph Department invite tenders for 420,000 porcelain insulators by Sept. 19.

Bury. Tenders are invited for the wiring of the new market hall and shops. Tenders by Sept. 14. Details in our advertisement columns.

Blackpool. — The Corporation Electricity Department invite tenders for 30 arc lamps, switches etc., suitable for rectified current. Details in our advertisement columns.

Ashton-under-Lyne. - The Corporation invite tenders for a surface condenser of about 1,000 square feet, with pumps. Tenders by Sept. 18. Details in our advertisement columns.

Listowel.—The Urban District Council are desirous of treating with a responsible firm for the supply of electricity for street-lighting. Tenders by Sept. 30. Details in our advertisement columns.

Kirkcaldy. — The Corporation invite tenders for the supply, delivery, and erection of overhead construction for electric tramways. Tenders by Sept. 13. Details in our advertisement columns.

Haslingden. -The Town Council invite tenders for the ventilating of the free library and technical school proposed to be erected on Bury-road. Tenders by Sept. 17. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of arc lamp-posts, wall brackets, and switch boxes. Tenders by Sept. 16. Details in our advertisement columns.

Whitehaven.—The Water and Lighting Committee invite tenders for the supply of incandescent lamps for a period of six months from October 1, 1901. Tenders by Sept. 16. Details in our advertisement columns.

Glasgow. - The Corporation invite tenders for the supply and laying of cables. Specification, etc., can be obtained on application to Mr. John Young, general manager, 88. Renfield-street, Glasgow. Tenders by Sept. 25.

Torquay.—The Electric Lighting Committee invite tenders for the supply and delivery of arc lamp carbons for a period of 12 months from Oct. 1, 1901. Tenders by Sept. 13. Details in our advertisement columns.

Poplar.—The Electricity Committee invite tenders for the supply of multiple-core, covered, lead feeder and network cable and accessories for mains extensions. Tenders by Sept. 18. Details in our advertisement columns.

Doncaster. — The Corporation invite tenders for the supply, delivery, and erection of tramway poles, and overhead construction for the system of Corporation electric trams. Tenders by Sept. 14. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of trolley wire, etc., for overhead equipment; line materials for ditto; span wire, brackets, etc., for ditto. Tenders by Sept. 14. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the electric lighting installation, etc., of the second portion of the Colinton Mains fever hospital, the number of lighting points being about 800. Tenders by Sept. 9. Details in our advertisement columns.

Warrington.—The Corporation invite tenders for the execution of electric lighting, etc., works at the Delph-lane pumping station. Specification, etc., may be obtained from the engineer, Mr. James Deas, A.M.I.C.E., M.I.M.E., Bank House, Warrington. Tenders by Sept. 14.

Salford.—The Health Committee invite tenders for the supply of a 55-kw. steam dynamo at the Ladywell Sanatorium, Eccles New-road. Specification, etc., may be obtained from Mr. C. D. Taite, borough electrical engineer, Strawberry-road Electricity Works, Salford. Tenders by Sept. 14.

Kingston-upon-Hull.—The Electric Lighting Committee invite tenders for two high-speed three-crank compound steam-engines, 800 i.h.p. each, and four steel Lancashire boilers, 30ft. by 8ft., for 150lb. steam pressure. Tenders by Sept. 26. Details in our advertisement columns.

Madrid.—The Department of Agriculture invite tenders for the installation and working of an electric tramway for not more than 60 years. The route is from Linares to the mines of San Rogue and Tortilla. The deposit is 11,105 pesetas provisional, and 55,526 pesetas finally. Tenders by Oct. 17.

Sheffield.—The Corporation invite tenders for boilers (type left open), induced draught, air heating tubes or economisers, motors, fans, iron chimneys, brickwork or iron flues, and all other accessories for evaporating 120,000lb. of water per hour. Tenders by Sept. 30. Details in our advertisement columns.

London, W.C.—The British Electric Traction Company invite tenders for the supply of about 5,000 tons of steel grooved girder tramway rails, fishplates, etc. Specifications, etc., can be obtained on application to the Chief Engineer of the Company, Donington House, Norfolk-street, London, W.C. Tenders by Sept. 20.

Dundee.—The Town Council invite tenders for the overhead equipment of the following routes of the Dundee city tramways—viz.: Constitution-road route and Victoria-road and Fairmuir route. Specifications, etc., may be had on application to Mr. Walter H. Tittensor, city electrical engineer, Dudhope-crescent-road, Dundee. Tenders by Sept. 14.

Lowestoft.—The Corporation invite tenders for the supply and erection of one 500-kw. steam dynamo (vertical enclosed engine), with pipework connections complete, and switchboard panel with cable connections to dynamo. Specifications, etc., may be obtained at the office of Mr. R. Beattie Nicholson, town clerk, 115, High-street, Lowestoft. Tenders by Sept. 9.

Bournemouth.—The Town Council invite tenders for steel grooved girder rails, etc.; conduit permanent-way construction and rail bonding, etc.; ploughs and carrying attachments to cars; wood block, tar macadam, and granite sett paving. Specifications, etc., may be obtained from Mr. W. Lacey, M.I.C.E., borough engineer, Municipal Offices, Bournemouth. Tenders by Sept. 16.

Oldham.—The Electricity Committee invite tenders for the supply, delivery, and erection of two electric overhead travelling cranes. Specification, etc., can be obtained from Mr. Arthur Andrew, Gas and Water Offices, Oldham. The specifications and drawings can be seen at, but not obtained from, the offices of Dr. Alex. B. W. Kennedy, 17, Victoria-street, Westminster, S.W. Tenders by Sept. 10.

Broompark (Durham).—The Broom Parish Council invite tenders for erection of poles and laying of the cables and all necessary fittings for lighting with electricity the village of Broompark and the western portion of the parish—namely, Station-road, White House-lane, and the adjoining streets at Flass Inn. Specifications, etc., may be seen at the office of Mr. John Bradley, clerk, Broompark, near Durham, after 6 p.m.

Reading.—The Corporation invite tenders for the construction of new tramways and the reconstruction of the existing tramways, including the electrical bonding of the rails, the provision and laying of conduits and drawing-in boxes for the underground work, etc. Specification, etc., may be obtained on application to Mr. John Bowen, A.M.I.C.E., borough engineer and surveyor, Town Hall, Reading. Tenders by Sept. 28.

Grimsby.—Tenders are invited for the electric lighting of the Flottergate Church, including fittings. Tenders to be in two parts: the first part to include the lighting of the church, minister's vestry, committee-room, and lecture hall; the second part to include school-room and all classrooms. Tenders to be sent by 5 p.m. on 13th inst. to Dr. Wright, J.P., Bourne Villa, Prince's-avenue, Grimsby, from whom all information may be had.

East Ham. - The District Council invite tenders for the construction of the permanent-way works on their tramway extensions along the Manor Way towards Woolwich and across the Wanstead Flats to the City of London Cemetery (together about 1 mile 4 furlongs in length). Specifications, etc., may be obtained on application to the engineer and surveyor (Mr. A. H. Campbell, A.M.I.C.E.), Public Offices, East Ham. Tenders by Sept. 17.

Batley.—The Corporation invite tenders for the supply, delivery, and laying in the borough of Batley of steel rails, points, crossings, bonds, and accessories, granite setts, stone setts, wood blocks, concrete, and all excavation work, and laying of the permanent way for tramway (approximately 3½ miles). Specifications, etc., may be obtained from the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by Sept. 14.

London, S.W.—The London County Council invite tenders for track rails and fastenings, slot rails and fastenings, tiebars and conductor tees, and roadwork and platelaying required for the construction on the conduit system of the tramway routes between Westminster Bridge, Blackfriars Bridge, and Waterloo Station respectively, and Tooting. Specifications and other particulars may be obtained from the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

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London County Council.—The County Council invite tenders for work to be done in supplying, fitting, and fixing lifts, motors, pumps, ventilating fans, lamps, cables, wires, conductors, switchboards, and columns, together with all supports, apparatus, fittings, and accessories which may be necessary or required for the electrical equipment of the Greenwich footway tunnel and its approaches. Specifications, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a continuous-current 1,500-kw. dynamo working at from 550 to 625 volts, and the erection of these sets in the generating station of the South London Electric Supply Corporation, near Loughborough Junction. Also for three auxiliary 250-i.h.p. vertical high-speed enclosed steam-engines, each coupled direct to a continuous-current dynamo working at from 200 to 225 volts, and for the erection of these sets in the Council's generating station at Greenwich. Specifications and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a three-phase 1,500-kw. generator working at from 6,500 volts between conductors, each with an exciter, and for one 750-kw. reversible synchronous motor-generator, with exciter, designed so that either the low-tension or the high-tension side of the set will act as generator, and for the erection of these sets in the Council's generating station at Greenwich; also for nine 300-kw. synchronous motor-generators, working at from 550 to 600 volts on the low-tension side, each with an exciter, and for three 50-kw. induction motor-generators, working at from 200 to 225 volts on the low-tension side, and the erection of these sets in sub-stations provided by the Council. Full particulars may be had at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

RESULTS OF TENDERS.

Manchester.—The following tenders have been received for switchboards: Electrical Company of Berlin, £39,306 (accepted); British Westinghouse Company, £42,551; Siemens Bros., Limited, £50,004.

Tyneside.—The Tyne Improvement Commissioners have accepted the tender of Crompton and Co., Chelmsford, for carrying out works of arc and incandescent electric lighting and mains at the Albert Edward and Northumbrian Docks, at £6,128.

Eastbourne.—The Electric Lighting Committee have accepted the following tenders: Gilbert Arc Lamp Company, supply of arc lamps (including the provision of apparatus for lowering and raising the lamps), at £1,147; Messrs. J. and A. Law for supply and erection of 75 arc lamp posts, at £1,084.

Metropolitan Electric Supply Company.—We understand that the company have placed an order with Kolben and Co., Limited, Prague, for two 5,000-h.p. alternate-current dynamos generating at 11,000 volts, direct coupled to steam-engines of 75 revolutions per minute, by Gebr. Sulzer, of Winterthur.

Dartford.—The Council have accepted the following tenders for meters (direct-current) and cut-outs: Venner and Co., 6, Old Queen-street, Westminster, S.W., two-wire meters; British Thomson-Houston Company, Limited, 83, Cannon-street, E.C., three-wire meters; Keighley Electrical Engineering Company, Limited, Vulcan Works, Keighley, cut-outs.

Glasgow.—The Telephone Committee have recommended the acceptance of the following tenders for laying and jointing of additional cables: Western Electric Company, Limited, and Henley's Telegraph Works Company, for two sections of the work, amounting to £322. 12s. 10d. and £492. 4s. 10d. respectively, and the offer of the British Insulated Wire Company for the remainder, amounting to £4,000; also an offer by the Ericsson-Bell Telephone Company to supply 1,500 wall instruments at £2. 12s. per instrument, and 200 table instruments at £2. 14s. per instrument.—The Tramways Committee have accepted the tender of Macartney, McElroy, and Co., Limited, for the overhead work for the electric tramway extensions, the amount being £32,511. The other offers accepted were: R. W. Blackwell and Co., London, copper bonds for the extensions, £2,682. 5s.; Evershed and Vignoles, Limited, London, patent telegraph signalling apparatus for Pinkston electric power station, £447. 5s.; Verity, Limited, motors for driving ventilating fans for the sub-stations, £407. 6s. 2d.; International Electric Engineering Company, electric motors for Coplawhill car works in order that the machinery there may be worked by electric power from Pinkston, £330.—The Libraries Committee have accepted the offer of J. D. Mackenzie and Co. to provide and fit up the necessary installation for the electric lighting of the Gorbals district library, at £118. 10s.

BUSINESS NOTES.

TRACTION.

Salford.—The Council have declined the terms offered by the Manchester tramways department.

West Hartlepool.—The tramways company have obtained permission to construct a line on the south side of the municipal buildings.

City and South London Railway.—It is stated that the company will open their extension from Moorgate-street to Islington in time to carry visitors to the annual cattle show at the Agricultural Hall.

New Works.—The European McGuire Manufacturing Company, of 4 and 5, Warwick-court, have recently purchased works at Elton Fold, Bury, Lancs., for the manufacture of electric traction specialities, prominent among which will be the McGuire truck.

Portsmouth.—Electric tramcars are rapidly becoming a familiar feature here, for though the committee have not yet received the license which will enable them to carry passengers, they are expecting it very shortly, and are pushing on with the training of the drivers and conductors.

Birkdale.—The District Council on Wednesday decided to serve notice upon the Birkdale and Southport Tramways Company requiring that company to sell to the Council so much of the undertaking attained by the Birkdale and Southport Tramways Order, 1880, as is situate in the urban district.

Tramway Orders.—Amongst the parliamentary papers just issued is a return by the Board of Trade of the orders made during the past session under the Tramways Act, 1870, showing that 24 orders were applied for, all of which but one were made by the Board of Trade and confirmed by Parliament.

Thurmaston.—The Urban District Council's request for Thurmaston North and South to be included in the forthcoming Leicester Electric Tramways and Gas Bill will be placed before a committee of the Corporation shortly. A small deputation has been appointed to confer with the County Council on the proposed light railways scheme.

Bradford.—The new Idle and Thackley lines of the Corporation electric tramways will be inspected on behalf of the Board of Trade on the 10th inst., and will immediately after be thrown open to traffic. The Tramways Committee of the Corporation on Monday decided to order 100 additional cars, making the total in stock and on order 250.

Ayr.—Messrs. Hurst, Nelson, and Co. have delivered their first car for the Corporation tramways. The car is of the single-truck double-decked type with improved reversed staircases. The truck is built up of pressed steel frames on an entirely new principle, and known as the "Hurst-Nelson" patent tramway truck. The Ayr cars are the first cars to be fitted with this new form of truck.

Staffordshire.—The inauguration of an extensive scheme of electric tramways in South Staffordshire, Worcestershire, and the Kinver district took place on Saturday. The British Electric Traction Company have now in the Black Country and adjacent districts upwards of 60 miles of tramways, the cost of which has been £1,500,000. At the Edge View Hotel, Kinver, the party were entertained at dinner.

Worsley.—One of the routes proposed to be covered by the South Lancashire Electric Tramways Company—viz., the one from Astley and Boothstown to Worsley—will run alongside Lord Ellesmere's grounds at Worsley Hall, and within 100 yards of the hall itself, forming a junction with the Walkden tramway system opposite the main entrance to the grounds. With a view of avoiding the tramway a new drive is about to be made.

Doncaster.—The Rural Council on Tuesday received a letter from Mr. Schoolbred explaining and asking the Council to support the proposed tram from Barnsley to Doncaster. It was decided generally to favour the scheme, but to leave the Council open to object to details. It was resolved to ask the Doncaster Corporation to lay the proposed tramway on the Bentley-road along one side of the road, as recommended by the Bentley Parish Council.

The "Underground."—The officials of the District Railway appeared before the Board of Trade and announced that they were ready to submit their plans for the electrification of the underground lines. The Metropolitan Company, however, who were also represented, were unable to place their plans before the Board, and insisted upon the benefit of the customary 30 days (expiring on Sept. 9) which are always allowed before any plans are submitted to that body for arbitration.

Warrington.—The Town Council having been advised by Messrs. Preece and Cardew to agree with the contractors for the construction of tramway No. 10 on the scheduled rates and prices of existing contracts, have resolved to enter into contracts with Mr. Ewart and Messrs. Blackwell and Co., Limited, accordingly. Estimates and report on the construction of the tramways between Scotland-road and Winwick-street, Winwick-street to Longford Bridge, and Buttermarket-street to Manchester-road are being prepared.

Aberdeen.—It appears that the tramway department contributes £50 per annum towards the salary of the electrical engineer. It is now proposed that in future all the work required for the maintenance of the tramway plant, including overhead equipment, etc., should be undertaken by the tramway department, and that the electrical engineer should be relieved of all responsibility for this work, but that when new work was being done the electrical engineer and his staff should be available, if required, at the remuneration of 2½ per cent. on the capital outlay.

Leyton.—The Urban District Council intend to call a meeting for the purpose of passing a resolution to buy up the Leytonstone tramlines from the North Metropolitan Tramway Company, subject to the approval of the Board of Trade. Only recently the East Ham Council started their own tramways, and have already made a handsome profit, and it is expected that the Leyton and Leytonstone lines will be an equal source of profit to the Leyton Council. Meantime the West Ham Borough Council and the Ilford District Council are pushing forward as rapidly as possible their electric tramway systems, so that when completed there will be a network of electric trams in eastern suburban London covering more than 30 miles.

Halifax.—The Tramways Committee, with a view to preventing crowding and disorder, have given instructions to the tram conductors to carry out the queue system amongst passengers waiting for cars. The London United Tramways might copy this with advantage to themselves as well as to the relief of their passengers. The Tramways

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Committee do not at present intend to continue the tramway beyond the end of Crown-street, Hebden Bridge. A petition asking for a tramway service between Halifax, *vid* King Cross, towards Sowerby Bridge and the Ryburn Valley, has been referred to the Traffic Sub-Committee. The tramway traffic between Halifax and Bradford is increasing so enormously that a 15 minutes' service between Halifax and Queensbury will be inaugurated.

Stockport.—The first section of the tramways has been opened. The service of cars on this route provides an admirable means of communication between Mersey-square, a central point in the borough, and Woodley, which is an outlying district governed by the Bredbury Council. The overhead trolley system has been adopted, and 20 cars, of the type used by the Liverpool Corporation, have been ordered, costing £700 each. Six of these are now in use. They are each capable of seating 56 persons—viz., 35 outside and 21 inside. The fact that no less than three brakes are fitted—an electric, a mechanical, and an air brake—makes the risk of a collision with other vehicles very small. The car-shed, capable of holding 34 cars, is situated adjacent to the new fire station in course of erection in Mersey-square.

Shields.—The promoters of the defunct Shields Bridge Bill propose to promote in the ensuing session of Parliament a project to construct a tunnel under the Tyne between North and South Shields for an electric tram service. Access to the platforms, which will be sunk at a depth of 25ft. on each side, will be obtained by lifts. There will be an easy gradient from the river, and the journey between the extreme points will be acomplished in 2½ minutes. The generating station for the supply of the electric current will be erected at South Shields. The proposed tunnel will not only link the tramway service of the two boroughs, but will practically connect the railways of the two counties. No opposition is expected from either of the two corporate authorities, but the Tyne Commissioners will probably take another view of the matter.

Middlesex Light Railways.—The Board of Trade have informed the Middlesex County Council that they have decided that the objections raised by the Finchley District Council to the confirmation of the order enabling the County Council to construct a light railway from Upper Holloway to Whetstone cannot be sustained. The points raised were that the Light Railway Commissioners refused to hear the Finchley District Council's application to run lines on the same road at the time the County Council's scheme was before them. There are now only the details of the schemes as passed by the Commissioners to be dealt with, and there is no doubt that the order will be confirmed, and the County Council, who have now engaged a special staff to carry out the construction of the lines, will immediately commence the work of laying the 12 miles which form the first part of the scheme.

Nottingham.—The Chairman of the Tramways Committee, in moving the adoption of the annual report in the Council meeting, said that the Sherwood line, since the opening of the electric system on Jan. 1, had brought in £15,396, against the horse cars for the past year of £4,258, a difference of £11,138. They carried last year 616,000 passengers, and this year 3,063,000, an increase of 2½ millions. The Sherwood line was carrying an average of about one and a half as many as the whole of the horse trams last year. In the five weeks the Bulwell cars had been running, £4,554 had been earned, as against £1,556 from the horse cars, an increase of £2,998. The passengers had increased from 247,000 to 815,000. When they opened the Trent Bridge line they would have no horse cars, with the exception of the Forest-road route. The Tramways Committee's report, providing for a comprehensive extension of the electric tramways in the city and instructing the town clerk to take the necessary steps to obtain the parliamentary powers required, has been adopted by the City Council.

Devonport.—The *Western Morning News* says that residents in the borough of Devonport, and especially those living at St. Budeaux, will be interested to learn that there is a prospect of the electric tramway service being extended in the near future. The Corporation have already acquired parliamentary powers to construct lines from the present terminus at Milehouse to Ham-lane, a short distance beyond Pounds; from the Albert-road end of Exmouth-road to Trafalgar-place in Tavistock-road; and from the present terminus at Camel's Head to St. Budeaux railway station. Negotiations are now in progress with the view of leasing these lines to the Devonport and District Tramways Company, whose system has proved such a great boon since it was inaugurated two or three months ago. So far as the St. Budeaux section is concerned, the negotiations have for their object not only the construction of the line to the railway station, but the acquiring of powers to continue the line to Saltash-passage. Assuming that these negotiations terminate satisfactorily, it is hoped that the line to St. Budeaux will be completed by the end of this year.

Sheffield.—Twenty-five new double-deck cars are now being delivered. The new shed, which has been built under the supervision of the city surveyor, at Queen's-road is a very large one, and affords space for 84 cars on six parallel roads. It is 374ft. long, 76ft. broad, and 21ft. high to the underside of the glazed roof, the height to the point of the roof being about 30ft. The total cost has been about £18,000. The building is now completed, and all that remains to be done is the laying of lines to it from Queen's-road. As there are half-a-dozen roads into the depôt, the construction of junctions and other work connected with the lines is not of the simplest. However, the Corporation workmen are now busy extending the lines down Queen's-road (thus making a section which will eventually become part of the tramway system), and in a few weeks more the junctions will be put in. Provision has been made for the enlargement of the shed to double the present width. The site on which the extension will be erected is now occupied by a temporary shed, affording accommodation for 48 cars, and it is not proposed to pull this down until there is a demand for additional room. At present the committee have about 155 cars, including those now being delivered, and the three sheds at Tinsley and Queen's-road provide storage accommodation for 224.

LIGHTING AND GENERAL.

St. Annes.—Arrangements have been made with Messrs. Smith and Co. for wiring.

Ilford.—Both Ilford and Seven Kings railway stations are being wired for the electric light.

Llandudno.—Sanction has been obtained to the borrowing of £1,027 for a new feeder cable.

Spennymoor.—The buildings of the Northern Counties Electricity Supply Company have been commenced.

Commercial Cable Co.—The directors have declared a quarterly dividend of 1¾ per cent. on the capital stock.

Stockton.—The opposition to the Cleveland and Durham Electric Power Bill has cost the Corporation £1,248. 0s. 9d.

Share Market.—The prices of electric shares and traction shares have remained practically unaltered during the week.

Accrington.—Enquiries are being made with a view to establishing municipal telephones for Accrington and Blackburn district.

Amblecote.—The work in connection with the electric lighting scheme for Brettell-lane will be commenced in a very short time.

Penzance.—The Town Council have asked Mr. W. H. Trentham to report on the best means of giving effect to the electric lighting order.

Hove Electric Lighting Co.—The directors have declared an interim dividend at the rate of 7 per cent. per annum, payable on Oct. 15 next.

Ilkeston.—The Town Council have concluded arrangements for the loan of a sum not exceeding £50,000 for the tramways and electric undertakings.

Nairn.—The Town Council have decided to ask Bailie Mackenzie, of Edinburgh, to advise them as to the desirableness of obtaining an electric lighting provisional order.

Tunbridge Wells.—The Council have refused Mr. Boot permission to act as consulting engineer for Camberwell or any other borough while the paid official of Tunbridge Wells.

Felling.—The Urban District Council will on 12th inst. consider the terms and conditions offered by electrical companies for the electric lighting of the district and for additional tramways.

Catalogue.—Messrs. Robert W. Blackwell and Co., of 59, City-road, London, E.C., have issued a new catalogue descriptive of "laminated edgewise" circuit breakers up to 12,000 amperes capacity.

Dover.—The electric travelling gangway between the mail steamers and the shore was started on Wednesday last week with most successful results. The transhipment occupied less than half the ordinary time.

General Electric Co.—We have received an illustrated souvenir containing a description of the exhibits of the General Electric Company (1900), Limited, at the Glasgow International Exhibition, 1901.

Clitheroe.—The Guardians are considering a letter from the North Lancashire branch of the National Telephone Company stating the terms on which they would make various connections with the workhouse.

Nottingham.—A proposal to take into consideration the possibility or the desirability of establishing a municipal telephone service in Nottingham will be laid before the General Purposes Committee at their next meeting.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to New General Traction Company's £200,000 5 per cent. mortgage debentures of £100 each.

Hastings.—A great improvement has been effected in the lighting arrangements of the Old Town by substituting electricity in High-street and George-street for the gas lamps. Gas was introduced into this town for the first time in 1828.

British Thomson-Houston Co., Limited.—We have received Pamphlets Nos. 106, 107, and 108 descriptive of rotary converters for railway and tramway systems, slow and moderate speed motors, type C E, and small direct-current motors, type C A.

Blyth.—A commencement has been made by the Northern Counties Electricity Supply Company with the cable-laying, and the supply is expected to be ready early in October. The gas company have notified a reduction of 20 per cent. in the price of gas from Oct. 1.

Telephones on Rifle Ranges.—It has been decided that telephone instruments on Government rifle ranges at home shall in future be supplied by the War Department, instead of by the Post Office, but the latter will continue to provide and maintain the conductors.

Keighley.—There were now about 40 consumers of light, and there are also three motors at work. The number of consumers is slowly increasing, and the Council are looking forward to a considerable demand for motors as soon as their advantages are better known.

Military Telephones.—The *Daily Telegraph* says that the military authorities have under consideration the provision and training of a proportion of non-commissioned officers and men as telephone operators, for duty in fortresses and defended ports on a mobilisation for home defence.

Horsham.—Mr. W. G. Proctor, chief engineer at the Nuneaton electric lighting works, has been appointed engineering clerk of the works in connection with the electric light. Mr. A. Selwyn Horton, clerk of works at the electric light works, reports that everything is going on satisfactorily.

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Worksop.—The lighting of the main streets by electricity, and the supply of generating power to the 70 consumers who have already signified their intention of using the light, will be commenced on the 17th inst., when Mr. Crowther, the electrical engineer, anticipates that everything will be ready.

Newburn.—At the meeting of the Council on Tuesday it was proposed that the Council consent to the Newcastle and District Electric Lighting Company's application for a provisional order to supply electrical current to the district, subject to certain details being supplied, but an amendment adjourning consideration for one month was carried.

Haslingden.—The Board of Trade have allowed the Town Council another 12 months in reference to the Haslingden electric lighting order. If, however, at the expiration of that period the undertakers are unable to assure the Board that they were going on with a scheme, the Board stated that they would not feel justified in allowing the order to remain in force.

Nelson.—A reduction has been made in the charges for electricity, the prices ranging from 4½d. per unit for 1,000 units consumed for lighting purposes per annum to 3d. for over 10,000, the charge for motive power being 2½d. Application is to be made for the borrowing of £8,700 in respect of the reconstruction and equipment of the tramways in the borough.

Crieff.—At a committee meeting of the Town Council last week the convener of the Lighting Committee intimated that a provisional order had now been obtained for lighting the town with electric light. After some discussion, further consideration of the matter was delayed to see whether or not it would be better for the Council to advertise for a company to carry out the scheme.

Long Eaton.—Tenders have been accepted by the Urban District Council for the whole of the works of electric lighting installation, etc., it having been also decided to apply for sanction to borrow £15,000 for the purpose. All negotiations with respect to the purchase of the undertaking are at an end, the Council dealing with the electric lighting scheme instead of further discussing the matter.

Kingston (Surrey).—The proposal to instal an electric lift at the new infirmaries has been adopted, with the exception that no new engine should be put down, but that the power be obtained for driving the dynamo by extending the present shafting in the engine-room and providing pulleys and belting for the purpose, the shafting to be continued through the wall of the store adjoining for working the drilling machine to be fixed hereafter.

Kilmarnock.—The Town Council on Wednesday last week considered a report as to a scheme for electric lighting. The committee recommended the acceptance of offers amounting to £29,000 for erecting and fitting-up an electric station at Riccarton. By 12 to 10 votes it was agreed to delay the matter till the engineer had furnished a written report of his reasons for recommending the acceptance of offers by certain firms.

Houghton Regis.—The Dunstable Town Council propose to apply to the Board of Trade for a provisional order authorising them to supply electrical energy for all purposes to the borough of Dunstable, and the parishes of Houghton Regis, Totternhoe, Kensworth, and Caddington. The Houghton Regis Parish Council have decided to oppose the application unless the Town Council scheduled Houghton in the area in which they intend to carry out the scheme.

Liverpool.—A recommendation that the sum of £300,000 (sanctioned by the Local Government Board) be placed at the disposal of the Electric Power and Lighting Committee for purposes connected with the supply of electrical energy was carried on Wednesday's meeting of the City Council; also the proceedings of the Tramways Committee, which contained a recommendation that a sum of £319,000 be placed at the disposal of the committee for tramway purposes.

Leeds.—The expediency of establishing a municipal system of public telephones was on Wednesday discussed at a meeting of the City Corporation, and the appointment of a committee to visit other towns on the subject was proposed. An amendment was moved that the question be referred to the Parliamentary Committee. Twenty-one votes were given on each side. The Lord Mayor said he had not sufficiently considered the question to feel justified in giving a casting vote, so they would remain as they were.

Colchester.—The borough electrical engineer has submitted the following statistics as to the supply of electricity in July, 1901, as compared with July last year: in 1901—output of electricity, in units, 4,644; number of consumers, 181; and total number of lamps now connected, 11,116; in 1900—2,920, 109, and 6,866 respectively The engineer reported that higher-voltage fittings had been attached to the temporary installations at the temporary municipal offices, and police courts and offices respectively; that each installation had been tested for its capability to take current at a pressure of 210 volts. He found the temporary installation at the municipal offices fairly satisfactory, but that at the police courts and offices faulty, and unfit to take current at the increased pressure. The Local Government Board have extended the time for repayment of £3,900 (for purchase of land and buildings) from 25 to 40 years. This means a saving of about £50 yearly.

Personal.—Mr. W. M. Brigg and Mr. J. B. Atherton have resigned their positions as directors of the British Insulated Wire Company, Limited. Mr. Atherton, at the unanimous request of the Board, has agreed to remain the general manager of the company. Mr. Arthur Rothwell, chief assistant engineer to the Radcliffe District Council, has been appointed district engineer of public works in Ceylon. During the 8½ years which Mr. Rothwell has been in the service of the Radcliffe Local Board and District Council many important undertakings were carried out by the Council. Mr. Rothwell is a member of the Manchester Society of Junior Electrical Engineers, and last year read a paper to the members on "Destructors and their Application to Electric Power Stations." Mr. Fred. Bathurst, of 6, Londoun-road, N.W., who has recently returned from an extended holiday in the U.S.A., asks us to state that he is severing his connection with the Conduit and Insulation Company, Limited.

Battersea Polytechnic.—From the syllabus of this institution, just issued, we note that the successes in day and evening classes for the session 1899-1900 included a Whitworth exhibition; three intermediate county scholarships; 26 evening County Council exhibitions and scholarships; 37 medals and prizes, and three domestic economy training school scholarships. The total value of scholarships, exhibitions, and prizes was £1,222. The next session commences on the 23rd inst, and the variety and number of day and evening classes is so large that we must refer our readers for details to the pamphlet, which is obtainable at the price of 1d. In the department of physics and electrical engineering the head of department is Mr. A. G. Cooke, M.A. (Cantab), A.M.I.E.E.; and the assistant lecturers and demonstrators are Messrs. R. S. Willows, D.Sc. (Lond.), B.A. (Cantab), F. H. Parker, B.Sc., and H. G. Wayling, B.Sc. (Dunelm). The courses comprise physics for London University examinations at very moderate fees, and there are special Saturday morning classes in advanced physics. The electrical engineering section comprises lectures and laboratory work for the preliminary or elementary grade, ordinary or advanced grade, and electrical engineering (honours). There are also Saturday morning classes in elementary electrical engineering. As far as is consistent with the ordinary work of the polytechnic, students can be admitted to the laboratories for the purpose of carrying out research or other special work. The trade classes on electric wiring and house fitting are conducted by Mr. Ivan F. Fawcett, and are divided into an elementary and an advanced course. There are also day classes (opening Sept. 16) for general elementary and advanced physics (the latter including electricity and magnetism). Students attending the classes may enter for the day examinations of the Science and Art Department of the Board of Education, which takes place in June. A large number of athletic and social clubs are formed in connection with the institution.

The Manchester Tenders.—We are indebted to the *Manchester Guardian* for a report of the remarks made by the chairman of the Electricity Committee, Dr. Bishop, who said he presumed most interest centred in the paragraph which related to the proceedings of the Stuart Works Sub-Committee, which had been approved by the committee, and which included the acceptance of a tender for switchboards required at the Stuart station and the several sub-stations in connection therewith. The letting of that contract had given rise to a great deal of discussion in the Press and elsewhere. He had nothing to say against the tone of that discussion, and he had no hesitation in supplying the information with regard to the matter which the public desired. He wished to state the reasons why the committee did not see their way to place the contract with firms at home Some persons were under the impression that the tender was not sufficiently advertised for. He assured the Council that it was, and that the advertisement appeared in some of the best papers in the country. It was also quite incorrect to assume that the committee invited any particular firm to tender for the work. They did nothing of the sort. They made their requirements as public as they possibly could, and left firms to send in their tenders if they desired to do so. Twenty-seven firms were supplied with specifications, but when they came in the committee discovered that seven of the number could not see their way to quote for any part of the work. That left 20 firms. The lowest tender was that of the Electrical Company, of Berlin, which amounted to £39,306, and which the committee had accepted. The next tender was that of the British Westinghouse Company, which amounted to £42,551. The difference was only small, but had it been accepted the work would have been done in America. The third tender was that of Siemens Bros., Limited, for £50,004, but in that case the work would have been done in Berlin. The lowest English tender was between £19,000 and £20,000 higher than the tender the committee had accepted. Only two were tenders in which, if the committee had accepted them, the work would have been done in this country. He maintained that it was quite impossible, under the circumstances, for the committee to have considered either of those two firms. It had been suggested that if the switchboards were made abroad there was no reason why the intruments could not be made in this country. He agreed, and, as a matter of fact, the instruments were being made in this country, and a considerable proportion of the money would not go abroad. So far as was possible, the committee had endeavoured to get work done in this country. Prof. Kennedy, who was the adviser of the committee, had advised that the tender of the Electrical Company should be accepted, and in his letter to that effect he said he regretted very much that the lowest tender from any British maker was very high up in the list, and he could not advise that there would be any justification in this case for passing over the lowest tender, which was for work at least as good as those at higher prices. Since the tender had been placed a circumstance had come to his knowledge which was of some interest. He had had the opportunity of looking at a letter from a well-known electrical engineer—a member of one of the oldest firms in England. He stated that the prices of his tender for the work had been made out while he was away from home. Since he returned he had personally revised the prices, and he was surprised to find that had he himself been drawing up the tender he would have been enabled to do the work for £35,000. He followed that up by saying that he had determined upon a thorough reorganisation of his switchboard staff. The company that had obtained the order could point to very large stations in various parts of the Continent where switchboards erected by them were working satisfactorily. The report was accepted, also a proposal to advance the price of current to all consumers ½d. per unit.

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South Africa.—A number of telegraph employés have been specially enlisted for service in South Africa, and are being prepared at Aldershot. They will eventually join the Royal Engineer Telegraph Battalion in the Transvaal. It is intended to augment their numbers by a draft from the School of Military Engineering at Chatham.

Newark.—The Derbyshire and Nottinghamshire Power Company has been given two months in which to reply when they could supply electricity in bulk. An application by Messrs. Harrison and Co., electricians, for permission to carry wires for telephone and electric light over certain streets is before the Electric Lighting Committee.

Worthing.—The report of the Electric Lighting Committee adopted on Tuesday stated that the engineer had reported that the whole of the works were proceeding satisfactorily, and that he expected to be in a position to test the machinery at once. Mr. A. C. Seaton was appointed, subject to the sanction of the Council, to the office of assistant engineer. The estimated cost of proposed extensions in Mill-road and Tennyson-road is £1,691, and application is to be made for sanction to borrow this amount, which includes £150 for street-lighting.

Electrical Co.—The last balance-sheet of the Electrical Company, Limited, of 122-124, Charing Cross-road, London, W.C., for the year 1901 has been passed at their annual general meeting. A dividend of 15 per cent. was declared, and a substantial amount has been added to the reserve fund, etc. The enormous business the Electrical Company are carrying on, and the establishing of further branches, as well as the enormous contracts in hand—we only mention one, the complete equipment of the central station for the Manchester Corporation—have made it necessary to increase the capital of the company to £100,000, which has unanimously been passed.

The Royal Tour.—According to Reuter's Montreal correspondent, plans for an electric display on Mount Royal during the Royal visit have been completed, and when carried out will surpass anything of the kind hitherto seen in America, the commanding position of the mountain affording an excellent opportunity for such a display. Both the Protestant and the Catholic School Commissioners are arranging stands on which some 20,000 children can congregate and sing patriotic songs while the Royal party pass on their way from the railway station to their temporary residence. The decorations for the route to be taken by the procession are already well under way.

St. Pancras.—At the Council meeting on Wednesday it was proposed that it be an instruction to the Parliamentary and General Purposes Committee to insert a clause in the Council's Bill to be promoted in Parliament for compulsory powers to acquire a site or sites for generating stations for electric lighting purposes, to provide that improvements in the lands or premises, referred to in the committee's report, after Sept. 4, 1901, when the schemes of the Borough Council were made public, shall not be taken into account in assessing compensation if such improvements be made with a view to obtaining or increasing the compensation payable by the Borough Council.

Inverness.—At a meeting of the Town Council on Tuesday a report on the electric lighting of the town was submitted by Mr. Jas. Fraser, C.E., Inverness. A scheme to have steam power fell through last year. Mr. Fraser recommended a water-power scheme, with the Caledonian Canal as the source of supply, at a point immediately above the Muirton Wharf, where the Glasgow steamers are berthed. There is here a head of 40ft. It is proposed to establish 600 h.p., with a tail race to the River Ness, through mostly agricultural land, and the cost, exclusive of electric plant, is estimated at about £15,000. The engineer states that little or no current will be caused on the canal by drawing off the water, not more, at any rate, than a mile in 11 hours. An expert electric engineer is to be consulted before the Council considers and decides upon the scheme.

Rotherham.—The Town Council have allowed the National Telephone Company to lay a pipe along Warwick-street up to Godstone-road, along Godstone-road and Tooker-road, instead of by way of Warwick-street and Gerard-road. The town clerk has been instructed to call the attention of the National Telephone Company to the insufficiency of telephone facilities between Rotherham and Sheffield, and to the immediate necessity for trunk lines from Sheffield being provided. The engineer's last report states that electric light applicants had risen to 103 in number, representing 7,520 8-c.p. lamps. Seventy-seven consumers were coupled up to date, the equivalent consumption being 5,224 8-c.p. lamps. The present capacity of the plant is 6,600 8-c-p. lamps. The committee have therefore taken steps to get a new engine and dynamo and to extend the switchboard.

International Telephones.—The Italian Government has just sanctioned the construction of two important trunk lines of telephone which will bring Europe a long step nearer to the goal of a Continental system of international telephones. One of these lines goes from Rome through Bologna, Florence, and Turin to Mont Cenis, where it is to be connected with the French line from Paris, by which means Rome will also gain communication with Brussels. The second new line branches off at Milan for Chiasso, where it joins the Swiss system, with which Vienna is already connected, and Berlin shortly will be. The four principal capitals of the Continent, with their chief provincial cities, will thus shortly be within "speaking distance" of each other, and as England is already connected with Paris the Continental network approaches completion. The next step will be find a common international exchange.

Sunderland.—The Electric Lighting Committee intend to ask the Council to instruct the Finance Committee to apply for sanction to borrow £30,000, partly for the new station in Hylton-road, and partly for the existing station in Dunning-street. The scheme includes £7,673 for the extension of mains, and over £12,000 for future extensions. The question of a reserve fund has been considered, and it is found that there ought to be a reserve of £5,000, whereas the committee have only set aside up to now £1,257, which with an estimated credit balance on the current half-year of £1,034, made a total of £2,291. In face of these facts, the committee have resolved that it was undesirable to give any of the profit towards the reduction of the ensuing rate. In the first two years of the undertaking the committee had to draw £1,849 from the rates, yet, as a business concern, they have paid in rates £1,631, and set aside as a sinking fund £8,870.

Glasgow Exhibition.—The *Glasgow Herald* says the exhibition buildings and art galleries were seen under electric light illumination at a late hour on Monday. The scheme, which is a most comprehensive one, 50,000 lamps being used, has been carried out by Claude Hamilton, Limited, electricians, Glasgow, and should strike visitors as being the most brilliant illumination ever seen in the country. The whole of the industrial hall is outlined with clear electric lamps, hanging in festoons, while the arcade of arches, which forms so striking a feature of the design of the building, are fringed with red lights. Green is also effectively used, notably over the grand entrance. The dome, the main towers, and the peristyle have been artistically treated, and the scheme at the art galleries is also of a very brilliant description. The large lamps in the grounds were extinguished, and the effect of the illumination, even at a mometary glance, was magnificent. The installation has cost £3,500.

Stoke Newington.—The Electric Lighting and Sites Committee reported to the Council on Tuesday that they had caused to be made a house-to-house canvass of the west side of Stoke Newington-road, High-street, and Stamford-hill from Castle-street to Manor-road, and had obtained satisfactory guarantees that there would be a sufficient consumption of electric light to warrant the expenditure of laying the mains and making connections for private purposes, and that the estimated additional expense of lighting the roads mentioned with 18 electric arc lamps would be £350 per annum; and the committee recommended that the work be undertaken. The committee concur with the Islington Council with regard to the proposed legislation to empower local authorities to wire and fit premises for persons desirous of using electric light, and to authorise local authorities to obtain from the London County Council loans for the purpose. The Hackney Borough Council have agreed to supply electrical energy in bulk to the Stoke Newington Council for private and public purposes.

Telegraph across Africa.—The Berlin correspondent of the *Standard* says the project of a telegraphic connection between the West and the East through Africa is now being discussed from the point of view of emancipation from the English telegraph monopoly in Africa. The *Allgemeine Marine Correspondenz* recommends an easy and cheap plan. This scheme is to form a competitive line, partly by using the French and partly the Belgian telegraphs and cables. Speaking of this plan the German paper says: "The inland telegraph in East Africa extends already as far as Mpwa Mpwa, the first division as far as to the junction with the Cape-Cairo telegraph, this latter being under German control. The Congo State has finished its telegraph as far as Stanley Falls. It would, therefore, be necessary to construct a line between Mpwa Mpwa and Stanley Falls, perhaps a not very costly undertaking. The telegraph then joins the French lines, *viâ* Brazzaville, Loango, Libreville, Dahomey, St. Louis, Teneriffe, and Cadiz. We hear that the French intend to lay a direct cable between Dakar, Teneriffe, and Bayonne or Bordeaux, thus avoiding Spain. In order to connect the Cameroons with this line a cable has only to be laid between Victoria and Libreville or Cotono. The execution of this plan would, without too great expense, secure the independence of the German telegraphic connection with South Africa, our colonies in East Africa, and the Cameroons. A case like the closing of both the English and French lines to Germany would only be possible if France and England united, but this is, at least for the present, not at all probable."

Road.—An interesting illustration of the manner in which the force contained in our rivers and streams can be turned to account for domestic and other purposes is to be found in the pretty little Somerset village of Road, where a complete electric light installation and pumping station has just been completed for supplying light and water to Mr. R. P. H. Batten Pooll's residence at Road Manor. The *Wiltshire Chronicle* says the plant is housed in two commodious rooms situated in what was formerly a disused portion of the flour mill at Road Bridge, but which has now been completely remodified on plans and specifications prepared by Mr. W. H. Stanley, the architect, of Trowbridge, the structural alterations being carried out by Messrs. Moore, builders, of Trowbridge. The motive power is supplied by a 126-h.p. turbine, and on the same floor are situated a set of three-throw pumps, all of which were supplied by Messrs. Gilbert Gilkes and Co., of Kendal, Westmoreland. The pumps are capable of raising 5,000 gallons of water per hour. On the second floor there is a Parker dynamo of 45 amperes and giving 150 volts at a speed of 770 revolutions per minute. This is connected by a concentric cable running underground through the park for a distance of about 700 yards from the battery room at the manor to a storage battery of the D.P. type. First-class telephonic connection is maintained between the manor and the station, and this is to be extended to the house of the working engineer, Mr. Prescott, who will shortly take entire charge of the machinery. The electrical fittings were supplied by Messrs. Edmundsons, of Westminster, and were put in under the direction of Mr. H. J. Read (of the firm), Mr. E. Brodrick being the working foreman. At present the dynamo supplies 150 lamps at the manor—namely, 100 of 8 c.p. and 50 of 16 c.p. Considerable interest has been taken by the villagers in the progress of the work.

Aberdeen.—Applications for extensions of mains in Ferryhill from the new station have been agreed to, also an extension of the electric main from Rose-street to Skene-street. The electrical engineer, in a report submitted to the Town Council on Monday, points out that for every unit sold during the year July, 1899, to July, 1900, coal cost ·69d., while this year the corresponding figure is ·94d. During the past 12 months 176 new consumers were connected, making the total number 778. Sixty-nine public and 31 private arc lamps have been added, making a gross total of 145 public and 271 private lamps. Thirty-three new consumers have taken advantage of the hiring out

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of motors by the Town Council, making the number now out on hire 60. The motors connected during the year—private and hired out—number 66, of an aggregate horse-power of 286, bringing the total number up to 126, representing 485 h.p. The motor consumption for last year was 42,326 Board of Trade units, and this year 67,244. Electrical heating has also increased this year by the equivalent of 413 33-watt lamps out of a total of 552 33-watt lamps coupled. The total number of consumers connected on July 31, 1901, for lighting, motors, etc., represented the equivalent of 79,663 33-watt lamps. During the year an additional 1·8 miles of frontage for supply has been laid down. In the west end there are now 84 consumers, and the revenue this year is £725. Good progress is reported to have been made with the new generating station. The Crown-street subway has cable drawn in up to Affleck-street. The electrical engineer recommended that the charges for private supply of electricity remain as before; but that for the street-lighting department the charges be reduced to 6d. per Board of Trade unit for the first hour of maximum demand, and 2d. for all subsequent supply, and for the harbour arc lamps a charge for the work connected with these lamps is to be made at the rate of £5 per lamp.

Cheltenham.—Mr. Kilgour, the electrical engineer, reported to the last meeting of the Town Council that all work, both of extensions and ordinary running, had progressed satisfactorily during the past month. The traction plant had been set to work, and had run exceedingly well under somewhat trying conditions, which are being gradually mitigated. Applications had been received for electric supply to three houses in Eldorado-road, to Waldon House in Lansdown-road, to two houses in College-road, and Mr. Holder had written pressing for supply to his house in Libertus-road. The Eldorado-road extension would cost £105, and necessitate carrying out an already authorised extension in Queen's-road of the value of £330, the Queen's-road extension would carry them within 80 yards of the Midland Hotel, which had applied for supply to the equivalent of 49 8-c.p. lamps, and the necessary extension to supply that hotel and Mr. Holder would cost £450. A complete extension to supply the whole of the west side of Gloucester-road from Queen's-road to the Lansdown Castle would cost £800. The Lansdown-road extension would cost £75. The College-road extension had been already authorised, but the present demand was for supply to 36 8-c.p. lamps only. He recommended that the necessary extensions for giving supply to Eldorado-road and Lansdown-road be authorised, that the inclusion of the complete Gloucester-road extension in the next application to the Local Government Board be also authorised, and that the carrying out of both the Gloucester-road and College-road extensions be deferred for the present. He had estimated the cost of lighting Montpellier-street from St. George's road to Queen's-parade by arcs, and found that seven lamps would be required, at an average distance of about 70 to 75 yards apart, the cost being £560. About £225 had been already authorised for the lighting of the street by incandescence lamps of 32 c.p., and if it was decided to substitute arc lighting, the extra cost would therefore be £335, this amount to be included in the next loan. It was resolved that the arc lighting be substituted for the proposed incandescent lighting in Montpellier-street, and that the recommendations of the engineer be approved and adopted.

BELFAST ELECTRICITY ACCOUNTS.

The accounts of the Belfast electricity works for the year ended March 31, 1901, state that the total expenditure on capital account was £173,889. Abstracts of the revenue account, general balance-sheet, statement of electricity generated, sold, etc., are appended:

REVENUE ACCOUNT.

Dr.				£	s.	d
Public Lamps.						
Attending, repairs, and renewals				26	3	1
Generation of Electricity.						
Coal	£2,856	10	7			
Oil, waste, water, and stores	266	12	6			
Salaries and wages	1,078	15	5			
Repairs and maintenance	534	4	7			
				4,736	3	1
Distribution of Electricity.						
Wages and repairs and renewals of mains				331	6	9
Rents, rates, and taxes				728	3	9
Management Expenses.						
Salaries—engineer's department	589	12	9			
Meter inspection	86	6	3			
Stationery and printing	126	2	11			
General establishment charges	265	18	11			
				1,068	0	10
Insurance				163	16	0
Miscellaneous (stamp duty, etc.)				79	11	5
				7,133	4	11
Amount carried to net revenue account				7,764	19	2
				£14,898	4	1
Cr.				£	s.	d.
Sale of current				14,226	2	5
Meter rents				642	2	2
Testing fees				9	19	6
Improver's fee				20	0	0
				£14,898	4	1

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Redeemable stock	139,610	0	0
Amount advanced by Gas Committee	32,500	0	0
	172,110	0	0
Sundry creditors	1,373	1	11
Suspense account	1,391	8	10
2¾ per cent. stock redeemed	250	0	0
Amount in hand	3,131	18	9
	£178,256	9	6
Assets.	£	s.	d.
Expenditure—capital account	170,755	15	5
Stocks on hand	249	2	10
Sundry debtors	6,092	13	8
Renewals suspense account—amount at debit	78	15	0
Balance in treasurer's hands	1,080	2	7
	£178,256	9	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units	1,091,895
Quantity sold (public lamps, 10,211)	908,067
Quantity used on works	51,195
Quantity lost in battery	42,677
Total quantity accounted for	1,001,939
Quantity not accounted for	89,956
Maximum supply demanded (watts)	1,308,000

AYR ELECTRICITY ACCOUNTS.

The accounts of the Ayr electricity works for the year ended May 15, 1901, state that the total expenditure on capital account for the electric lighting works amounted to £56,158, and for the tramways to £8,598. Abstracts of the lighting revenue account, statement of electricity generated, sold, etc., and tramways accounts are appended:

REVENUE ACCOUNT.

Dr.	Expenditure.			£	s.	d.
Generation of Electricity.						
Coal	£1,993	11	2			
Oil, waste, water, and engine-room stores	73	17	3			
Wages at generating stations	638	19	3			
Repairs and maintenance	245	5	0			
Miscellaneous expenditure	4	8	0			
				2,956	0	8
Distribution of Electricity.						
Wages	146	16	8			
Repairs, mains, transformers, etc.	31	0	8			
				177	17	4
Public lamps—attending and repairs				101	12	8
Management.						
Salaries—treasurer, auditor, engineer, &c.	410	5	0			
Stationery and printing	35	13	3			
General establishment charges	24	3	8			
Miscellaneous	28	14	10			
				498	16	9
Rates, taxes, etc.				229	8	4
Repairs to front property				46	4	3
Expenses of renewing mortgages				59	13	2
Special charges—insurances, etc.				88	8	11
Balance to net revenue account				1,432	17	4
				£5,590	19	5
Cr.	Receipts.			£	s.	d
Public lighting				2,065	0	0
Sale of current per meter				3,327	2	6
Miscellaneous				198	16	11
				£5,590	19	5

BALANCE SHEET.

Liabilities.	£	s.	d.
Mortgage debt	53,962	7	8
Sinking fund	4,067	19	6
General cash balance account—due to bank on revenue, £213. 12s. 6d.; capital, £195. 15s. 4d.	409	7	10
	£58,439	15	0
Assets.	£	s.	d.
Capital account	56,158	3	0
Sinking fund—invested on deposit receipt of Bank of Scotland	2,067	19	6
Recoverable accounts outstanding	213	12	6
	£58,439	15	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units		553,615
Quantity sold { Public lamps	319,760	490,496
Quantity sold { Private consumption	170,736	
Quantity used on works		12,000
Total quantity accounted for		502,496
Quantity not accounted for		51,119

Number of public lamps: arc, 85; incandescent, 146. Total maximum supply demanded, 282 kw., including public lamps.

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ABSTRACT OF ACCOUNTS OF THE ELECTRIC TRAMWAYS.

Expenditure.	£	s.	d.
Permanent way	6,271	2	6
Buildings	586	14	6
Machinery and plant	23	9	4
Engineers' fees and miscellaneous charges	373	0	1
Proportion of expenses of new burgh Bill	1,000	0	0
Expenses of loans	343	15	10
	8,598	2	3
Sum on deposit receipt with Bank of Scotland, dated March 8, 1901, £15,000; and balance due by bank at May 15, 1901, £1,414. 4s. 3d	16,414	4	3
	£25,012	6	6

Receipts.	£	s.	d.
Money borrowed during year	25,000	0	0
Interest on deposit receipt for £5,000, dated March 8, 1901	12	6	6
	£25,012	6	6

PROVISIONAL PATENTS, 1901.

AUG. 26.

17066. Improvements in registering and pole-changing mechanism for electric meters and other electrical apparatus. Rankin Kennedy, 65, Albion-street, Leeds.

17070. Improvements in or connected with incandescent electric lamps. Albert Louis Reinmann, 15, Water-street, Liverpool.

17068. Improvements in dynamo-electric machines. Matthew William Wallbank Mackie and Ergerton John Glyn, 122, Golden-lane, London.

AUG. 27.

17132. Improvements in the construction of insulators for electrically separating sections of overhead trolley line and the like. Robert Cornelius Quin, Ambleside, Palatine-road, Blackpool.

17139. Improvements to safety lifeguards for electric trams or other motor-driven vehicles with means for automatically stopping the vehicle on coming in contact with any impediment. Samuel Dean and Alfred Joseph Instone, 68, Belrington-road, New Ferry, Cheshire.

17142. Improvements in incandescent lamp fittings. William Bunting, 1, Balmoral-street, Manchester-road, Hollinwood, Lancs.

17144. Improvements in supporting devices for brush-holders. Arthur O'Neill Fox, 46, Lincoln's-inn-fields, London. (Complete specification.)

17187. Improvements in cells of primary batteries. Alb Lessing, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17192. Improvements in braking apparatus for tramcars and the like. The British Electric Car Company, Limited, Bush-lane House, Cannon-street, London. (James A. Trimble, United States.)

17193. Improvements in electric switches or circuit breakers. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

17194. Improvements in electric arc light electrodes. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Robert H. Read, United States.) (Complete specification.)

AUG. 28.

17215. Improvements in the construction of insulators for supporting overhead trolley lines and the like. Robert Cornelius Quin and Joseph Fitzalan Simpson, Ambleside, Palatine-road, Blackpool.

17216. Improvements in trolley heads for electrically-propelled vehicles. Samuel John Cathrock D'Aintree, 8, Lombard-chambers, Bixteth-street, Liverpool.

17236. Improvements in apparatus for testing insulation of electric cables. Ernest Alexander Claremont, 4, Bloomsbury-square, London.

17249. Improvements in magneto-electric machines. Frederick Richard Simms and Robert Bosch, 4, South-street, Finsbury, London. (Complete specification.)

17256. An improvement in the connecting of electrically-propelled cars. Siemens Bros. and Co., Limited, and Alexander Siemens, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

AUG. 29.

17277. Improvements in or relating to apparatus for quickly referring to the dimensions, weight, cost, electrical capacity, or other suitable data of electric storage batteries and the like. Malcolm Sutherland and Elias Marcuson, 61, Chandos-street, Strand, London.

17282. Improvements in incandescent lamps of the Nernst type. Bernard Mervyn Drake, Gibert Scott Ram, and the Nernst Electric Light, Limited, 18, Southampton-buildings, Chancery-lane, London.

17285. Improvements in electric burglar-proof cases. George Lewis Hogan, Hotel Cecil, Strand, London.

17287. An improved incandescent lamp shade or like carrier. George Birch and Henry Crowther Bowman, 55, Market-street, Manchester.

17320. Improvements in or relating to the electrolytic manufacture of chlorates and perchlorates. Paul Eugène Charles Corbin, 111, Hatton-garden, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 25, 1901, being date of application in France.)

17338. Improvements in telephone systems. Isaac Hardy Parsons, of the firm of Gent and Co., 4, South-street, Finsbury, London.

17342. Improvements in electric telephony. Charles Adams-Randall, 5, Salters' Hall-court, Cannon-street, London.

17343. Improvements in telephonic repeaters and relays and circuits connected therewith and therefor. Charles Adams-Randall, 5, Salters' Hall-court, Cannon-street, London.

17344. Improvements in aerial or wireless telephony. Charles Adams-Randall, 5, Salters' Hall-court, Cannon-street, London.

17345. Improvements in simultaneous electric telegraphy and telephony. Charles Adams-Randall, 5, Salters' Hall-court, Cannon-street, London.

17346. Improvements in electric telegraphy. Charles Adams-Randall, 5, Salters' Hall-court, Cannon-street, London.

17348. Improvements in and relating to plates for secondary batteries. Edward Bennett Viles, 322, High Holborn, London.

17349. Improvements in or relating to electric locomotives operated by accumulator batteries. Otto Böhm and Rudolf Menckhoff, 322, High Holborn, London.

17357. Improvements in or relating to trolley arms for electrical conductors. Sidney Alfred Hunter, 111, Hatton-garden, London.

AUG. 30.

17367. Protective safety appliances for roof passengers of overhead electric cars. John Smith Comrie, 7, Great Winchester-street, London.

17381. Improvements in the electric lighting of railway carriages. Ernest Oscar Mawson and Ardesher Temoolji Mirza, 70, Deansgate, Manchester.

17383. Improved safety devices for guard wires of trolley wires and other conductors. Donald Smeaton Munro, 58, Kelvingrove-street, Glasgow.

17400. A combined brake and apparatus for preventing accidents and loss of life in connection with tramcars, motorcars, railway, and other road vehicles. William Philipson, Thomas Whittle Hopwood Philipson, and Percy Clarkson Philipson, 8, Quality-court, Chancery-lane, London.

17410. Improvements in means for breaking inductive electric circuits. The British Thomson-Houston Company, Limited, and Reginald Charles Clinker, Bush-lane House, Cannon-street, London.

17416. Improvements in connection with electric tramcars. John Timon, 23, Coleman-street, London.

17425. Improvements in circuit breaking apparatus for electrical circuits. The British Westinghouse Electric and Manufacturing Company, Limited, Westinghouse-building, Norfolk-street, Strand, London. (Lewis Buckley Stillwell, United States.)

AUG. 31.

17480. An improvement in aluminium electrolytic cells. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

17482. Improvements in apparatus for electrically lighting railway trains. Arthur Bernard Gill, 77, Chancery-lane, London.

17485. An improved incandescent lamp socket or holder. Joseph Hartig and Peter Glaser, 6, Lord-street, Liverpool.

17489. Improvements in armature windings for dynamo-electric machines. Henry Metcalf Hobart, Bush-lane House, Cannon-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 21.

1900.

9731. Apparatus for use in the electro-deposition of metals. Cowper-Coles.

11808. Party line and telephone systems. Cerebotani and Moradelli.

15680. Electric motor wheels. Sayer.

15870. Apparatus for producing electric waves. Ricaldoni.

15920. Electric furnaces. British Thomson-Houston Company, Limited. (Steinmetz.)

19076. Means for electrically lighting miners' safety and similar lamps. Best.

19486. Electric clocks. Leake.

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19829. Electrical locking apparatus for railway signals. Jelfs.

22330. Alternate-current measuring and indicating instruments. Mordey.

23395. Electrical apparatus for transmitting motion to a distant point. British Thomson-Houston Company, Limited. (Thomson.)

1901.

12954. Electrical secondary or storage batteries or accumulators. Peto. (Gouin.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Aug. 31	848	807	+ 40	—	—
Birmingham Tramways	,, 31	4,625	4,479	+ 146	155,256	— *b*
Birkenhead Corporation	,, 25	746	—	—	—	—
Blackburn Corporation	—	—	—	—	—	— *b*
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 31	1,154	1,520	- 366	12,979	13,125
Bolton Corporation	Sept. 1	1,446	1,373	+ 73	50,792	40,723*b*
Bradford Corporation	,, 1	1,185	568	+ 617	28,772	15,475*b*
Bristol Tramways Company	Aug. 30	3,759	3,455	+ 304	—	—
Carlisle Tramways Company	—	—	—	—	— *b*	—
Central London Railway	,, 31	5,412	—	—	51,027	—
City and South London Railway	Sept. 1	1,952	1,528	+ 424	16,560	13,536
Cork E. T. and L. Company	Aug. 29	527	493	+ 34	16,233	14,195*b*
Darwen Corporation	—	—	—	—	—	—
Dover Corporation	,, 31	307	289	+ 18	7,577	7,123*b*
Dublin & Lucan Electric Railway	Sept. 1	153	109	+ 44	1,341	1,080
Dublin U. T., electric cars	Aug. 30	4,120	4,227	- 107	—	—
Dublin S. District, Electric	,, 30	1,520	1,629	- 109	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 31	13,086	9,269	+ 4,217	—	—
Halifax Corporation*	Sept. 1	2,829	1,655	+ 1,174	26,871	17,569
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 31	1,651	1,307	+ 344	15,776	12,038
Liverpool Corporation	,, 24	10,182	8,625	+ 1,557	301,387	260,506*b*
Liverpool Overhead Railway	Sept. 1	1,670	1,735	- 65	15,754	15,695
Oldham-Ashton-Hyde Tramways	—	—	—	—	—	— *b*
Portsmouth Corporation	Aug. 31	1,132	—	—	—	—
Potteries Tramways	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	Sept. 1	3,685	—	—	—	—
Southampton Corporation	Aug. 29	1,084	753	+ 331	—	—
Southport Corporation	—	—	—	—	— *d*	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. *b* From Jan. 1. *d* From April 1. 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £356 decrease.
Barcelona Ensanche y Gracia, £30 decrease. Barcelona, £329 increase.
Brisbane, £280 increase.
Buenos Ayres and Belgrano Electric, £526 increase.
Calcutta, £134 increase.
Cape Town (month of July), receipts, £13,440; expenditure, £6,832.
Mexico Electric (month of July), receipts, £17,600; expenditure, £10,800.
Perth Electric, £232 increase.
Port Elizabeth (month of June), receipts, £2,983; expenditure, £1,800.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	⅜-¼
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	⅜-½
—— Ordinary, 1-125,000	1	⅜-½
British Electric Works, Ordinary, 50,001-95,000	1	1-16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1	3/16-5 16
—— 4½ per cent. First Mortgage Debentures	108	85-90
British Insulated Wire, Ord., 1-70,000	5	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5	5½-6½
—— 5 per cent. Mortgage Debentures	100	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	4½-5¼
Brush Electrical Engineering, Ordinary	2	1½-1⅝
—— Non. Cum., 6 per cent. Pref.	2	2-2¼ xd
—— 4½ per cent. Debenture Stock	100	102-105 xd
—— 4½ per cent. 2nd Debenture Stock	100	99-102
Callender's Cable, Debentures	100	110-114
—— Ordinary	5	15-16
—— 5 per cent. Pref.	5	5⅛-6¼
Crompton and Co.	3	3⅛-3⅜
—— 5 per cent. Debentures	—	100-105
Edison and Swan United, Ordinary	3	0-¼
—— 5 per cent. Debentures	5	1½-2¼
—— 4 per cent. Deb. Stock, Red.	100	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	—	85-90
Electric Construction, Limited, Nos. 1 to 112,100	2	1½-2
—— 7 per cent. Cumulative Pref.	2	2½-2⅝
—— 4 per cent. Perp. 1st Mort. Deb.	100	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10	9⅜-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	99-102
W. T. Henley's Telegraph Works, Ordinary	5	16½-17½ xd
—— 4½ per cent. Preference	5	5½-6 xd
—— 4½ per cent. Debentures	100	110-114 xd
India Rubber, Gutta Percha, and Telegraph Works	10	21-22
—— 4 per cent. Debentures	100	101-104
Telegraph Construction and Maintenance	12	38-42
—— 5 per cent. Bonds	100	104-106
Telegraph Manufacturing, Ordinary	5	10½-11½
—— 5 per cent. Cum. Pref.	5	5⅜-6¼
Willans and Robinson, Ordinary, 1-30,000	5	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5	6¾-7¼
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	95-100
Bournemouth and Poole, Ordinary	10	12-13
—— 4½ per cent. Cum. Pref.	10	9½-10¼
—— Debenture Stock, Red.	100	101-104
Brompton and Kensington, Ordinary	5	7⅜-8¼
—— 7 per cent. Preference	5	8¼-8⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7¼-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½ xd
—— ,, ,, £10 Ord.	6	10⅜ xd
Charing Cross and Strand	5	9-10
—— 4½ per cent. Cum. Pref.	5	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	103-105
Chelsea Electricity Supply	5	5¼-6
—— 4½ per cent. Debentures	100	107-110
City of London, Ordinary	10	8-9
—— 6 per cent. Cumulative Pref.	10	11½-12½
—— 5 per cent. Debenture Stock	100	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	101-103
County of London and Brush Provincial, Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	103-106
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	5⅜-6¼
—— 6 per cent. Cum. Pref.	5	5¼-6
—— 4½ per cent. First Mort. Deb.	100	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	4½-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5¼-5⅜
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7½-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	11-12
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10½
London Electric, Ordinary	3	1¼-1⅜
—— 6 per cent. Pref.	5	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190	96-100
Metropolitan, Ordinary	10	13-14
—— ,, 85,001-98,769	5	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	111-114
—— 3½ per cent. Mortgage Debenture, Red.	100	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9¼
—— Preference	4	6¼-6⅜
Notting Hill Electric Lighting	10	15-16
Oriental, 1879	1	1¼-1⅜
—— £5 Shares	5	7⅜-8¼
—— £4½ Shares, New	4½	7-7½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5¼-5½
—— 4 per cent. Debenture Stock	100	99-102
River Plate Electric Light and Traction, Deb.	100	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	2-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2-3
St. James's and Pall Mall, Ordinary, 101-20,080	5	15-16
—— 7 per cent. Pref.	5	8¼-9⅛
—— 3½ per cent. Deb.	100	97-100
Westminster, Ordinary	5	12-13
Electric Railways.—		
Central London, Ordinary	100	102-105
—— 4 per cent. Pref.	100	105-108
—— ,, deferred	100	98-101
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	113-118
City and South London, Consolidated Ordinary	100	52-54
—— Ordinary	10	5¼-5⅜
—— 4 per cent. Debenture Stock	100	113-118
—— 5 per cent. Pref. Stock '91	100	129-134
—— ,, ,, ,, '96	100	123-127
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	93-96
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100	124-129
Blackpool and Fleetwood Tramroad	10	14-15 xd
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4½-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	102-104
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	6-6¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9¼-9⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	100-102 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	13½-14¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	11⅜-12⅛
—— 5 per cent. Perpetual Debenture Stock	100	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅜-1¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100	103-106
—— Prov. Cert., all paid	100	97-100
Cape Electric Tramways, Nos. 1-400,000	1	1⅜-2¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5¼-5⅜
—— 4 per cent. 1st Mortgage Debentures	100	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	97-100 xd
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114.
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	105-107
New General Traction, Ordinary	5	3-3½
—— 6 per cent. Cum. Pref.	10	4½-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10⅝
—— 5 per cent. Cum. Pref.	10	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	9¼-10¼
—— 4½ per cent. Debenture Stock	100	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	8s.	7/16
—— £50,000 ,, ,,	1	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c.	40 p.c.
Wolverhampton Tramways Company	—	—
Telephones.—		
National Telephone, Ordinary	5	3½-4 xd
—— 6 per cent. Cum. First Pref.	10	12-14 xd
—— 6 per cent. Cum. Second Pref.	10	12-14 xd
—— 5 per cent. Non. Cum. Third Pref.	5	4⅛-4½ xd
—— 4 per cent. Deb. Stock, Red.	100	96-98
—— 3½ per cent. Deb. Stock, Red.	100	95-98
Oriental Telephone and Electric Company	1	¾-1

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NOTES.

High Telegraph Poles.—America claims to have some of the highest telegraph poles in the world. Two in particular have just been erected at Beaumont, Texas, by the Western Union Telegraph Company. They stand on the opposite bank of the Neches River, and support the telegraph company's cables so as to permit the passage of vessels through a drawbridge. The span measures 144ft. The poles are of iron skeleton construction.

Lightning Research. — We understand that the Lightning Research Committee of the Royal Institute of British Architects, having invited the assistance of the Institution of Electrical Engineers in the collection of information bearing on the subject in question, papers are being sent to the local honorary secretaries of the Institution abroad in the hope that members resident in these several districts may be willing to co-operate.

The Electric Arc Under Water.—It has been shown by experiment that an electric arc can be employed under water for fusing metal The intense heat turns the water surrounding the arc into steam, thus forming an insulating cushion of vapour. In view of this state of things, the suggestion seems common sense that with proper apparatus the electric arc could be employed by divers for quickly cutting through large chain cables or iron plates under water.

Nernst Lamps in Scotland.—On Wednesday evening last week Lord Kelvin performed the ceremony of switching on the Nernst lamp installation for the first time in Scotland at the stand of the Electrical Company, Limited, at the Glasgow Exhibition. To witness the proceedings there were present Lady Kelvin, Dr. Bottomley, LL.D., and Mrs. Bottomley, Sir William Preece, Geheimerath E. Rathenau, Mr. Oscar von Miller, Mr. J. Stottner, the general manager of the Electrical Company, Limited, and many other eminent scientists and engineers. The Nernst lamps, which brilliantly illuminate the large stand of the Electrical Company, will be alight every evening until the close of the exhibition.

Exhibition of Photography. — The forty-sixth annual autumn exhibition of the Royal Photographic Society, which opens on Monday, the 30th inst., for five weeks, will again be held in the spacious premises of the New Gallery, Regent-street. Sections will be devoted to (1) selected pictorial photographs; (2) general professional work; (3) apparatus and material; (4) photo-mechanical processes of reproduction; and (5) scientific photography and photography in its technical applications. On Saturday, the 28th, there will be a private view, followed in the evening by a conversazione, when the president and council will receive the fellows and members of the society, exhibitors, and their friends.

The Nernst Lamp.—An able article appeared in a recent issue of the *Elektrotechnischer Anzeiger*, giving an account of experiments made with three commercial 220-volt, 200-watt Nernst lamps. These lamps, it would seem, were continually tested until they failed, and their lives were recorded at 124, 293, and 369 hours respectively. All three lamps were destroyed because the glower feeding wire melted close to the incandescent body. The results of photometric tests of the lamp, the life of which was 369 hours, were also given in this article. The voltage was continually 220 volts. The candle-power dropped from 146 candles at the start to 99 after 100 hours, 81 after 220 hours, 60 after 300 hours, and 48 after 350 hours, the watts consumed per candle being 1·33, 1·91, 2 19, 2·68, and 2·89 respectively. In practice it seems preferable to use a lamp not more than 200 hours—*i.e.*, down to about 80 candles.

American Transactions.—The discussions of four papers read before the American Institute of Electrical Engineers are included in the institute's *Transactions* for June and July. The papers in question are: "Stott on Distribution of Received Currents"; "Ryan on the Transformer for Measuring Large Currents"; "Brady on Electricity in Mountain Mines"; and Kennelly on the Edison Storage Battery." This issue also contains several of the Buffalo Convention papers, including "Synchronism and Frequency Indication," by Mr. Paul M. Lincoln; "Performance of an Artificial 40-Mile Transmission Line," by Messrs. Wm. L. Aldrich and G. W. Redfield; "Power Factor Indicators," by Mr. William Hand Browne, jun.; "Elements of Design particularly pertaining to Long-Distance Transmission," by Mr. F. A. C. Perrine; and "Development of the Nernst Lamp in America," by Mr. Alexander J. Wurts.

Proposed National Industrial Association.—In the August number of the *Engineering Times* the editor devotes several pages to a scheme for promoting the industrial welfare of this country. The originator of the movement is Mr. J. Lackie, of Newcastle on-Tyne, and his scheme, in fine, is the formation of an association under the above style and title, which will federate existing employers and trades union organisations, with the main object of promoting a feeling of common interest between masters and men. It is felt that if this be achieved, not only will strikes, lock-outs, and labour disputes generally be minimised, but the country will be in a much stronger position to cope with foreign competition.

Electric Filter.—A patent has been granted in the States to Messrs F. W. Lemp and Wm. Kolding, for an electrolytic water purifier. In the new invention there are electrodes of iron, in the form of a series of vertical closely-spaced plates, of which the end members only are connected with the source of current, the intermediate plates acting as bipolar electrodes. The water to be purified passes upward between these plates from a distributor, and thence, under pressure, to a settling tank, which it enters tangentially, whereby is imparted to it a swift rotary movement that carries the bulk of the suspended impurities to the periphery. The purer water is withdrawn axially from the tank, and passes upward through a filtering bed, still under pressure, to an ingeniously constructed valve in the discharge pipe.

Proposed American Tramway Combine.—According to the *Electrical Review* of New York a scheme is on foot for a combination of electric street railways and interurban trolley lines in the States, which will, if made, be the greatest system of electric roads in that country. The proposal includes roads covering Cleveland, Toledo, Sandusky, and Detroit, giving a total mileage of 1,141. Some of the leading capitalists of New York and Philadelphia are said to be interested in the movement, as well as several well-known men in the electric traction world. Should the "combine" become an accomplished thing, it is proposed to operate freight and express cars over the various lines, and to compete for both freight and passenger traffic with the steam railroads. The capital of the company, it is stated, would be over 20 millions sterling.

Electrical Illumination.—The impending visit of the Duke and Duchess of York to Canada is affording the Government an excellent opportunity for showing what they can do in the matter of electrical illumination. It is stated that the stay of the Royal party at Ottawa will mark one of the finest electrical exhibits, in comparison to the size, ever seen on the continent of America. With this object in

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view, the Government officials responsible for the illumination of the Parliament Buildings have secured designs of the Buffalo lighting arrangements, and the plans which are being worked out are adaptations of these illuminations. The great buildings will be illumined not from the prominent lines, but from the recesses, which is calculated to give fine effects. All the windows are being picked out in this way, while the big central tower will be framed in electric lights, peculiarly resembling the magnificent appearance of the great electrical tower at the Pan-American Exhibition.

Time Indicator for Telephones.—An ingenious device which measures the actual time a telephone has been in use, so that the company may charge the subscriber only for the actual service he has had, is the subject of a patent lately granted to Mr. Thomas Baret, of Sydney, New South Wales. The idea, of course, is that a subscriber who has but little use for his telephone will not be compelled to pay the same as one whose instrument is in fairly constant use. To this end the lever switch of the telephone is connected with the clock or other mechanism, which shall be inoperative when the telephone is not in use; but as soon as the receiver is lifted from the hook the clockwork shall commence to operate, and will thus register the extent of time that the instrument has been working. The apparatus is so arranged that the up-and-down movement of the lever switch shall wind up the clockwork, and thus the operation will be almost entirely automatic. A dial is provided for indicating the length of time the telephone has been in use.

Dynamo Design.—In a recent patent, Mr. B. G. Lamme takes up the subject of armature winding for alternating-current generators. The object is to provide a generator which shall have certain advantages over those heretofore designed and employed in similar relations. Among such advantages are the utilisation of an armature which has a large number of slots and a small number of conductors per circuit; one which may have as many circuits in parallel as may be desired without regard to the number of field-magnet poles; one in which each circuit is uniformly distributed entirely around the armature periphery; one in which the coils are so constructed and arranged that in case of accident to any winding the remaining windings will be uniformly distributed, and may therefore be used satisfactorily; one in which the windings may be used independently for separate circuits if desired; one in which part of the windings may be reversed when the number of circuits is an odd number, so as to provide a symmetrical arrangement, and one in which the difference of potential between adjacent end conductors is less than that between the end conductors of any one of the windings that are nearest to each other.

The Tramway and Light Railway Association.—This association held its annual dinner at the Windsor Hotel, Glasgow, on Wednesday, the 4th inst. The chair was taken by Sir Charles Rivers Wilson, G.C.M.G., C.B., the president of the association, and he was supported at the high table by the following gentlemen: Councillor W. Paton, Mr. W. W. Beaumont, Mr. A. H. Steward, Mr. J. Barber Glenn, Mr. E. G. Mawbey, Mr. J. W. Courtenay, Mr. John Young, Mr. R. A. Smithson, and Mr. George Flett. The "coupiers" were Mr. E. Garcke, Mr. Stephen Sellon, and Mr. Philip Dawson. After the usual loyal toasts the chairman interposed a description of the association, so as to acquaint those present with the aims and objects for which the tramway engineers present had joined together. He ended his speech by a strong appeal to the Glasgow tramway authorities to join the association. The speech of the evening was delivered by Mr. E. Garcke, who explained that the Light Railway Act was threatened by extinction, due to the opposition of the association of municipalities. He advocated fair treatment for all tramway undertakings, and explained how the companies were hampered by the short tenure under the Tramway Acts.

Searchlight Signalling.—The feasibility of the searchlight method of signalling at night was clearly demonstrated a short while ago when Prof. Geo. F. Sever succeeded in communicating with Niagara Falls from the electric tower of the Pan-American Exposition, in the presence of the electrical jury. More recently, searchlight signals have been sent from Buffalo to Toronto, a distance of 58 miles, through arrangements completed by Prof. Sever in co-operation with a consulting engineer, and so far this remains the record distance for signalling by searchlight at night over land. On the occasion of the first trial, clouds were over Toronto, and the local illumination of the sky by the electric arc lights in the strects of the city effectually prevented any discrimination being made between the local and the Buffalo illumination of the clouds. The second trial was made with a perfectly clear atmosphere. Special long-distance communication was arranged between the top of the municipal hall tower, Toronto, and the electrical tower at the Pan-American Exhibition. The special instructions were to depress the searchlight to the lake horizon, bearing on the municipal hall tower, Toronto; then to sweep the horizon a definite angle, to the right and left of this bearing; and later to elevate and depress the light at the original bearing. All of these signals are said to have been very clearly discerned, and the results are looked upon as most satisfactory.

National Physical Laboratory.—At the last meeting of the Electrical Section of the Glasgow International Engineering Congress, Mr. W. Langdon, the president, announced that he had received some information from Dr. Glazebrook respecting the above. It was hoped by Dr. Glazebrook, who was in charge of this laboratory, that it would be opened for work by the end of the year. An engineering laboratory 80ft. long by 50ft. wide had been constructed, and provided with a travelling crane and lines of shafting from which experimental machines could be worked. Adjoining this was the drawing office, while the engine-room and boiler-room were at the one end. The electrical power required would be obtained from a 60-kw. Parsons steam turbo-dynamo, which had been selected in order to avoid any vibration. Amongst the work which Dr. Glazebrook proposed to commence immediately the laboratory was opened was the continuation of the researches on alloys inaugurated by the Institution of Mechanical Engineers; also a large series of experiments would be carried out on the examination of steel and iron by means of micro-photometric methods. The apparatus to be installed would also enable them to make experiments on the elasticity of the alloys above referred to. A complete set of apparatus was being arranged for the standardisation of pressure gauges and steam-engine indicators. A certain amount of attention had also been paid to the provision of the requisite plant for the carrying out of research on high-temperature thermometers. All classes of electrical apparatus could be tried in these new laboratories, which would be of great service to the electrical profession. Mr. Langdon added that Dr. T. E. Stanton had been appointed the superintendent of the engineering department.

Plotting Alternating Waves.—In the digest of the *Electrical World* of New York for the 31st ult. reference will be found to a new instrument devised by Mr. Hospitalier for plotting the wave form of an alternating

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current, or E.M.F., or power, etc. The name which the inventor gives the instrument is "ondographe" or "cymatographe." The chief advantage claimed for it is that it is simpler than all similar instruments. Tracing directly as it does a continuous record of the wave form on a slip of paper, the instrument is said to work very quickly, giving the record of a wave in 10 to 30 seconds, while, for instance, the Callendar cycle-curve recorder requires an hour for the same purpose. The instrument is based upon the principle of Joubert's method of plotting the wave form by means of instantaneous contacts, the different points of the wave being obtained by making the contact at moments corresponding to different phases. The different parts of the new instrument are the following: A synchronous motor driven by the source of E.M.F., the wave of which is to be traced. This motor drives the commutator by means of a train of gearing of such design that when the motor makes n revolutions, corresponding to n periods, the commutator makes only $n-1$ revolution. The commutator consists of a cylinder of insulated material covered by a copper or brass tube, of which certain parts are cut away. In the diagram which accompanies the description of the instrument the points at which the electric phenomenon takes place, the wave form of which is to be plotted, are shown, also the condenser and the registering apparatus. The operation consists of two steps. In the first step the condenser is charged, in the second it discharges through the measuring instrument. The measuring instrument may be any form of the moving-coil type—for instance, a Weston instrument. The record is plotted on a revolving cylinder.

The Scottish Automobile Trials. — It must be exceedingly gratifying to the British public to learn that one result of the automobile trials which took place in and around Glasgow last week, is to show that the English-made car can at least hold its own against the foreign machine in point of reliability. We may say that to this object it was that the contest was mainly directed, the question of speed being quite a secondary consideration. Although the ultimate object of the trials was to promote the British motorcar industry and to regain for it that prestige which it enjoyed in years gone by, the entry list showed that the committee had considered it of primary importance that the public should be made aware of the capabilities of the motor vehicle in its most modern development, without regard to nationality. About a third of the competing cars were of French and two of American make. Comparing generally the cars with those in last year's 1,000-mile trial, a pronounced improvement is to be noticed in safety, speed, and hill-climbing capabilities; but this year's trials were much more severe. No repairs were allowed, and the cars obtaining full marks have accomplished over 500 miles, running up hill and down dale, showing reliability in a marked degree. The last day of the trials was the most severe of all, the course being 115¼ miles through a mountainous district by Loch Lomond. Out of the 34 cars which started 30 were driven by petroleum, three by steam, and one by electricity; 18 were of British manufacture, 11 French, three American, and two German. Seven belonged to private owners, and 27 were entered by manufacturers or agents. Amongst the British cars the Motor Manufacturing Company is said to have obtained the best results. Three cars ran steadily every day, almost without stopping, and earned an aggregate of 4,488 marks out of a possible 4,500. We trust that the excellent results obtained by the English-made cars in the latest international contest, will stimulate British manufacturers to yet greater exertions in the effort to get beyond the reach of foreign competition.

Electric Fire-Engines.—It may fairly be stated that the time is not far distant when we may expect to hear of the introduction of the electric automobile into the Paris fire brigade. A short while ago the authorities entered upon a number of tests of different types of electric automobiles, such as fire-pumps, hose carriages, etc., and it is satisfactory to note that these have proved very successful in general. Of course, the great point is the increase in speed over horse traction, and an immediate putting in use of the pumps, etc., on arrival at a scene of conflagration. Among the first machines experimented with was the "fourgon," or wagon, carrying six men, hose, ladders, and fire-extinguishers. The motor, of the Boquet, Garcin, and Schivre type, is of 4,000 watts capacity, and the accumulators, which give 200 ampere-hours, weigh 1,500lb. The electric fire-pump is perhaps the most striking feature of the equipment of this carriage. It is fed by a water reservoir containing 150 gallons of fire-extinguishing liquid, and this supply is utilised until the hose can be connected with the street mains. The same electric motor which is used to work the pump does service to propel the carriage from the fire station. The car has a front seat with the steering devices, and in the centre is the battery box, suspended below the vehicle. Above it is the motor. The reservoir is in the rear, and above it is the hose reel, the water being taken to the hose through the hollow axle. The pump at the back of the reservoir has three vertical cylinders, and delivers 20 gallons per minute at a pressure of four atmospheres. The vehicle has an electric brake, besides a cord brake. It weighs 5,060lb., or 6,380lb. when fully equipped, including three men and 100 gallons of water. The motor gives 4,000 watts, and the accumulators 180 ampere-hours. An arrangement is provided for using part of the current for lighting the scene of the disaster by incandescent lamps, or even by arc lamps. Two of these machines have been repeatedly tried in actual service, and are said to have proved quite successful.

Drop in Alternators.—The following digest of an article on the "Predetermination of Drop in Alternators," by G. Giles, which appeared originally in *Eclairage Electrique*, is given by "A. H." in *Science Abstracts* for August: "The author develops a method of calculating the drop of potential difference in alternators which is based mainly on the consideration of the reluctances of the air-gap and the leakage paths. Let the open-circuit characteristic of the alternator be given. If R_1 = reluctance of air-gap (corresponding to useful flux), R_2 = reluctance of leakage paths, $S\,i$ = demagnetising ampere-turns due to armature when the power factor is zero, and if we suppose that the total magnetic flux through the field core is the same as it was on open circuit; then in order to pass from any point on the open-circuit characteristic to a corresponding point on the internal characteristic, we have to reduce the volts by an amount corresponding to the flux $\frac{4\pi}{10} \cdot \frac{S\,i}{R_1 + R_2}$, and to increase the ampere-turns by an amount $S\,i \frac{R_2}{R_1 + R_2}$. In order to find the external characteristic, we have further to subtract from the ordinate of the internal one an amount corresponding to the impedance drop in the armature. In order to obtain this latter correctly, the author uses an experimental armature coil of very fine wire superposed on the main coil and connected to a voltmeter. If the alternator is run on short circuit with a current corresponding to the load current, the true impedance drop is easily found from the voltmeter reading and the number of turns in the exploring and main armature coils. The author next investigates the effect of damping coils, and shows that if damping is perfect, then the armature back

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turns are (power factor = 0) given by $\frac{1}{2}$ S I_0, where I_0 is the maximum value of the armature current (sine function assumed). If there are no damping coils, then the E.M.F. of the alternator when loaded contains a third harmonic, even if the open-circuit E.M.F. is a pure sine wave. The results are applicable to two and three phase machines, the back armature turns of which are (power factor = 0) given by S I_0 and $\frac{3}{2}$ S I_0 respectively. Experimental results are given in support of the theory developed."

Water-Power Development in New Zealand.—New Zealand is making great strides in the development of its water power for electrical purposes. The latest project on foot is to utilise the water of the Waimakariri river for generating electricity for the proposed electric tramways at Christchurch and for electric lighting. In accordance with instructions, Mr. Robert Hay, M.I.C.E., has prepared a report for the Christchurch Corporation on the subject and of the two schemes submitted to him, he recommends that known as the George bridge project. The race to be constructed at the point of intake will be about six miles in length. A good site has been selected for the power station on the banks of the river, and the engineer considers that a permanent foundation for the building and machinery may be obtained without risk of encroachment by the river. The power required at Christchurch is 3,000 h.p., for which Mr. Hay estimates it is necessary to provide 5,000 h.p. at the generating station. The fall at the point of delivery having been fixed at 90ft., the required flow of water will be 489 cubic feet of water per second, and allowing $7\frac{1}{2}$ per cent. for sundry losses by bends, etc., the capacity of the race must be equal to a discharge of 525 Government heads of water. Dealing with the subject generally, Mr. Hay draws attention to the danger of interferences with supply of power through interruptions of the water supply from various causes. He, however, considers the scheme quite feasible, and thinks the actual works for conveying 500 or 600 heads of water from the Waimakariri to the site of the proposed power-house can be successfully carried out, and utilised for the purpose of providing power for the generation of electricity for transmission to Christchurch. He estimates the cost of the work from the intake at the Waimakariri to the pipe head at the termination of race, including inlets, tunnels, race excavation, concrete lining, benching, new race, and piping at £54,700. Turbines, with connections, generators, switchboards, transformers, exciters, meters, buildings, etc., would also have to be estimated for, but with these Mr. Hay does not deal. He recommends, in conclusion, that the Corporation should lease or sell the concession to a private syndicate to carry out the scheme, reserving a right of purchase.

Electric Haulage on Canals.—Mr. L. Gerard, in a communication to the Société Belge d'Electriciens, furnishes some numerical data relating to various systems of electric traction on canals, calculating the efficiency as the ratio of power actually developed in the tow rope to the electrical power applied. As the result of trials, the Köttgen rack system on the Finow Canal showed a maximum efficiency of 0·704 when towing a 100-ton barge at $2\frac{1}{3}$ miles an hour. The tractor worked up to 20 e.h.p. at most, with an expenditure of $5\frac{3}{4}$ e.h p. when running light at $4\frac{2}{3}$ miles an hour. The Denèfle tricycle (old form) on the Aire and Deule gave an efficiency of 0·414 when towing a barge of 293 tons at $1\frac{1}{4}$ miles an hour, with a maximum power of 19·2 e.h.p. Running light at $2\frac{1}{3}$ miles an hour, the tricycle took 4·17 e.h.p. A new pattern of the tricycle gave an efficiency of 0·44 with the same load at $1\frac{2}{3}$ miles an hour. The Gerard tractor gave 0·534 at $2\frac{1}{4}$ miles, towing two 70-ton barges, and took 5·5 h.p. at $2\frac{3}{4}$ miles empty. Figures are given relating to the power absorbed by road friction. The Gerard screw propeller system gave an efficiency of 0·322 at about two miles an hour, the screw making 375 revolutions per minute when towing two 70-ton barges, taking 5·4 h.p. at 5·1 miles an hour empty. This result is compared with steam practice, for which a maximum efficiency of 0·294 is given. Commenting on these figures, the author points out that the cost of maintenance of the banks and of the tractors will in many cases more than outweigh the low efficiency of the electric towage system, while in addition the banks are often unfit to bear the weight of the tractors. Where these considerations do not hold, the rack system is the best, except for low speeds and loads, which are best handled by tractors without rails. The effect on the section of the canal and the strong influence of the current along it are next dealt with, and the very important question of the state of the towpath is considered in detail. The author shows that the loss due to rolling friction may amount to 35 per cent. By comparing figures obtained with animal haulage with those of electrical haulage, an increase of over 42 per cent. in the voyages annually made by a barge is shown in favour of the latter. In conclusion, the author emphasises the advantages gained by the electrical distribution of energy along the line of the canal for lighting, pumping, dredging, and motive power in general.

The James Watt Laboratory.—On the 3rd inst the Right Hon. Lord Kelvin formally opened the James Watt Laboratory, which is now in course of completion for the engineering department of the Glasgow University. A large company assembled in the laboratory to witness the ceremony, Sir Wm. Arrol, chairman of the Engineering Laboratory Committee, presiding. In declaring the laboratory open, Lord Kelvin paid a high tribute to the memory of James Watt. The first practical engineering work under the wing of any university in the world, so far as he knew, was done by James Watt within the walls of the old college at Glasgow, and it was happy for them now, a century and a half later, to be present and, feeling grateful for what he did for the engineering profession of the whole world, to dedicate that laboratory to his memory. His Lordship referred to the practice that was observed in the university in chemical analyses before outside laboratories and professional analysis were so common, and he hoped experiments in the engineering laboratory would be carried out on the same commercial principles. The university ought to be in touch with all knowledge of the properties of matter, discovered by university men or scientific men, not merely for the abstract scientific value of the knowledge, but for the possibilities of its useful practical application. He believed every person present was convinced that the university and practical men must work hand in hand, and he felt that they were most willing to do so. It was with the greatest possible pleasure that he inaugurated this laboratory, from which he hoped the most splendid results. It was particularly interesting that the name of Murdoch, so much associated with the discovery of gas for illuminating purposes, should be commemorated by the engine presented by the North British Association of Gas Managers. Other contributions had been received in the shape of apparatus, endowments, and assistantships connected with the names of prominent engineers. The family of the late Mr. Burnett, architect, had founded the Lindsay Burnett medal for experimental research, in memory of their brother, Mr. Lindsay Burnett. They had the Watt scholarship, the Young assistantship, the Walker prizes, the George Harvey prizes in naval architecture. All these were commemorative of engineers, and he hoped they might have other benefactions. He was

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sure it would be a proud thing for any engineer to have his name connected with such an institution, doing so much good as they anticipated for it in the future.

Proposed Irish Channel Tunnel.—Among the many interesting papers read before the several sections of the International Engineering Congress at Glasgow last week was one in the Railways Section, on the proposed tunnel between Scotland and Ireland, which calls for notice. Mr. James Barton, member of council, Inst.C.E., the author, has dealt with the subject in a very thorough manner. Referring to the water question, he gives his reasons for believing that it is not likely to be a very serious difficulty. In the first place, in the case of both the Severn and the Mersey Tunnels no large water leakage was encountered under the sea, the great Severn leak being fresh water and a quarter of a mile from the sea. This view is confirmed in the case of a tunnel driven for some distance under the River Forth by Sir Benjamin Baker, giving good ground for believing that the sea bed under the Irish Channel, which is generally covered by a slimy ooze, has throughout the ages during which it has been undisturbed gradually sealed all interstices, so that excavation sufficiently low may be expected to be fairly dry. Moreover, the water difficulty of the Severn Tunnel occurred in limestone strata of the coal measures, where fissures and underground channels are not uncommon; no such rocks are, in the opinion of Prof. Hull and others, to be found in the Irish Channel. The working of the tunnel and the line from Stranraer to Belfast is proposed to be by electric motors, from two installations, one near the main shaft at each side of the channel. There seems no reason to doubt, says the author, that trains can be run regularly at a speed of 60 to 70 miles per hour through the tunnel, so that the time occupied in passing through it would be about half an hour, and the whole distance from Stranraer to Belfast, being without intermediate stops, could be done regularly under the hour. The ventilation of a tunnel after completion is, by the use of electric power, made comparatively easy. The products of coal combustion are the difficulty in all ordinary tunnels. Fans to send in a current at one end and draw it out at the other would set up a constant current in one direction, and probably be quite sufficient. A point worthy of notice, which the author makes towards the end of his paper, is that the provision of power for drilling the rock, as well as moving the wagons of material during construction, would probably best be attained from electric motors, and there seems little doubt that through the marls on the Irish side, and sandstone, if not through the silurian rocks, large excavating drills to form the whole heading, 8ft. or 9ft. diameter, in one operation, may be constructed capable of doing even more rapid work than by the use of explosives.

British Association at Glasgow.—On Wednesday evening the seventy-first annual meeting of the British Association for the Advancement of Science was opened at Glasgow under the presidency of Prof. Arthur Rücker, whose inaugural address will be found elsewhere in this issue. The following morning the various sections of the association met in the lecture theatres of the University, Gilmore-hill, for the transaction of business, and in the evening a reception and conversazione was held in the City Chambers by invitation of the Lord Mayor and Corporation of Glasgow. The Bute Hall has been set apart as a reception-room during the continuance of the conference, and here also are located the various offices. In close proximity to the reception-room is the ladies' drawing-room, smoking-rooms, general secretaries' room, etc. To-day (Friday) the programme includes a garden party at Overtoun, Dumbartonshire, given by Lord and Lady Overtoun; a lecture in St. Andrew's Hall, by Prof. W. Ramsay, F.R.S., on "Inert Constituents of the Atmosphere"; and a smoking concert in Berkely Hall of St. Andrew's Halls. Several interesting excursions are arranged for on Saturday, and on Monday a garden party is to be given in the Botanic Gardens and Queen Margaret College, Glasgow, by invitation of Lord and Lady Blythswood. On Tuesday special visits to public works will be made, and other features of the day will be a conference of delegates of corresponding societies and a conversazione in the exhibition buildings, given by the president, the chairman of the executive council of the Glasgow Exhibition Association. The concluding general meeting of the conference takes place on Wednesday. The day's programme also includes two conversaziones, two dinners, and an "at home." In the Engineering Section the following papers are down to be read: Address of the President (Colonel R. E. Crompton) on (*a*) "Modern Development of Passenger and Goods Traffic, as affecting Carriage on Railways, Tramways, and Ordinary Roads," (*b*) "Standardisation and Interchangeability," and (*c*) "The National Physical Laboratory"; paper by Mr. D. H. Morton, on "The Mechanical Exhibits in the Glasgow Exhibition"; "Report of the Committee on Resistance of Road Vehicles to Traction"; "The Carriage of Goods over Electric Trolley Systems," by Mr. A. H. Gibbings; "Railway Rolling-Stock, Present and Future," by Mr. M. N. Macdonald; "The Panama Canal," by Mr. Bunau Varilla; "Tunnelling through Quicksands," by M. A. Gobert; "The Protection of Public Buildings from Lightning," by Mr. Killingworth Hedges; "The Diesel Engine," by Mr. Rudolf Diesel; "The Commercial Importance of Aluminium," by Prof. E. Wilson; "Aluminium as a Fuel," by Sir W. C. Roberts-Austen, K.C.B., F.R.S.; "Report of the Committee on the Small Screw Gauge"; "Recent Developments of Chain Driving,' by Mr. C. R. Garrard; "The Critical Point in Rolled-Steel Joists," by Mr. E. T. Edwards; "Machinery for Engraving," by Mr. Mark Barr; and "Measurement of the Hardness of Materials by Indentation by a Steel Sphere," by Mr. T. A. Hearson; "Long Continuous-Burning Petroleum Lamps for Buoys and Beacons" and "New Scintillating Lighthouse Lights," by Mr. J. H. Wigham; "A Recording Manometer for High-Pressure Explosives," by Mr. J. E Petard; "A Leaf Arrester for Intercepting Leaves in the Intake of a Water Supply," by Lord Rosse; "Bridges in Western China," by Mr. Lockhart Jack; "Recording Soundings by Photography," by Mr. James Dillon; "The Size of Waves Observed at Sea," by Dr. Vaughan Cornish; "A Portable Folding Range Finder for Use with Infantry," by Prof. G. Forbes; "On the Making of Type," by Mr. Mark Barr; and "Air Currents: Churches and Public Buildings," by Mr. S. W. Thomas The president's address to the Chemistry Section is "On the Position of British Chemistry at the Dawn of the Twentieth Century." In this address Prof. Percy Frankland, F.R.S., directs attention to the factors which have been instrumental in promoting the growing activity in original investigation during the past 20 years. He points out the disadvantages at the present time incidental to university education, and indicates some of the more important reforms which are required in the immediate future. Other papers which have been arranged for this section are: "The Present Position of Electro-chemical Industries in this Country and Abroad," by Dr. Shields; and "The Chemical Exhibits at the Glasgow Exhibition," by Dr. Lewkowitsch. Wednesday, the 18th inst., is the concluding day of the conference.

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KEIGHLEY CORPORATION ELECTRICITY WORKS.

The multiplication of electricity supply works has been so rapid of late that it has been almost impossible to keep pace in the matter of descriptive accounts. The Keighley works, which form the subject of the present article, cannot lay claim to the distinction of being the latest addition to the list of completed stations, having been opened as far back as June 15 last, under circumstances duly reported in these columns at the time. However, since no detailed description has yet appeared outside the local Press, a brief account may be appreciated by our readers. In the first place, it may be mentioned that the town which the works supply has a population of 41,500 and a ratable value of £125,000, the area of the borough being 3,600 acres. At present the area over which the supply of electricity from the Corporation works is available amounts to about 500 acres. The gasworks are owned also by the Corporation, the price charged for gas being 2s. 6d. per 1,000 cubic feet. The following is a brief history of the electricity supply undertaking:

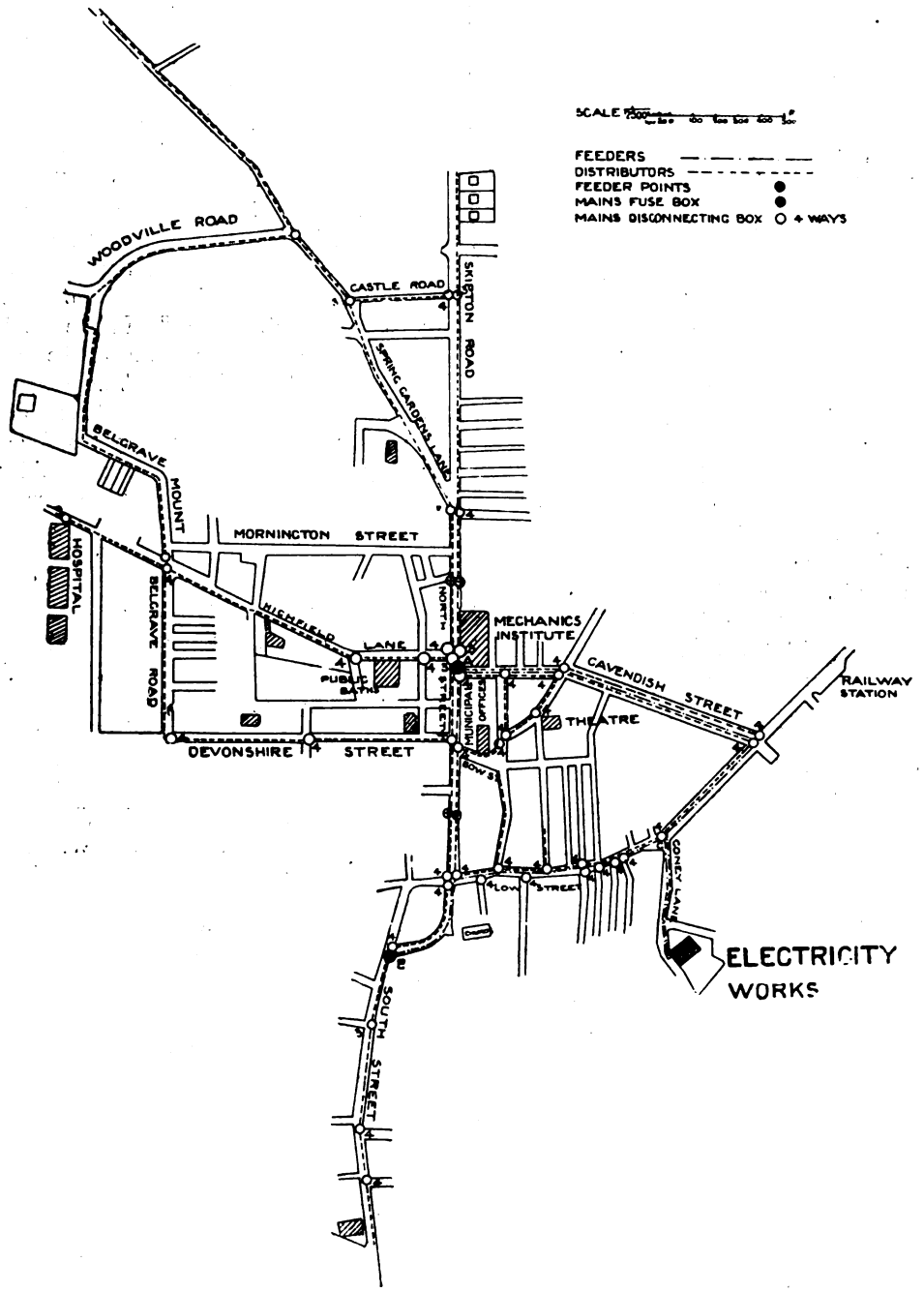

FIG. 1.—Map of Area of Supply, showing position of Generating Station and Mains, Keighley

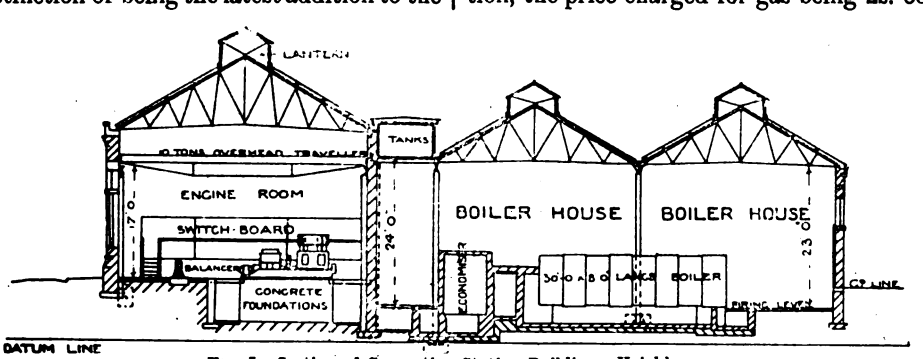

FIG. 3.—Section of Generating Station Buildings, Keighley.

In 1898 the Town Council appointed Mr. Reginald T. Wilson to report on the question of a public supply of

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electricity in the town. Mr. Wilson accordingly submitted a report, but after due deliberation it was decided by the Council to leave the matter in abeyance for a time. Meanwhile, however, a provisional order for supplying electricity was obtained, and it was agreed by the Council in July, 1899, to put the order into force. In accordance with this decision, Mr. J. M. Smyth was appointed borough electrical engineer to design and carry out a complete scheme. Mr. Smyth commenced his duties in August, 1899, and in December of the same year the Council approved a low-tension, three-wire, direct-current scheme submitted by him for their consideration, and decided to apply to the Local Government Board for sanction to borrow £34,600, the estimated cost of the work. At the same time the engineer was instructed to prepare detailed plans and specifications and get in tenders for carrying out the work. The necessary borrowing powers were obtained from the Local Government Board, and during May and June, 1900, contracts for machinery and buildings were let as follows:

Machinery.—Thos. Parker, Limited, Wolverhampton, and W. H. Allen, Son, and Co., Limited, Bedford, engines and dynamos, £5,140; Thos. Parker, Limited, switchboard, £1,905; Clayton, Son, and Co., Limited, Leeds, boilers, economisers, and feed pumps, £1,915; Tudor Accumulator Company, Limited, storage battery, £1,623; J. Carrick and Sons, Limited, Edinburgh, travelling crane, £259; W. Lucy and Co., Limited, Oxford, condensers and tanks, £1,600; W. B. Haigh and Co., Limited, Oldham, steam-pipes, £900; Callender's Cable and Construction Company, Limited, mains and arc lighting, £10,400—total, £23,742.

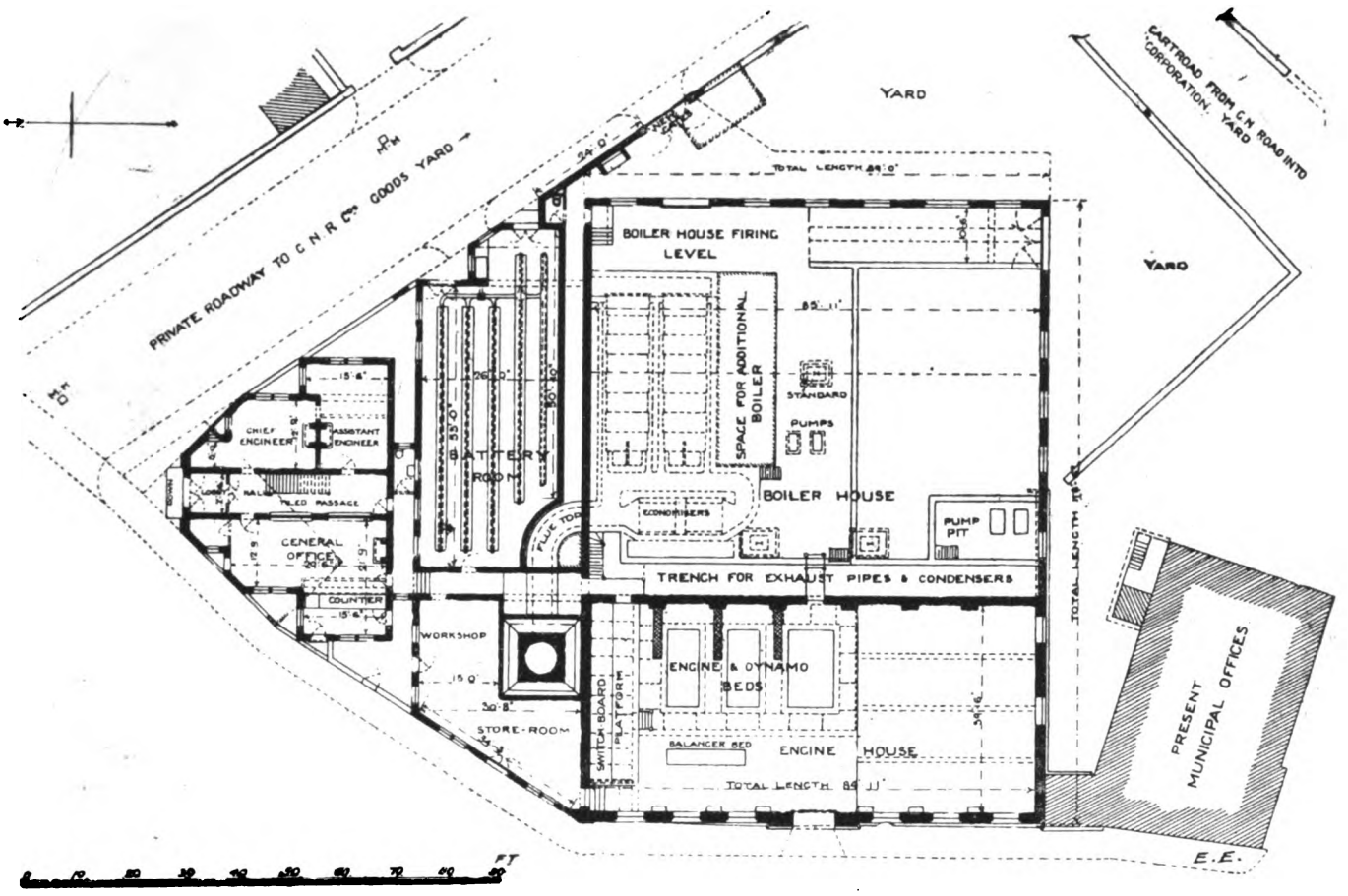

FIG. 2.—Block Plan of Station Buildings, Keighley.

Buildings.—T. E. Sugden, Keighley, masonry, concrete, and joinery, £4,200; Carter Bros., Limited, Manchester, steel roof and girders, £1,130; W. Thornton, Bingley, slater's work, £330; W. and J. Harrison, Keighley, plumbers and glaziers, £280; Edmundson Bros., Keighley, plasterers, £130; W. Seaton and Co., Keighley, painting, £118; Lancs. and Cheshire Opalite Tile Company, Manchester, wall tiling, £390—total, £6,578.

On July 3 of the same year building operations were commenced, and both engine and boiler houses were ready for the reception of the machinery early in December, when the work of erecting the engines and dynamos,

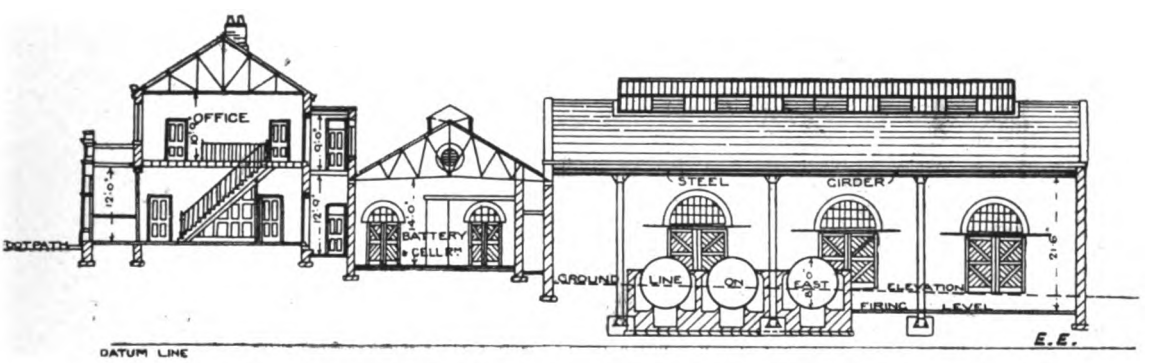

FIG. 4.—Section of Generating Station Buildings, Keighley.

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switchboard, boilers, etc., was started, and the pipe work proceeded with as expeditiously as possible, with the result that the engineer was able to give a supply for private lighting on March 30, 1901, the date promised to the Council before the works were commenced. The site of the works (shown on Fig. 1) is at Low Bridge, a very central part of the town, and close to the Great Northern

THE CHAIRMAN OF THE ELECTRICITY COMMITTEE, KEIGHLEY, ALDERMAN PAGET, J.P

MAYOR OF KEIGHLEY, H. C. LONGSDON, ESQ., J.P

BOROUGH ELECTRICAL ENGINEER, KEIGHLEY, J. M. SMYTH, ESQ

Railway goods siding and the River Worth, from which water is obtained for condensing and feed purposes. The general arrangement of the buildings is shown in Fig. 2, while sections are shown in Figs. 3 and 4, and Figs. 5 and 6 serve to indicate their architectural style. On referring to Fig. 2 it will be seen that the engine-room is 85ft. long by 40ft. wide approximately. The room is lined with opalite tiles up to the traveller ways, and is provided with a red-tiled floor. The boiler-house is 85ft. long by 70ft. wide, and runs parallel with the engine-room. The battery room is 53ft. long by 26ft. wide. Office accommodation is provided, as shown, at one corner of the site, and includes chief engineer's and assistants' offices, general office, drawing office, and test-rooms. A workshop and stores will be noticed next to the engine-room. A chimney shaft, 100ft. high and 5ft. diameter inside, which existed previously, has been incorporated in the plan. This chimney is in good condition, and is, moreover, situated in a fairly suitable position on the site. When extensions require it, another and larger shaft will be erected in a different position, the present one being kept as a stand-by.

In the boiler-house (Fig. 7) two Lancashire boilers, 30ft. long by 8ft. diameter, by Messrs. Clayton, Son, and Co., Limited, of Hunslet, Leeds, have been fixed, and these are fitted with Bennis's mechanical stokers driven by an electric motor. The mountings for the boilers were made by Messrs. J. Baldwin and Co., of Keighley. A Green's economiser, having 192 tubes in two sets of 96 each, is placed at the back of the boilers. The boiler feed pumps are of the Worthington horizontal ram type, and two in number. Duplicate feed pipes (Fig. 8) to supply either through the economisers or direct to the boilers are provided. The boilers are designed for a working pressure of 160lb. per square inch, and were tested hydraulically at the makers' works to 270lb. per square inch. The main steam-pipes (Fig. 9) are of steel, and in duplicate throughout. Two 7in. pipes from the boilers feed into two 9in. pipes supported from the engine-room wall, and from these again bends are taken through to the engines. The whole of the steam-pipes, including drains and traps, have been supplied by Messrs. W. B. Haigh and Co., Limited, of Oldham. The condensing plant consists of three Körting ejector condensers, one being fixed behind each engine. They are known as "Class B" overhead type, and two are of size 21 and one of size 27. Size 21 passes 12,000 gallons and size 27 passes 18,000 gallons per hour. They can deal with 4,500lb. and 7,000lb. of steam per hour respectively, and give a vacuum of 24in. of mercury with inlet water at 60deg. F. and barometer at 30in. The condensers are supplied from overhead tanks, placed on the roof, which have a total capacity of 21,000 gallons. These tanks are supplied with water from the River Worth by two 6in. Gwynne centrifugal pumps, driven by General Electric motors of 11 b.h.p. There is an ample supply of cold water available without using any cooling arrangements. Each pump is capable of delivering 30,000 gallons of water per hour when running at a speed of 925 revolutions per minute. The water for feeding the boilers is taken from the overhead tanks by a separate outlet delivering into a hot-well. The town supply is available in case of breakdown, but will only be used on

FIG. 5. Elevation of Electricity Works, Keighley.

emergency. A 12in. exhaust-pipe is open to atmosphere; and any engine can be exhausted either into condenser or atmosphere by operating two valves. The condensing plant and exhaust-pipe work has been carried out by Messrs. Lucy and Co., Limited, of Oxford.

The engine-room plant (Fig. 10) consists of three engines by Messrs. W. H. Allen and Co., Limited, of Bedford, two being of 200 i.h.p. and one of 330 i.h.p., at 360 revolutions

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per minute. They are all two-crank compound engines, of the enclosed forced lubrication type.

The dynamos are three in number, and were made by Messrs. Thomas Parker, Limited, of Wolverhampton, two coupled to boosters giving 100 amperes at from 20 to 90 volts for battery charging.

The switchboard consists of four enamelled slate slabs, the general arrangement of the instruments mounted upon

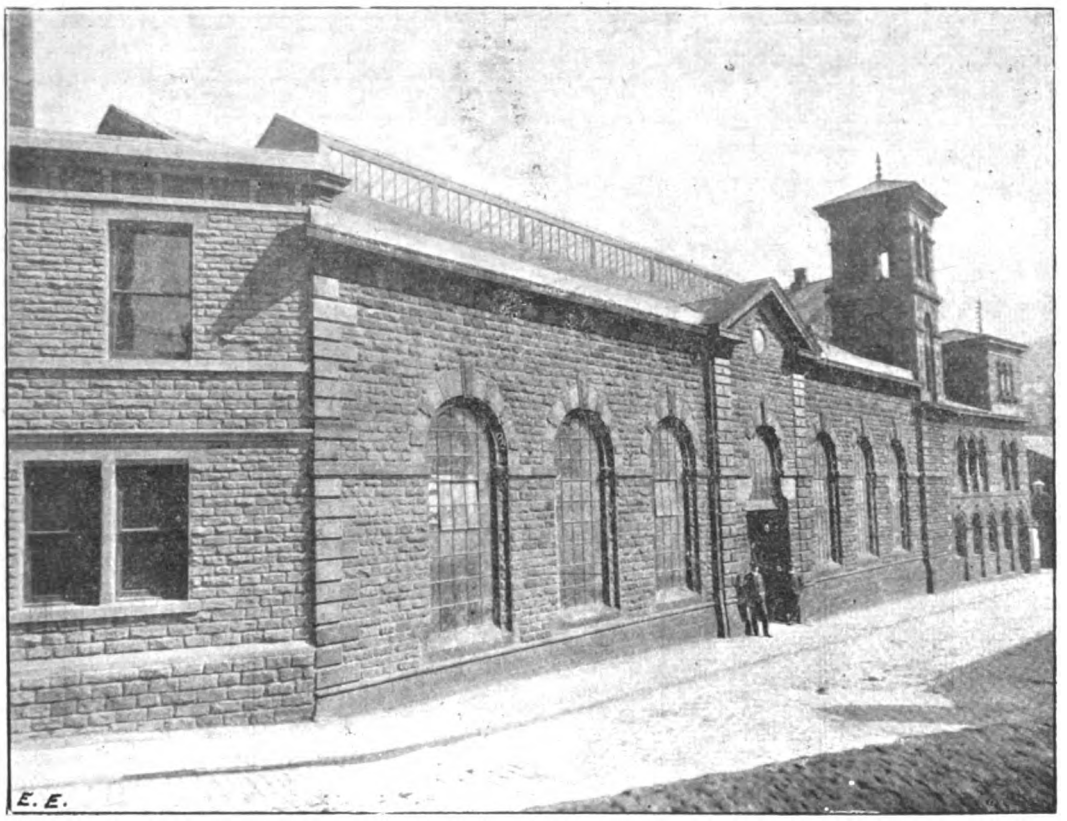

Fig. 6.—Elevation of Electricity Works, Keighley.

being bipolar and of 120 kw. capacity each, and one four-polar of 200 kw. capacity. All are direct coupled to the engines, and are shunt-wound for the lighting load, provision also being made whereby they may be over-compounded by cutting-in series coils for the contemplated traction load, the range of pressure being from 460 to 550 volts. Balancers are further provided which can supply a load of 50 kw. out of balance. These are direct

them being shown in Fig. 11. It is arranged for four dynamos, and there is ample room for further extensions. The two middle panels are for the battery, balancers, and

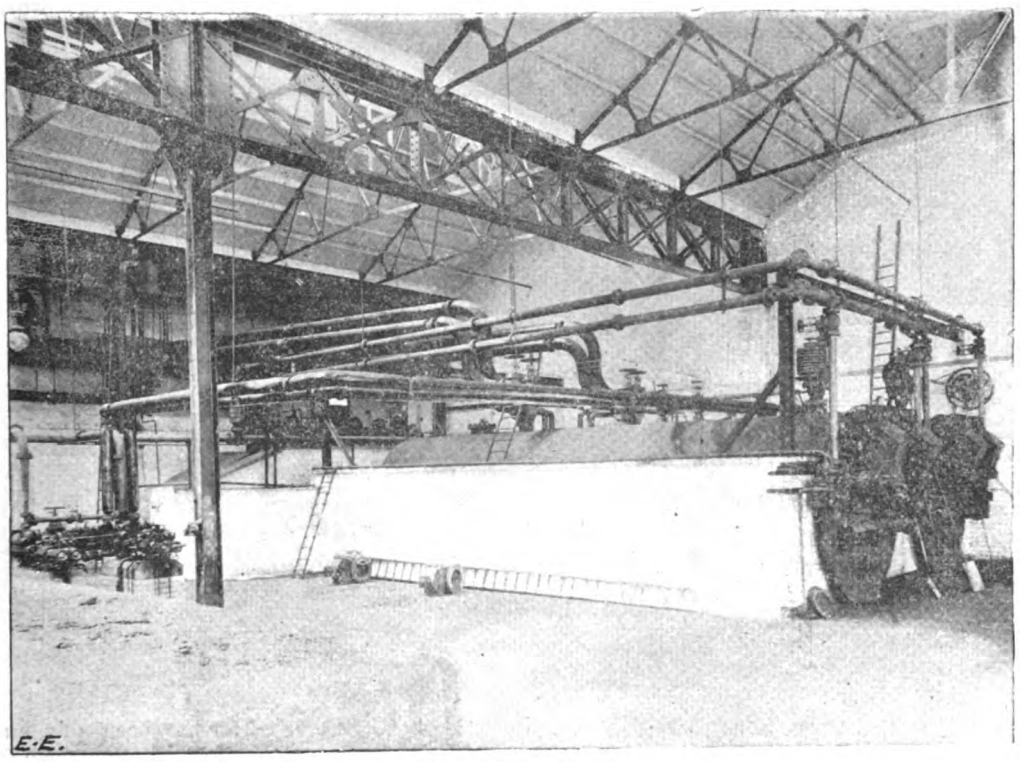

Fig. 7.—Interior of Boiler House, Keighley.

voltmeters. Chamberlain and Hookham meters are placed in circuit with the dynamos.

The battery consists of 256 cells, arranged in two groups of 128 each. They are of the Tudor L.B. 11-plate type in glass boxes. The capacity of the battery is 700 ampere-

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hours, the normal discharge rate being 70 amperes for 10 hours, and the emergency rate 300 amperes for one hour. The rate of charge is 100 amperes for seven hours.

An overhead travelling crane, designed to lift 10 tons, and for a span of 40ft., is provided in the engine-room. This was supplied by Messrs. J. Carrick and Sons, Limited, of Edinburgh. The repair workshop is equipped with a lathe and drilling machine run by electric motors.

Now we come to the outside work—in the first place, of

up amongst power users. The charges for electrical energy are as follows: 5d. per unit flat rate for lighting, or, at option of consumer, 7d. for first hour and 3d. after on the maximum demand system; for power, 2½d. per unit.

The existing horse tramways have recently been purchased from a company, and are to be equipped for electric traction at once. The length of line immediately in question is about three miles, but extensions will probably be carried out next summer.

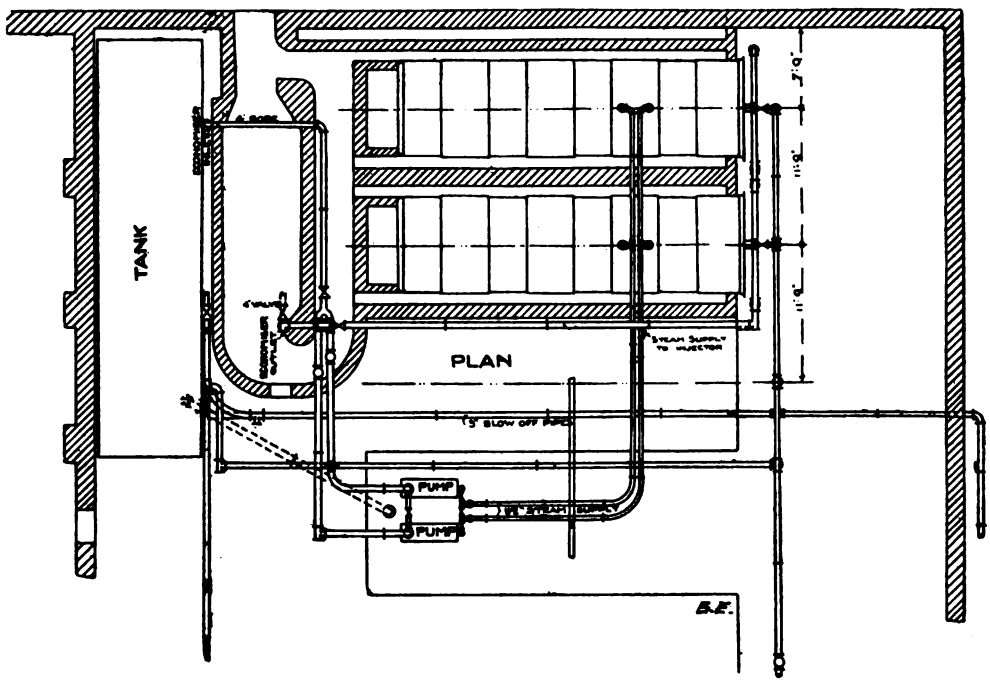

FIG. 8.—Plan of Feed Water Pumps and Pipes, Keighley.

course, the mains. These were supplied and laid by Messrs. Callenders, Limited, and consist of single cables, lead covered, and laid solid in earthenware troughs filled in with bitumen and covered with hard-burnt tiles. Up to date two feeders have been laid—one of ·4, ·15, ·4 square inch area, 800 yards long, and one of ·3, ·10, ·3 square inch area, 700 yards long. The distributing mains are of ·15, ·07, ·15

The chairman of the Electricity Committee, Alderman Paget, J.P., whose portrait we give herewith, is to be congratulated on having piloted to a successful issue the first work undertaken by the committee, and we trust that this, one of the latest additions to municipal electrical undertakings, will have the prosperous career which it deserves. The whole of the works described above has been designed

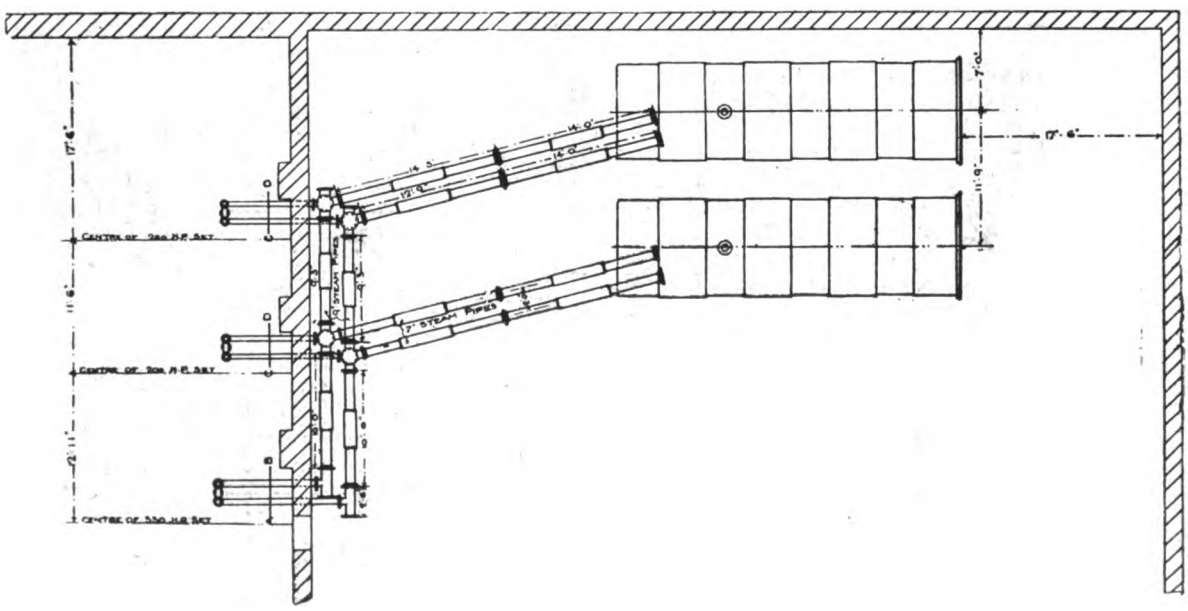

FIG. 9.—Plan of Main Steam Pipes, Keighley.

and ·10, ·05, ·10 square inch area; about four miles have been laid at present.

As regards public lighting, 24 arcs have been erected for this purpose, 12 of the enclosed type and 12 of the open type—all by Messrs. Crompton and Co., Limited. The equivalent number of 8-c.p. lamps at present connected is about 3,000, not including 10 h.p. in motors. It has been decided by the Corporation to let motors on hire, and already a considerable demand for small motors is springing

by Mr. J. M. Smyth, who has been ably assisted by Mr. H. Chilvers as architectural draughtsman and Mr. W. Mackintosh as assistant electrical engineer. Another point worthy of mention is that the works have been carried out to the original specification at a cost of about £31,000.

In conclusion, we have to thank Mr. Smyth for his courtesy in placing at our disposal the particulars and illustrations necessary for the preparation of this description.

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Smyth, John McFall, the borough electrical engineer, was born in 1869, and educated at Queen Elizabeth's Grammar School, Barnet, Herts, the Glasgow and West of Scotland Technical College, Glasgow, and University College, London. He served a five years' apprenticeship to mechanical engineering in the works of Messrs. Aitken, McNeil, and Co., Glasgow, and then one year in the engineering and electrical laboratories at the University College, London, under Profs. Beare and Fleming, afterwards spending another year in the drawing office and works of Messrs. Goolden and Co., London. From 1892 he spent three years as assistant engineer to the Metropolitan Electric Supply Company, acting as engineer at the Whitehall, Sardinia-street, Manchester-square, and Amberley-road stations. In 1895 he was appointed chief assistant electrical engineer at Blackburn, where, in addition to lighting, he was engaged on the equipment of three miles of overhead trolley tramways. In 1899 he received his present appointment as chief electrical engineer to the Keighley Corporation, for whom he has had the whole responsibility of carrying through the scheme for supply of electric light and power to the town. Mr. Smyth is an associate member of the Institute of Mechanical Engineers and the Institution of Electrical Engineers.

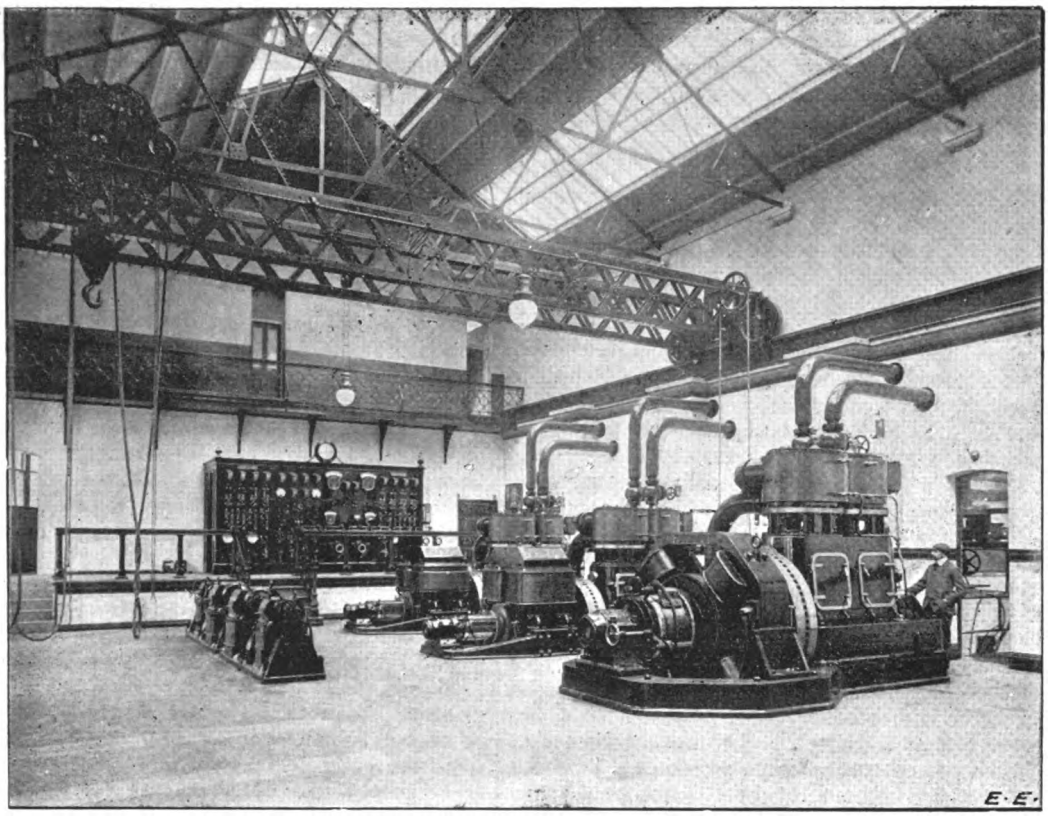

FIG. 10.—Interior of Engine Room, Keighley.

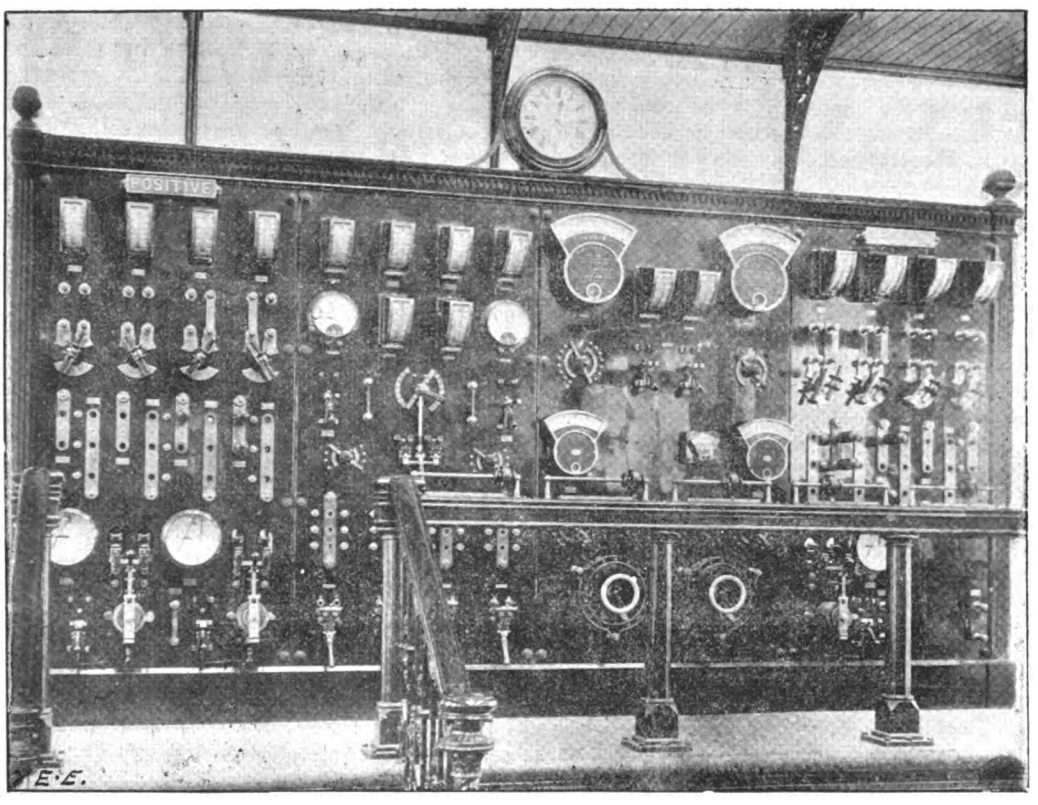

FIG. 11.—Elevation of Switchboard, Keighley.

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DESTRUCTION OF GAS-PIPES BY MEANS OF ELECTRICITY.*

BY DR. W. LEYBOLD, OF HAMBURG.

As is well known, for the distribution of gas in towns it is usual to lay long lengths of iron pipes, the largest of cast and the smaller of wrought iron. The durability of these pipes varies from 25 to 50 years, those of cast iron lasting longer than those of wrought. In a few cases a quicker destruction takes place—for instance, when the pipes are embedded in cinders or ashes. Pipes are also soon corroded in gasworks, where they are frequently laid in spent gas lime or spent oxide of iron, the constant formation of sulphate of iron, as well as sulphuric acid, most certainly producing a dissolving effect. Formerly it was customary in small gasworks to allow the gas liquor to run into the ground, and this also caused corrosion. The pipes were formerly, and are now, principally coated with hot tar before being laid in the ground. Lately several works, including those at Hamburg, have commenced to cover all wrought-iron pipes with canvas and boiled tar in order to protect them from outside destructive influences.

In recent years a new and previously unthought of enemy of our gas-pipes has showed itself—viz., electrolysis. Electric tramlines have been constructed, and through these a strong electric current is carried both above and below the surface of the ground. In most cases—at least, so far as Germany is concerned—the construction of these tramlines is so arranged that an electric current from one or more stations of about 500 volts passes into the wires lying above the surface leading to the trams, and after running into the motor lying below the trams, returns, by means of the rails, to the engines at the electricity works. In order to cause the easier return transmission, the single rails are jointed at the points they meet by thick copper wires soldered to them. As the rails give a certain resistance to the current used, it is evident that part of the current on a favourable opportunity—*i.e.*, at a short distance—will pass through the earth into the gas and water pipes.

This happens in such a way that the current from the places far distant from the electricity works goes from the rails into the pipes; whereas near the same works the current which has gone into the earth returns to the rails, and the part remaining in the rails returns to the engines, giving the current by the return transmission wire. As the pipes yield a less resistance to the current than the earth, a larger proportion of the current passes through the pipes than into the earth itself. The current flows from the rails into the pipes in the districts further away from the electricity works, and in the vicinity of the works again flows from the pipes into the rails, the pipes in this case proving to be the positive pole. The difference of tension between the pipe and the rail in various districts can be easily ascertained. It was advisable to determine whether, in pipes in the vicinity of which there were no electric trams, an electric current was in existence.

Dr. Bunte sent his assistant, Herr Lubberger, to investigate such a water-pipe on the tableland Plinz, near Karlsruhe. This tableland lies 140m. higher than Karlsruhe, and is 6 km. distant from the nearest electric station at Durlach. The system of water-pipes is certainly not influenced from the outside, and yet considerable tensions were found. Also, during the time when the electric trams were not running at night at Karlsruhe, tension was observed in the gas-pipes. Electric current flows in the pipes, and that pretty constantly.

The existence of the current at points which could not possibly be influenced by the electric current can only be traced to the fact that the pipes are made of cast and wrought iron, and that lead is used as a jointing material, which metals, lying under damp ground, produce a galvanic action. When early in the morning the traffic of the trams commences at Karlsruhe on one line only, it sends the tensions through the whole length of pipes to the most distant parts. When the tramline is in full working, there is everywhere a tension difference. In Hamburg this amounts to scarcely anything in some places, but generally about 0·2 to 1 volt, and near the electricity works even as much as 4·65 volts. It must be borne in mind that at that time the Hamburg trams were only supplied from one electric works in the Carolinen-street, so that the current in the rails must always return there. It may be seen from the yearly report for 1900 that the electric working line was about 100 km. long, and that about 400 cars were in use. The annual consumption of current amounted to 13 million kilowatt-hours.

The gasworks own a line of main pipes of 526 km. in length and 50mm. to 1,100mm. diameter, with 443 km. of service pipes for houses. The experiments were extended over the whole town, and, as already stated, some tension was found at almost every point.

Now, it is known that by the electric current, in the presence of saline solutions of different kinds, metals can easily be dissolved. Chloride of sodium is completely split up, and this is easily seen when two iron plates are placed in a solution of chloride of sodium, and a current allowed to pass through them. In the negative pole a development of hydrogen at once takes place, while the fluid rapidly becomes thick through the separation of green protoxide of iron. Chloride of sodium is split up by the electric current into chlorine and sodium, which latter forms with water sodium hydroxide and hydrogen. The chlorine runs to the positive pole, and forms there protochloride of iron. This is precipitated by the sodium hydroxide as mentioned, as protoxide of iron. The process thus goes on until the positive pole is completely dissolved.

The process is easily shown if a current of electricity is passed through a thick glass pipe, closed at both ends by sheet-iron plates and filled with sand soaked in a solution of chloride of sodium. The sand at the positive pole becomes of a green colour, as it sucks up the protoxide of iron which is formed. By degrees a yellow rust is produced through the admission of air. The same effect is caused by a solution of chloride of ammonia, gypsum, carbonate of lime, in such organic salts as are always found in the earth, and also of a watery solution of earth.

The ground in Hamburg contains small quantities of chloride of sodium to the extent of 0·006 to 0·04 per cent. It is also known that the electric tramway authorities in winter time melt up the snow and ice on the rails with raw salt or refuse of refined nitrate of soda. Soft ground is saturated with the solution, whereas from asphalte or granite pavement it flows off to the sewers. Accordingly, an opportunity is afforded for the eating-up of iron in the earth in the presence of a solution of salt and an electric current. American newspapers have from time to time mentioned this matter, but in Germany nothing of the kind was noticed until a few years ago. In Hamburg the first electric tramway (called the circular tram) was constructed in 1884; and gradually all tramways were converted into electric trams, the whole work being completed by about the end of 1899.

In April, 1899, close to the electricity works in the Carolinen-street, an escape of gas was found. On one side of the street is the main gas-pipe of cast iron. Wrought-iron service pipes cross the road to the lamps on the other side. In the middle of the road there are two lines of tramway rails, cars passing at intervals of three minutes, so that about every 1½ minutes a tram passes any particular spot. The rails are placed upon a bed of concrete 0·2m thick. The gas-pipes are laid at right angles to the rails at a depth of from 0·55m. to 1m. The street is paved with granite setts jointed with asphalte. Upon investigating the cause of the gas escape, a hole was found in a wrought-iron pipe under the first rail, and after further investigating the matter, a complete penetration was discovered under every rail. The pipe was taken out of the ground, and the four holes coincided exactly with the positions of the rails. Upon closer examination it was found that nearly all the pipes in this street were damaged in a similar way.

Owing to the holes fitting in exactly with the positions of the rails, it was clear that an electric influence was the cause. A melting of the pipes, as was often found in the case of the transmission of a strong current into gas-pipes in houses, had evidently not taken place.

These 1in. pipes are covered with canvas soaked in boiled tar. The investigation in the laboratory gave the following result: In some places the tar as well as the canvas had

* Paper read in Section VIII. of the Glasgow International Engineering Congress.

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fallen off, and the pipes were eaten through in parts to the size of a centimetre. In removing the covering it was found that the corrosion existed in every stage, from the beginning until the complete penetration. Curiously enough, the destruction was principally of spiral formation, and coincided with the wrapping of the canvas, where between the stripe of the canvas a portion of tar had been pressed out.

In many places there were blisters between the iron and the tar, which were filled up with a green solution of protochloride of iron, in some places also with crystals of the same salt. From such a blister 0·032 grain of crystalised protochloride of iron was taken out, the fluid (about one cubic centimetre) contained 0·0604 grain of protochloride of iron, 0·0086 grain of chloride of sodium, 0·0095 grain of chloride of ammonia, and 0·0037 grain of free hydrochloric acid. The solution was very sour, and a strong destruction of the iron was visible.

At other places there were also found blisters concealed by the layers of tar, which were filled with a green, slimy mass of protoxide of iron, of which it contained about 0·2 grain. Here also the decay was strongly visible. In other parts the iron was completely eaten through, and covered with a thick layer of rust, the tar as well as the canvas at these places having become soft and brittle. The rust of the iron was very considerable, and contained acid, beside oxide of iron, about 9½ per cent. protochloride of iron and chloride of iron; also 0·8 per cent. of sulphate of iron. Only 0·12 per cent. of chloride of sodium was found.

The collection of these chlorides of salts in one place is very strange. They were derived without doubt from common salt. Therefore, where a particle of a solution of salt can penetrate the tar covering the iron, the destruction commences, and, as previously stated, in one or two ways, either into protochloride of iron or protoxide of iron—apparently as the formed hydrate of sodium gets to the spot in question, and replaces the dissolved iron, or not.

Examined samples of the earth taken from the vicinity of the pipes consisted of clayish sand containing 0·006 to 0·04 per cent. of chloride of sodium, and in other parts 0·007 and 0·012 per cent. Apparently the wrapping with boiled tar and canvas favours the destruction, for in the blisters under the tar it quietly goes on; while with a direct bedding of the pipes into the earth without any covering, the earth would have absorbed the fluid.

All the gas-pipes in the Carolinen-street were taken up and replaced by others all covered; but after the expiration of seven to eight months, the destruction showed itself to have taken place again in the same manner as before, the pipes being penetrated with holes.

New trials were then made with pipes simply covered and tarred, also with untarred pipes, and others protected by being placed inside a second one. After two years—during which time the electricity works had taken some measures to prevent damage—the covered pipes showed signs of destruction, also the outer pipe, while the one inside it remained intact. The plain tarred, and also the untarred pipes, were fairly well preserved, though heavily covered with rust, but it could not be decided whether to a greater extent than in other streets. In exposing same to the air the rust covering of about 2mm. fell off. Besides this, the pipes were covered all round with a firm layer of sand.

The quantity of common salt and soluble salts of iron in the rust was in this case very small. One pipe covered partly with 5mm. of copper wire was laid down. The same after two years had turned into a green mass, consisting of carbonate of copper and hydrate of copper, besides chloride of copper, and 0·7 per cent. of chloride of sodium. It appears doubtful whether the packing protects the pipes; but, anyhow, at every bending of the covered pipes, the covering was destroyed by the falling off of the tar. Meanwhile, other pipes of different kinds, covered and uncovered, were placed in particularly dangerous spots.

Every endeavour must be made to reduce the currents passing into the pipes; and when laying down electric tramways, great care must be taken to prevent the current flowing into the earth. This can be done in one way by the laying of well-conducted rails; the rails having sufficient transverse section, and the points of contact well joined together by soldered copper wire. The welding of the points of contact (according to the system of Dr. Goldschmidt, of Essen) by means of thermite, will probably be of great service. A further method—and this should certainly be done in Hamburg—is by fixing insulated return transmission cables in many places, in order to direct the current back from the rails to the electricity works, and thus to disburden the rails. These cables should be distributed in such a manner that the tension in the rails becomes sufficiently small. Only where small tramways come into consideration can such cables be dispensed with.

With the quick development of the electric tram traffic in Hamburg, the engines were in the beginning connected with the rails in the vicinity of the works by plain copper wires; and it was remarked that, even under these wires, the gas-pipes showed signs of decay. Formerly the current for the trams was supplied from one works only. During last year a second one was opened at Barmbeck; and shortly a third one at Hammerbrook will be opened, in order to assist the others. The supply will then be divided among the three works. The tensions at each place will therefore be lessened.

The electricity authorities were persuaded to place a large number of insulated return transmissions similar to the feeding cables of the trams, and in consequence of this measure, the destruction of gas-pipes caused by the current escaping from the rails can in future be left out of the question. While formerly in the Carolinen-street tensions between rails and gas-pipes occurred up to five volts, these have now been lessened to 0·45 volt maximum. Also in the whole system of the town a pretty uniform and very small tension is observable, which in some cases is nought, and even has a tendency on the other side.

The whole affair has cost a great deal of money to the electricity works, but the measures taken proved to be necessary in order to avoid the threatened danger to all the gas and water pipes. It has to be remarked that in cast-iron pipes no such destruction has so far been perceptible—the pipes of the waterworks, which generally are lying deeper than those of the gasworks, showed no signs of decay, with the exception of some lead pipes in the vicinity of the rails.

Not long since, at Erfurt, similar damage appeared. Upon the commencement of the running of the electric trams the old rails of the tramway were kept in use. They were not suitable, however, for the heavy electric tram; the consequence was that the connection of the rails became bad, owing to the proportionately heavy bending at the points where the rails meet each other. They gradually became looser and looser, and this, in conjunction with the very small transverse section, caused great electrical resistance in the current. This circumstance is no doubt the cause which led to the finding of the electrical destruction of the pipes at Erfurt.

Recently the German Electrical Technical Association has been busy with the drawing up of directions for the protection of gas and water pipes, and they prepared a statement of precautions, of which particulars will shortly be published. In the report the requisite directions will be given for construction and arrangements, so that the escaping currents may be reduced to a minimum. At any rate, gas and water works can demand that the electricity authorities shall do everything in their power to protect their pipes. It may be remarked that electric currents in dwelling-houses are suspected of having caused destruction to embedded pipes within the walls, whereby the electric wires must have a connection with the earth. Such an example has been recently found.

It is well known that among different metal currents circulate in a solution of salt, as, for example, in a gas-meter, the drum of which consists of Britannia metal, and the outer casing of lead-covered iron plate; whereas the filling is chiefly salty glycerine, chloride of lime, chloride of magnesia, or water. The water of Hamburg is filtered water from the River Elbe, one litre containing 0·25 grain of salt. Even this is sufficient to produce a current. This may be to a certain extent the cause of the gasmeter drums being destroyed. A slight current also circulates in the station governor of a gasworks between the outside tank

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and the governor bell, the tank consisting of cast iron and the bell commonly of tin-plated iron sheets. Sometimes in this apparatus signs of destruction are found, principally on the bell and on the closed air-vessel.

It is hoped that the author has shown in the paper that the electric currents are of great importance to gas companies, and that they are worth serious observation, with a view to the protection of their property.

DISCUSSION.

The **Chairman** (Mr. George Livesey), in opening the discussion, said that the subject of the paper was of extreme importance to all present. He held that the undertakers for the distribution of electrical energy should be bound to keep their electricity to themselves. He personally had no doubt but that the Board of Trade would take further action in the matter in the near future.

Mr. James Mansergh said that the subject was equally important to water engineers as to the gas industry. He was pleased to find that Mr. Geo. Livesey was agitating so strongly in the matter, and felt quite safe in consequence.

Mr. Carpenter said that his first experience with electrolysis occurred in the Clapham-road, where a 4in. main was eaten practically away. They made an experiment by introducing an insulated joint in the gas-pipe and connecting the two sides through an ammeter. They found that a considerable current was regularly passing through the pipe. He urged those present to keep a careful watch for the earliest sign of electrolysis, so that a joint action could be taken to prevent electrical engineers having their own way altogether.

Mr. George Livesey interposed to say that if any member found evidence of electrolytic action, they should not remove the pipe which had been damaged, but should advise him so that Messrs. Ayrton and Perry could report on the occurrence *in situ*. It was only in this way that a strong case could be prepared.

Another member, whose name was not given at the meeting, agreed with the author that cast-iron pipes were free from attack, whereas wrought-iron pipes soon were destroyed. He protected his pipes by surrounding them with a mixture of tar and pitch in a V-shaped wooden trough. He thought that the electrical action largely depended on the salts in the soil, and it was elicited that in the case spoken of there was no system of electric traction or even of electric light in the town.

Other gentlemen present, whose names were also not given, stated that a large current was not required to produce electrolysis, but that if once a small current started the action, it would go on for ever. This intimate knowledge of electrical matters was added to by a speaker who said that one-thousandth part of a volt was quite sufficient to cause electrolysis.

Mr. Gisbert Kapp said that he had addressed on behalf of a German society of electrical engineers circular letters to all the gas managers in the German Empire. He was surprised to find that only 5 to 6 per cent. of the gas companies in towns where electric light and tramways were in use had replied at all; also the number of complaints of damage were exceedingly few. He quite agreed that the seven-volt limit of the Board of Trade was quite inadequate as a means of protection. Even two volts would be dangerous in certain cases. He personally had been on the committee appointed to discuss the Board of Trade rules, and he believed that the seven-volt limit was selected without any reason whatever. Referring to the German experience, it was obvious that the tramways at Hamburg must give trouble, as the path for the return current from the tramways was most inadequate when the lines were first equipped. He explained that good bonding was most essential, and that besides the cross-bonding, a longitudinal wire laid at the centre of the track as a protection in case the bonds on two opposite joints should give out together. Again, insulated return conductors were most essential, but these would not give the protection required unless a system of negative boosters was also employed. He explained to the meeting the working of a system of negative boosters having their field circuits excited by the current in the positive feeders. In this way the negative boost could be kept proportionate to the exigencies of the tramway service, and an even potential could be kept on the rails. This prevented electrolysis, and with good bonding gave protection to the gas and water pipes.

The **Author**, in reply, thanked those who had taken part in the discussion for the kindly way in which they had received his paper.

THE BRITISH ASSOCIATION.

Presidential Address.

BY PROF. ARTHUR W. RUCKER, M.A., LL.D., D.SC., SEC.R.S.

The first thought in the minds of all of us to-night is that since we met last year the great Queen, in whose reign nearly all the meetings of the British Association have been held, has passed to her rest. To sovereigns most honours and dignities come as of right; but for some of them is reserved the supreme honour of an old age softened by the love and benedictions of millions; of a path to the grave, not only magnificent, but watered by the tears both of their nearest and dearest, and of those who, at the most, have only seen them from afar. This honour Queen Victoria won. All the world knows by what great abilities, by what patient labour, by what infinite tact and kindliness, the late Queen gained both the respect of the rulers of nations and the affection of her own subjects. Her reign, glorious in many respects, was remarkable, outside these islands, for the growth of the Empire; within and without them, for the drawing nearer of the Crown and the people in mutual trust; while, during her lifetime, the developments of science and of scientific industry have altered the habits and the thoughts of the whole civilised world.

The representatives of science have already expressed in more formal ways their sorrow at the death of Queen Victoria, and the loyalty and confident hope for the future with which they welcome the accession of King Edward. But none the less, I feel sure that at this, the first meeting of the British Association held in his reign, I am only expressing the universal opinion of all our members when I say that no group of the King's subjects trusts more implicitly than we do in the ability, skill, and judgment which his Majesty has already shown in the exercise of the powers and duties of his august office; that none sympathise more deeply with the sorrows which two great nations have shared with their sovereigns; and that none cry with more fervour, "Long live the King."

But this meeting of the British Association is not only remarkable as being the first in a new reign. It is also the first in a new century. It is held in Glasgow at a time when your international exhibition has in a special sense attracted the attention of the world to your city, and when the recent celebration of the ninth jubilee of your university has shown how deeply the prosperity of the present is rooted in the past. What wonder, then, if I take the chair to which you have called me with some misgivings? Born and bred in the South, I am to preside over a meeting held in the largest city of Scotland. As your chosen mouthpiece I am to speak to you of science when we stand at the parting of the centuries, and when the achievements of the past and present, and the promise of the future, demand an interpreter with gifts of knowledge and divination to which I cannot pretend. Lastly, I am president of the British Association as a disciple in the home of the master, as a physicist in a city which a physicist has made for ever famous. Whatever the future may have in store for Glasgow, whether your enterprise is still to add wharf to wharf, factory to factory, and street to street, or whether some unforeseen "tide in the affairs of men" is to sweep energy and success elsewhere, 53 years in the history of your city will never be forgotten while civilisation lasts.

More than half a century ago a mere lad was the first to compel the British Association to listen to the teaching of Joule, and to accept the law of the conservation of energy. Now, alike in the most difficult mathematics and in the conception of the most ingenious apparatus, in the daring of his speculations and in the soundness of his engineering, William Thomson, Lord Kelvin, is regarded as a leader by the science and industry of the whole world. It is the less necessary to dwell at length upon all that he has done, for Lord Kelvin has not been without honour in his own country. Many of us who meet here to-night met last in Glasgow, when the university and city had invited representatives of all nations to celebrate the jubilee of his professorship, for those two or three days' learning was surrounded with a pomp seldom to be seen outside a palace. The strange Middle-Age costumes of all the chief universities of the world were jostling here, the outward signs that those who were themselves distinguished in the study of nature had gathered to do honour to one of the most distinguished of them all. Lord Kelvin's achievements were then described in addresses in every tongue, and therefore I will only remind you that we assembled here to-night owe him a heavy debt of gratitude, for the fact that the British Association enters on the twentieth century conscious of a work to do and of the vigour to do it, is largely due to his constant presence at its meetings, and to the support he has so ungrudgingly given. We have learned to know not only the work of our great leader, but the man himself; and I count myself happy because in his life-long home, under the walls of the university he served so well, and at a meeting of the association which his genius has so often illuminated, I am allowed, as

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your president, to assure him in your name of the admiration, respect, nay, of the affection, in which we all hold him.

I have already mentioned a number of circumstances which make our meeting this year noteworthy. To these I must add that for the first time we have a section for education, and the importance of this new departure, due largely to the energy of Prof. Armstrong, is emphasised by the fact that the chair of that section will be occupied by the vice-president of the Committee of Council on Education—Sir John Gorst. I will not attempt to forecast the proceedings of the new section. Education is passing through a transitional stage. The recent debates in Parliament, the great gifts of Mr. Carnegie, the discussion as to university organisation in the North of England, the reconstitution of the University of London, the increasing importance attached to the application of knowledge, both to the investigation of nature and to the purposes of industry, are all evidence of the growing conviction that without advance in education we cannot retain our position among the nations of the world. If the British Association can provide a platform on which these matters may be discussed in a scientific but practical spirit, free from the misrepresentations of the hustings and the exaggerations of the partisan, it will contribute in no slight measure to the national welfare.

But amid the old and new activities of our meeting the undertone of sadness, which is never absent from such gatherings, will be painfully apparent to many of us at Glasgow. The life work of Prof. Tait has ended amid the gloom of the war cloud. A bullet, fired thousands of miles away, struck him to the heart, so that in their deaths the father and the brave son, whom he loved so well, were not long divided. Within the last year, too, America has lost Rowland; Viriamu Jones, who did yeoman's service for education and for science, has succumbed to a long and painful illness; and one who last year at Bradford seconded the proposal that I should be your president at Glasgow, and who would unquestionably have occupied this chair before long had he been spared to do so, has unexpectedly been called away. A few months ago we had no reason to doubt that George Francis FitzGerald had many years of health and work before him. He had gained in a remarkable way not only the admiration of the scientific world, but the affection of his friends, and we shall miss sadly one whom we all cared for, and who, we hoped, might yet add largely to the achievements which had made him famous.

The Science of the Nineteenth Century.—Turning from these sad thoughts to the retrospect of the century which has so lately ended, I have found it to be impossible to free myself from the influence of the moment and to avoid, even if it were desirable to avoid, the indication to look backward from the standpoint of to-day. Two years ago Sir Michael Foster dealt with the work of the century as a whole. Last year Sir William Turner discussed in greater detail the growth of a single branch of science. A third and humbler task remains—viz., to fix our attention on some of the hypotheses and assumptions on which the fabric of modern theoretical science has been built, and to enquire whether the foundations have been so "well and truly" laid that they may be trusted to sustain the mighty superstructure which is being raised upon them. The moment is opportune. The three chief conceptions which for many years have dominated physical as distinct from biological science have been the theories of the existence of atoms, of the mechanical nature of heat, and of the existence of the ether. Dalton's atomic theory was first given to the world by a Glasgow professor—Thomas Thomson—in the year 1807, Dalton having communicated it to him in 1804. Rumford's and Davy's experiments on the nature of heat were published in 1798 and 1799 respectively; and the celebrated Bakerian lecture in which Thomas Young established the undulatory theory by explaining the interference of light, appeared in the *Philosophical Transactions* in 1801. The keynotes of the physical science of the nineteenth century were thus struck, as the century began, by four of our fellow-countrymen, one of whom—Sir Benjamin Thompson, Count Rumford—preferred exile from the land of his birth to the loss of his birthright as a British citizen.

Doubts as to Scientific Theories.—It is well known that of late doubts have arisen as to whether the atomic theory, with which the mechanical theory of heat is closely bound up, and the theory of the existence of an ether have not served their purpose, and whether the time has not come to reconsider them. The facts that Prof. Poincaré, addressing a congress of physicists in Paris, and Prof. Poynting, addressing the Physical Section of the association, have recently discussed the true meaning of our scientific methods of interpretation; that Dr. James Ward has lately delivered an attack of great power on many positions which eminent scientific men have occupied; and that the approaching end of the nineteenth century led Prof. Hæckel to define in a more popular manner his own very definite views as to the solution of the "Riddle of the Universe," are perhaps a sufficient justification of an attempt to lay before you the difficulties which surround some of these questions. To keep the discussion within reasonable limits I shall illustrate the principles under review by means of the atomic theory, with comparatively little reference to the ether, and we may also at first confine our attention to inanimate objects.

The Construction of a Model of Nature.—A natural philosopher, to use the old phrase, even if only possessed of the most superficial knowledge, would attempt to bring some order into the results of his observation of nature by grouping together statements with regard to phenomena which are obviously related. The aim of modern science goes far beyond this. It not only shows that many phenomena are related which at first sight have little or nothing in common, but, in so doing, also attempts to explain the relationship. Without spending time on a discussion of the meaning of the word "explanation," it is sufficient to say that our efforts to establish relationships between phenomena often take the form of attempting to prove that if a limited number of assumptions are granted as to the constitution of matter, or as to the existence of quasi-material entities, such as caloric, electricity, and the ether, a wide range of observed facts falls into order as a necessary consequence of the assumptions. The question at issue is whether the hypotheses which are at the base of the scientific theories now most generally accepted are to be regarded as accurate descriptions of the constitution of the universe around us, or merely as convenient fictions. Convenient fictions, be it observed, for even if they are fictions, they are not useless. From the practical point of view, it is a matter of secondary importance whether our theories and assumptions are correct, if only they guide us to results which are in accord with facts. The whole fabric of scientific theory may be regarded merely as a gigantic "aid to memory"; as a means for producing apparent order out of disorder by codifying the observed facts and laws in accordance with an artificial system, and thus arranging our knowledge under a comparatively small number of heads. The simplification introduced by a scheme which, however imperfect it may be, enables us to argue from a new first principles, makes theories of practical use. By means of them, we can foresee the results of combinations of causes which would otherwise elude us. We can predict future events, and can even attempt to argue back from the present to the unknown past.

But it is possible that these advantages might be attained by means of axioms, assumptions, and theories based on very false ideas. A person who thought that a river was really a streak of blue paint might learn as much about its direction from a map as one who knew it as it is. It is thus conceivable that we might be able, not indeed to construct, but to imagine, something more than a mere map or diagram—something which might even be called a working model of inanimate objects, which was, nevertheless, very unlike the realities of nature. Of course, the agreement between the action of the model and the behaviour of the things it was designed to represent would probably be imperfect, unless the one were a fac-simile of the other; but it is conceivable that the correlation of natural phenomena could be imitated, with a large measure of success, by means of an imaginary machine, which shared with a map or diagram the characteristic that it was in many ways unlike the things it represented, but might be compared to a model in that the

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behaviour of the things represented could be predicted from that of the corresponding parts of the machine. We might even go a step further. If the laws of the working of the model could be expressed by abstractions, as, for example, by mathematical formulæ, then, when the formulæ were obtained, the model might be discarded, as probably unlike that which it was made to imitate, as a mere aid in the construction of equations, to be thrown aside when the perfect structure of mathematical symbols was erected. If this course were adopted, we should have given up the attempt to know more of the nature of the objects which surround us than can be gained by direct observation, but might nevertheless have learned how these objects would behave under given circumstances. We should have abandoned the hope of a physical explanation of the properties of inanimate nature, but should have secured a mathematical description of her operations. There is no doubt that this is the easiest path to follow Criticism is avoided if we admit from the first that we cannot go below the surface; cannot know anything about the constitution of material bodies; but must be content with formulating a description of their behaviour by means of laws of nature expressed by equations.

But if this is to be the end of the study of nature, it is evident that the construction of the model is not an essential part of the process. The model is used merely as an aid to thinking; and if the relations of phenomena can be investigated without it, so much the better. The highest form of theory—it may be said—the widest kind of generalisation, is that which has given up the attempt to form clear mental pictures of the constitution of matter, which expresses the facts and the laws by language and symbols which lead to results that are true, whatever be our view as to the real nature of the objects with which we deal. From this point of view the atomic theory becomes not so much false as unnecessary; it may be regarded as an attempt to give an unnatural precision to ideas which are and must be vague. Thus, when Rumford found that the mere friction of metals produced heat in unlimited quantity, and argued that heat was, therefore, a mode of motion, he formed a clear mental picture of what he believed to be occurring. But his experiments may be quoted as proving only that energy can be supplied to a body in indefinite quantity, and when supplied by doing work against friction it appears in the form of heat. By using this phraseology we exchange a vivid conception of moving atoms for a colourless statement as to heat energy, the real nature of which we do not attempt to define; and methods which thus evade the problem of the nature of the things which the symbols in our equations represent have been prosecuted with striking success, at all events within the range of a limited class of phenomena. A great school of chemists, building upon the thermodynamics of Willard Gibbs and the intuition of Van t'Hoff, have shown with wonderfull skill that if a sufficient number of the data of experiment are assumed, it is possible, by the aid of thermodynamics, to trace the form of the relations between many physical and chemical phenomena without the help of the atomic theory. But this method deals only with matter as our coarse senses know it; it does not pretend to penetrate beneath the surface. It is, therefore, with the greatest respect for its authors, and with a full recognition of the enormous power of the weapons employed, that I venture to assert that the exposition of such a system of tactics cannot be regarded as the last word of science in the struggle for the truth. Whether we grapple with them or whether we shirk them, however much or however little we can accomplish without answering them, the questions still force themselves upon us: Is matter what it seems to be? Is interplanetary space full or empty? Can we argue back from the direct impressions of our senses to things which we cannot directly perceive; from the phenomena displayed by matter to the constitution of matter itself? It is these questions which we are discussing to-night, and we may therefore, as far as the present address is concerned, put aside, once for all, methods of scientific exposition in which an attempt to form a mental picture of the constitution of matter is practically abandoned, and devote ourselves to the enquiries whether the effort to form such a picture is legitimate, and whether we have any reason to believe that the sketch which science has already drawn is to some extent a copy, and not a mere diagram, of the truth.

Successive Steps in the Analysis of Matter.—In dealing, then, with the question of the constitution of matter and the possibility of representing it accurately, we may grant at once that the ultimate nature of things is, and must remain, unknown; but it does not follow that immediately below the complexities of the superficial phenomena which affect our senses there may not be a simpler machinery of the existence of which we can obtain evidence—indirect, indeed, but conclusive. The fact that the apparent unity which we call the atmosphere can be resolved into a number of different gases is admitted; though the ultimate nature of oxygen, nitrogen, argon, carbonic acid, and water vapour is as unintelligible as that of air as a whole, so that the analysis of air may be said to have substituted many incomprehensibles for one. Nobody, however, looks at the question from this point of view. It is recognised that an investigation into the proximate constitution of things may be useful and successful, even if their ultimate nature is beyond our ken. Nor need the analysis stop at the first step. Water vapour and carbonic acid, themselves constituents of the atmosphere, are in turn resolved into their elements—hydrogen, oxygen, and carbon—which, without a formal discussion of the criteria of reality, we may safely say are as real as air itself.

Now, at what point must this analysis stop if we are to avoid crossing the boundary between fact and fiction? Is there any fundamental difference between resolving air into a mixture of gases and resolving an elementary gas into a mixture of atoms and ether? There are those who cry halt at the point at which we divide a gas into molecules, and their first objection seems to be that molecules and atoms cannot be directly perceived, cannot be seen or handled, and are mere conceptions, which have their uses, but cannot be regarded as realities. It is easiest to reply to this objection by an illustration. The rings of Saturn appear to be continuous masses, separated by circular rifts. This is the phenomenon which is observed through a telescope. By no known means can we ever approach or handle the rings; yet everybody who understands the evidence now believes that they are not what they appear to be, but consist of minute moonlets, closely packed indeed, but separate the one from the other. In the first place, Maxwell proved mathematically that if a Saturnian ring were a continuous solid or fluid mass it would be unstable and would necessarily break into fragments. In the next place, if it were possible for the ring to revolve like a solid body, the inmost parts would move slowest, while a satellite moves faster the nearer it is to a planet. Now spectroscopic observation based on the beautiful method of Sir W. Huggins, shows not only that the inner portions of the ring move the more rapidly, but that the actual velocities of the outer and inner edges are in close accord with the theoretical velocities of satellites at like distances from the planet. This and a hundred similar cases prove that it is possible to obtain convincing evidence of the constitution of bodies between whose separate parts we cannot directly distinguish, and I take it that a physicist who believes in the reality of atoms thinks that he has as good reason for dividing an apparently continuous gas into molecules as he has for dividing the apparently continuous Saturnian rings into satellites. If he is wrong, it is not the fact that molecules and satellites alike cannot be handled and cannot be seen as individuals, that constitutes the difference between the two cases.

It may, however, be urged that atoms and the ether are alleged to have properties different from those of matter in bulk, of which alone our senses take direct cognisance, and that therefore it is impossible to prove their existence by evidence of the same cogency as that which may prove the existence of a newly discovered variety of matter or of a portion of matter too small or too distant to be seen.

This point is so important that it requires full discussion, but in dealing with it it is necessary to distinguish carefully between the validity of the arguments which support the earlier and more fundamental propositions of the theory; and the evidence brought forward to justify mere specu-

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lative applications of its doctrines which might be abandoned without discarding the theory itself. The proof of the theory must be carried out step by step. The first step is concerned wholly with some of the most general properties of matter, and consists in the proof that those properties are either absolutely unintelligible, or that, in the case of matter of all kinds, we are subject to an illusion similar to that the results of which we admit in the case of Saturn's rings, clouds, smoke, and a number of similar instances. The believer in the atomic theory asserts that matter exists in a particular state; that it consists of parts which are separate and distinct the one from the other, and as such are capable of independent movements.

Up to this point no question arises as to whether the separate parts are, like grains of sand, mere fragments of matter; or whether, though they are the bricks of which matter is built, they have, as individuals, properties different from those of masses of matter large enough to be directly perceived. If they are mere fragments of ordinary matter, they cannot be used as aids in explaining those qualities of matter which they themselves share. We cannot explain things by the things themselves. If it be true that the properties of matter are the product of an underlying machinery, that machinery cannot itself have the properties which it produces, and must, to that extent at all events, differ from matter in bulk, as it is directly presented to the senses. If, however, we can succeed in showing that if the separate parts have a limited number of properties (different, it may be, from those of matter in bulk), the many and complicated properties of matter can, to a considerable extent, be explained as consequences of the constitution of these separate parts, we shall have succeeded in establishing, with regard to quantitative properties, a simplification similar to that which the chemist has established with regard to varieties of matter. The many will have been reduced to the few. The proofs of the physical reality of the entities discovered by means of the two analyses must necessarily be different. The chemist can actually produce the elementary constituents into which he has resolved a compound mass. No physicist or chemist can produce a single atom separated from all its fellows and show that it possesses the elementary qualities he assigns to it. The cogency of the evidence for any suggested constitution of atoms must vary with the number of facts which the hypothesis that they possess that constitution explains. Let us take, then, two steps in their proper order, and enquire, first, whether there is valid ground for believing that all matter is made up of discrete parts; and, secondly, whether we can have any knowledge of the constitution or properties which those parts possess.

The Course-grainedness of Matter.—Matter in bulk appears to be continuous. Such substances as water or air appear to the ordinary observer to be perfectly uniform in all their properties and qualities, in all their parts. The hasty conclusion that these bodies are really uniform is, nevertheless, unthinkable. In the first place, the phenomena of diffusion afford conclusive proof that matter when apparently quiescent is, in fact, in a state of internal commotion. I need not recapitulate the familiar evidence to prove that gases and many liquids when placed in communication interpenetrate or diffuse into each other; or that air, in contact with a surface of water, gradually becomes laden with water vapour, while the atmospheric gases in turn mingle with the water. Such phenomena are not exhibited by liquids and gases alone, nor by solids at high temperatures only. Sir W. Roberts-Austen has placed pieces of gold and lead in contact at a temperature of 18deg. C. After four years the gold had travelled into the lead to such an extent that not only were the two metals united, but on analysis appreciable quantities of the gold were detected even at a distance of more than 5mm. from the common surface, while within a distance of $\frac{1}{4}$mm. from the surface gold had penetrated into the lead to the extent of 1oz. 6dwt. per ton, an amount which could have been profitably extracted. Whether it is or is not possible to devise any other intelligible account of the cause of such phenomena, it is certain that a simple and adequate explanation is found in the hypothesis that matter consists of discrete parts in a state of motion, which can penetrate into the spaces between the corresponding parts of surrounding bodies.

The hypothesis thus framed is also the only one which affords a rational explanation of other simple and well-known facts. If matter is regarded as a continuous medium, the phenomena of expansion are unintelligible. There is, apparently, no limit to the expansion of matter, or, to fix our attention on one kind of matter, let us say to the expansion of a gas; but it is inconceivable that a continuous material which fills or is present in every part of a given space could also be present in every part of a space a million times as great. Such a statement might be made of a mathematical abstraction; it cannot be true of any real substance or thing. If, however, matter consists of discrete particles, separated from each other either by empty space or by something different from themselves, we can at once understand that expansion and contraction may be nothing more than the mutual separation or approach of these particles. Again, no clear mental picture can be formed of the phenomena of heat unless we suppose that heat is a mode of motion. In the words of Rumford, it is "extremely difficult, if not quite impossible, to form any distinct idea of anything capable of being excited and communicated in the manner the heat was excited and communicated in [his] experiment [on friction] except it be motion." And if heat be motion there can be no doubt that it is the fundamental particles of matter which are moving. For the motion is not visible, is not motion of the body as a whole, while diffusion, which is a movement of matter, goes on more quickly as the temperature rises, thereby proving that the internal motions have become more rapid, which is exactly the result which would follow if these were the movements which constitute sensible heat. Combining, then, the phenomena of diffusion, expansion, and heat, it is not too much to say that no hypotheses which make them intelligible have ever been framed other than those which are at the basis of the atomic theory.

Many other considerations also point to the same conclusion. Many years ago Lord Kelvin gave independent arguments, based on the properties of gases, on the constitution of the surfaces of liquids, and on the electric properties of metals, all of which indicate that matter is, to use his own phrase, coarse-grained—that it is not identical in constitution throughout, but that adjacent minute parts are distinguishable from each other by being either of different natures or in different states.

And here it is necessary to insist that all these fundamental proofs are independent of the nature of the particles or granules into which matter must be divided. The particles, for instance, need not be different in kind from the medium which surrounds and separates them. It would suffice if they were what may be called singular parts of the medium itself, differing from the rest only in some peculiar state of internal motion or of distortion, or by being in some other way earmarked as distinct individuals. The view that the constitution of matter is atomic may and does receive support from theories in which definite assumptions are made as to the constitution of the atoms; but when, as is often the case, these assumptions introduce new and more recondite difficulties, it must be remembered that the fundamental hypothesis—that matter consists of discrete parts, capable of independent motions—is forced upon us by facts and arguments which are altogether independent of what the nature and properties of these separate parts may be. As a matter of history the two theories, which are not by an means mutually exclusive, that atoms are particles which can be treated as distinct in kind from the medium which surrounds them, and that they are parts of that medium existing in a special state, have both played a large part in the theoretical development of the atomic hypothesis. The atoms of Waterston, Clausius, and Maxwell were particles. The vortex-atoms of Lord Kelvin, and the strain atoms (if I may call them so) suggested by Mr Larmor, are states of a primary medium which constitutes a physical connection between them, and through which their mutual actions arise and are transmitted.

(To be continued.)

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ELECTROLYSIS OF GAS AND WATER PIPES.

The paper read by Dr. Leybold, of Hamburg, before the Gas Section of the Glasgow International Congress, is one which deserves the attention of both gas and electrical engineers. Even those electrical experts who have been retained by the gas companies would do well to read and digest the paper, and also a verbatim report of the discussion on the same. We would particularly call the attention of these experts to the following extract from Dr. Leybold's paper: "Respecting the conditions near Karlsruhe, the system of water-pipes is certainly not influenced from the outside, and yet considerable tensions were found. Also, during the time when the electric trams were not running at night at Karlsruhe, tension was observed in the gas-pipes. Electric current flows in the pipes, and that pretty constantly. The existence of the current at points which could not possibly be influenced by the electric current (of the tramways?) can only be traced to the fact that the pipes are made of cast and wrought iron, and that lead is used as a jointing material, which metals lying under damp ground produces a galvanic action." This fact has been known for generations, and can be verified by anyone who cares to inspect an iron fence which has been secured into a stone coping by lead. Every vertical iron rod of such a fence will be found to be eaten away just above the lead fitting. This electrolytic action has been the cause of the wasting away and corrosion in all pipes buried in the soil, and was referred to by one gas engineer at the above meeting. It caused rather an awkward pause, however, when, in reply to a question from the chairman, the gentleman added that there were no electric trams in his town, or even any electric light. The rest of the speakers who were gas engineers showed a lamentable ignorance of the primary facts of the case, which ignorance may and does lead them to draw most erroneous conclusions as to the damage which may be done by electric tramway currents to their systems. On this point Dr. Leybold's paper, together with Mr. Gisbert Kapp's remarks, is of great value. The electric tramways at Hamburg caused great damage to gas-pipes, but it was shown that the electrical work was badly designed, as no return feeders were laid at first, and the rail returns were quite inadequate to comply even with the Board of Trade seven-volt limit. But the same conditions as to damage do not apply in other towns in Germany, where only 5 or 6 per cent. of the gas engineers think the matter of sufficient interest to warrant their answering a letter on the subject. We regret to find from the remarks of Mr. George Livesey, and the actions of other gas engineers, that a further attempt is to be made to charge electric tramways undertakings in this country with the cost of repairing all pipes within their area on which electrolytic action has been found. With righteous indignation Mr. Livesey states that electrical engineers must keep their electricity to themselves. We would remind him of the time when explosions of gas in electric conduits and street boxes were common, and they would still be so in London were there not a regular system of opening the boxes to let out the gas in vogue. The cost of this is being borne, not by the gas engineers, who fail to keep their poisonous and explosive commodity within bounds, but by the electricity supply companies. We do not take up the position that electrical undertakings should be freed from responsibility for damage done, but rather that an intelligent attempt should be made to discriminate between the corrosion due to ordinary electrolytic action, due to the placing of the pipes in damp soil, and the extra damage done by stray tramway currents. The Board of Trade

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advisers on electrical matters are not satisfied yet that the present regulations are inefficient, and yet tramway engineers in carrying out new work arrange for a drop in the return of only one or two volts. We also know of gas engineers who refuse consent to the tramway engineer to connect recording voltmeters to their gas-pipes, in order that some information may be obtained as to the voltage between their pipes and the rail returns. If now, when Messrs. Ayrton and Perry have to investigate the cases of damage done, as they have been retained to do by Mr. Livesey, a similar refusal were made by tramway engineers to allow test wires on their track, there would be much indignation shown. We think that the retaining of these experts is a wise step, but we shall have some strong words to say on the reports hereafter published by them if they do not insist on investigating the many cases of electrolysis on gas-mains in towns where electric tramways are not in vogue. A truthful determination of the extra corrosion due to the strong tramway currents can only be ascertained by such comparative test between places with and without electric tramways.

BRITISH ASSOCIATION AT GLASGOW.

In continuance of our note on the proceedings of the above association, which will be found in another column, the following arrangements also hold good: In Section A to-day (Friday) a discussion will take place on "The Magnetic Effect of Electric Convection," to be opened by Dr. Crémien. On Saturday the electro-chemical papers will be taken, including a discussion on "The Teaching of Mathematics," introduced by Prof. Perry. The section will meet on Monday in two departments—viz., mathematics and meteorology. The arrangements for Tuesday include the reading of optical papers and a discussion on "Scientific Class," opened by Dr. Glazebrook, is also expected. Wednesday will be devoted to the consideration of magnetic papers as follows: "On the Absence of Induced Currents on Starting a Convection Current," by Prof. A. Gray; "On the Zero Magnetic Field due to the Motion of a Charged Condenser," by Dr. F. T. Tronton; "On the Laws of Electrolysis of Alkali Salt Solutions," by Dr. H. A. Wilson; "The Surface Tension of Mercury in Contact with Salt Solutions," by Mr. J. A. Crow; "Æpinus Atomised," by Lord Kelvin; "On Electrical Conduction through Mercury Vapour, by Prof. A. Schuster; "On New Instruments for Magnetic Work on Board Ship," by Captain Creak; "Stress and Magnetisation of Nickel and Cobalt," by Messrs. Stewart and Peek; "On a Simple Method of Observing and Comparing Hysteresis in Iron," by Dr. F. T. Tronton; "The Influence of a Magnetic Field on the Viscosity of Magnetisable Liquids," and "The Influence of a Magnetic Field on the Viscosity of Magnetisable Solids," by Prof. A. Gray.

LEGAL INTELLIGENCE.

SUPPLY OF ELECTRICITY TO PRIVATE CONSUMERS.

An important case affecting the liability of corporations to supply private consumers with electricity was heard at the Manchester City Police Court on Wednesday.

Mr. S. Howard, the complainant, became tenant in June of premises which had previously been supplied with electric current. When he took possession a month later he found that the meter had been taken away. On Aug. 9 he wrote to the electricity department for a form of application for the current. No reply was received, and after several more letters, with no satisfactory result, the matter was placed in legal hands. A firm of solicitors wrote that the Corporation would be held responsible for loss of trade suffered by the complainant. The secretary of the electricity department then wrote that the committee could not connect the installation until they knew what energy could be supplied by their new station in Bloom-street. Counsel said the Corporation's real reason was they were husbanding their resources to drive the electric cars. This, however, was no legal excuse, because under the Board of Trade order of 1890 they were bound to supply private consumers with the current, provided their premises were within 50 yards of the main. In default they were liable to a penalty of 40s. per day.

For the defence it was argued that the summons was bad because the Corporation were stated to have failed to supply the current as asked for on the 9th ult. As a matter of fact, only a form of application was asked for on that date.

The summons was dismissed, without costs.

FAREHAM ELECTRICITY ACCOUNTS.

The total expenditure on capital account for the year ended March 31, 1901, amounted to £11,490. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given herewith:

Dr. Revenue Account.	£	s.	d.
Coal or other fuel	298	15	0
Oil, waste, water, and stores	54	19	10
Wages at generating station	194	6	0
Repairs and maintenance of buildings and plant	64	15	2
Distribution of electricity	26	6	11
Attending, repairs, and renewals of lamps	95	6	9
Rents, rates, and taxes	35	11	4
Salaries—engineer's department	140	0	0
Salaries or commissions of collectors	20	11	7
Stationery and printing	1	19	6
Insurances, etc.	57	9	6
Total expenditure	£990	1	7

Cr.	£	s.	d.
Sale of current per meter, at 7d. per B.T.U.	888	11	2
Rental of meters and other apparatus	22	12	6
Balance carried to net revenue account	78	17	11
	£990	1	7

General Balance-Sheet.

Liabilities.	£	s.	d.
Capital account—amount received	11,084	7	3
Amount charged to general district rate account	860	18	6
Amount due to treasurer	405	11	5
	£12,350	17	2

Assets.	£	s.	d.
Capital account—amount expended for works	11,489	18	8
Stores on hand	15	0	0
Balance at debit of net revenue account	845	18	6
	£12,350	17	2

Statement of Electricity Generated, Sold, etc.

Quantity generated in Board of Trade units		79,881
Quantity sold { Public lamps (consumption)	34,850	64,115
Quantity sold { Private consumers by meter	29,265	
Quantity used on works		2,851
Total quantity accounted for		66,966
Quantity not accounted for		12,915

Total maximum supply demanded, 63 kw. Number of public lamps: arc, 27; incandescent, 103.

APPOINTMENTS VACANT.

Assistant Engineer, county borough of Burnley, £2 per week, Sept. 14. Full particulars in our advertisement columns.

Cable Jointer, West Bromwich electricity department, £2 per week, Sept. 14. Full particulars in our advertisement columns.

Mains Superintendent, Edinburgh Corporation electricity supply, £250 per annum, Sept. 21. Full particulars in our advertisement columns.

Demonstrator in Electrical Engineering at Heriot-Watt College, Edinburgh, £100 per annum, Sept. 21. Full particulars in our advertisement columns.

Two Fitter-Drivers, 36s. per week of 56 hours. Full particulars in our advertisement columns.

Assistant Manager for accumulator works. Full particulars in our advertisement columns.

Traveller, by large firm of manufacturers of motors and dynamos. Full particulars in our advertisement columns.

Electrical Draughtsman, with knowledge and experience of station switchgear. Full particulars in our advertisement columns.

Shift Engineer and Improver, Dundee Gas Commissioners, 25s. per week for shift engineer and 20s. per week for improver. Apply before 16th inst. to Mr. W. H. Tittensor, city electrical engineer Dudhope-crescent-road, Dundee.

Electrical Engineers, Hackney electricity department, £400 per annum.

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HIGH-SPEED RAILWAY CAR OF THE ALLGEMEINE ELEKTRICITATS-GESELLSCHAFT, BERLIN.*

BY O. LASCHE, BERLIN.

(Continued from page 346.)

In view of the difficulties just described, a further series of designs was worked out, having in view a reduction as far as possible in the weights of the motors, with the object of attaining such a gross weight as might appear to be admissible for the parts not mounted on springs. Figs. 11, *a*, *b*, *c*, show such designs for the diameter of wheel at first adopted (about 1,800mm.), the speed of the motors being correspondingly reduced. The motor was sufficiently accessible in *a* and *b*,

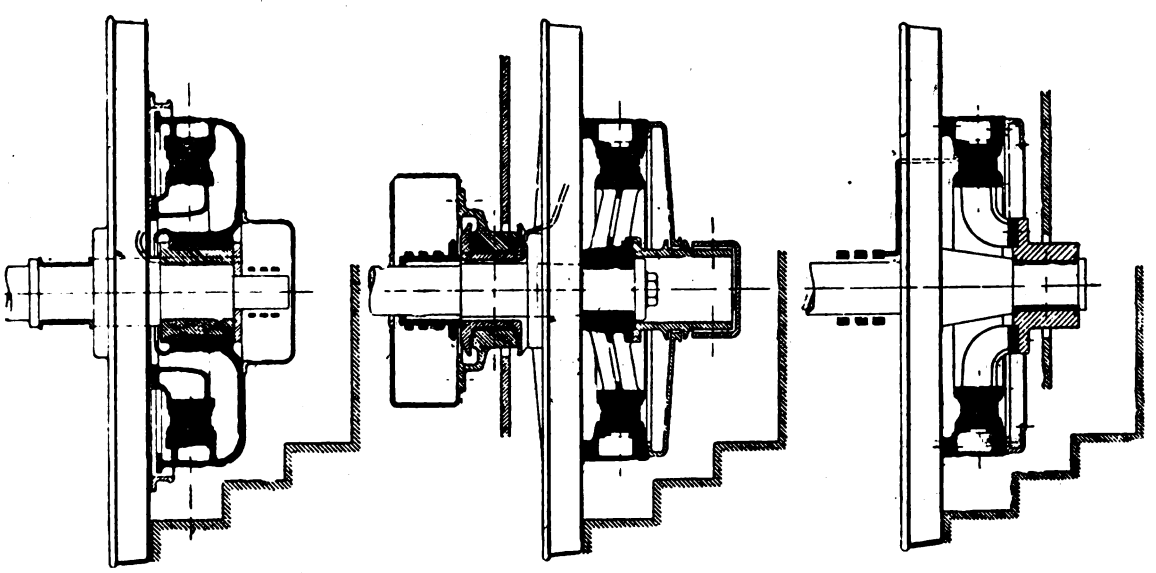

FIG. 11.

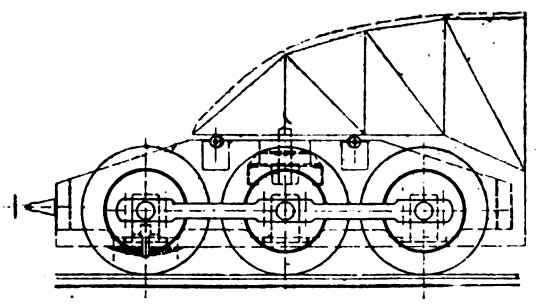

FIG. 12.

but not so much so in *c*. In the latter case, however, the axle bearing was free. Large wheels would have been more suitable for high speeds, since the number of revolutions of the motors, and consequently also the relative speed of the bearing surfaces, would have been lower; moreover, the vibrations or shocks caused by rail joints would have been less. But the part of the car located above the wheels could not then have been utilised, and a considerable portion of the length would thus have remained unused, as is clearly shown in Fig. 12. Similar investigations were therefore made with smaller wheels. Fig. 13 gives some idea of these investigations. The diameter of the wheel is here 1,250mm., the speed of the motor being about 1,000 revolutions. The frame of the motor comes just within the standard structure gauge. These sketches show the abandonment of the usual casing, leaving the ribbed magnet uncovered. Owing to the weight of such motors, the weight of each wheel set was doubled. The number of the motors had to be raised from four to six for each bogie—*i.e.*, 12 motors for the car; and the resultant advantage appeared to be too small when the higher price and the inconvenient arrangement of the cables that would have resulted were taken into account. One of the chief difficulties in designing the coupling and bearings was, as above explained, the considerable deflection of the springs when the motor was attached to the car or bogie; it has been stated also that arrangements for supporting the motor by a number of small springs did not appear to afford sufficient security, although the motion of a few millimetres should be sufficient. The motor was no longer connected with the frame of the bogie, but it was supported by strong springs bearing against the axle box. These springs had to deflect but a few millimetres, as stated before. By means of an adjustable curved block, "*a*" Fig. 14, for the first one or two millimetres this spring bends very readily, then the spring grows stiffer up to a maximum of 8mm. to 10mm. Fig. 14 shows the construction of this arrangement. The motor is firmly screwed to a frame of sheet iron with channel-iron bars. This frame is supported on both sides of the car on plate springs, resembling the usual car springs, the buckle being mounted by means of the buckle of the axle spring at the axle box. The motor is prevented from moving laterally by suitable abutments, which bear against the slides, *b*. Means were also provided to prevent rotation of the stator in either direction. Certain slight alterations which were made during the manufacture will be referred to later. With this simplified construction it was possible to make the coupling shown in Fig. 15A. A ring consisting of three parts was mounted at each end of the hollow shaft, in each of these parts double arms were fitted in the form of bundles of springs. The ends of these plate springs bear against guide pieces fastened to the wheel. This sliding and elastic movement allow of a steady and constant motion of the hollow shaft relatively to the axle. There was some uncertainty at first as to the working of the coupling, and Fig. 15B shows another design that was made. The coupling (Fig. 15A) contains sliding parts, and is therefore subject to a frictional resistance. In the form shown in Fig. 15B this frictional resistance is diminished to less than 1 per cent., or, in other words, it is practically obviated. Calculation showed that, with the construction *a*, the coupling allowed a deflection of the motor suspension even at a differ-

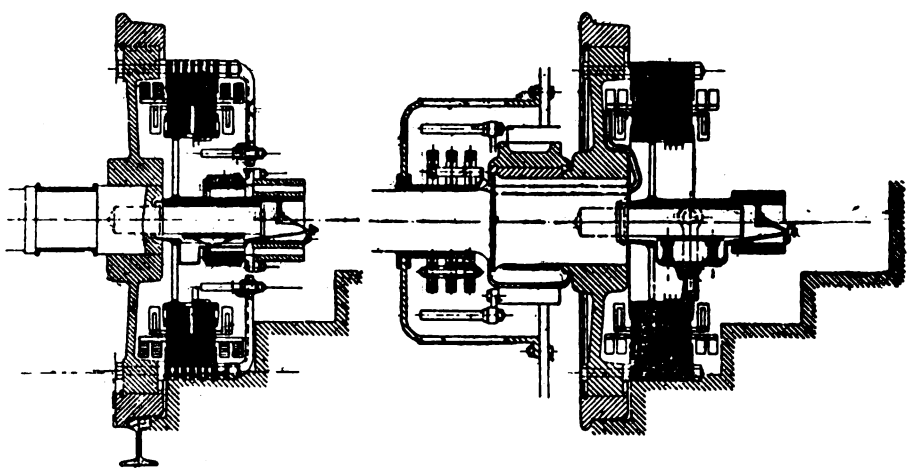

FIG. 13.

* Paper read in Section IX. of the Glasgow International Engineering Congress.

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ence of level of 5mm. in a length of 15m., or a 0·5mm. deflection in 1·5m. length of track, when going at full speed. This degree of sensitiveness should be sufficient; if not, the parts shown in Fig. 15B could be introduced without difficulty. The reduction in the deflection of the spring allows the diameter of the hollow shaft to be diminished, and so the construction of the bearings is simplified, and their lubrication is facilitated.

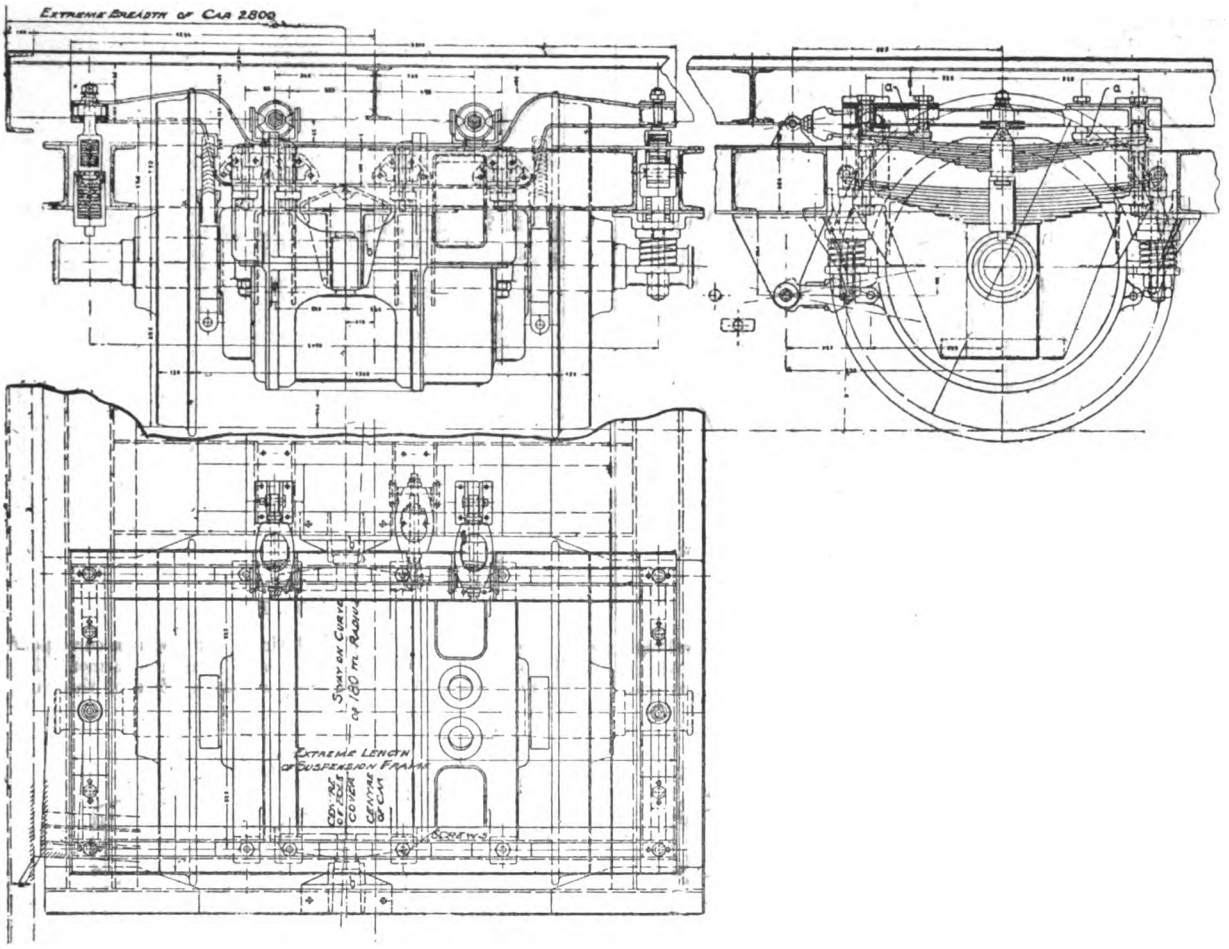

FIG. 14.

Fig. 16 is taken from a photograph of the experimental arrangement, built in the mechanical experiment department of the Allgemeine Elektricitäts-Gesellschaft, for the purpose of examining the working of the bearings at very high peripheral speeds. In imitation of the stress to which the motor bearings would be submitted, an upward pull was imparted to them, and the pressure was ascertained by means of an interposed spring balance. A block of nickel steel, of the material, diameter, and shape adopted for the bearings (260mm. diameter), was used for the shaft. This block was mounted on an axle 100mm. in diameter, secured in long bearings with white-metal brasses. The whole arrangement was driven by an electromotor of which the power could be ascertained at any moment. The series of tests was made almost exclusively with brasses of white metal and axles of nickel steel, but a few experiments were also made with cast steel and with brasses of magnolia metal. As regards the system of lubrication, considerable changes were made in the course of the experiments. At first, oil under pressure was provided in order to feed each of the bearings separately from one central point. This necessitated a supply of oil under pressure through the whole car, with pipe connections that were somewhat cumbersome, in order to allow for the turning of the bogies and for the relative movements between the axles and the body of car. Lubrication with oil under pressure was soon dispensed with, and a rinsing system of lubrication—*i.e.*, an adequate supply of oil without pressure—was adopted. For railway purposes, of course, the usual ring lubrication could not be used, whilst some of the other recognised methods either were not reliable enough or caused a frothing of the oil. A smooth disc of large diameter mounted concentrically on the axle raised the large quantity of oil required admirably without producing any froth.

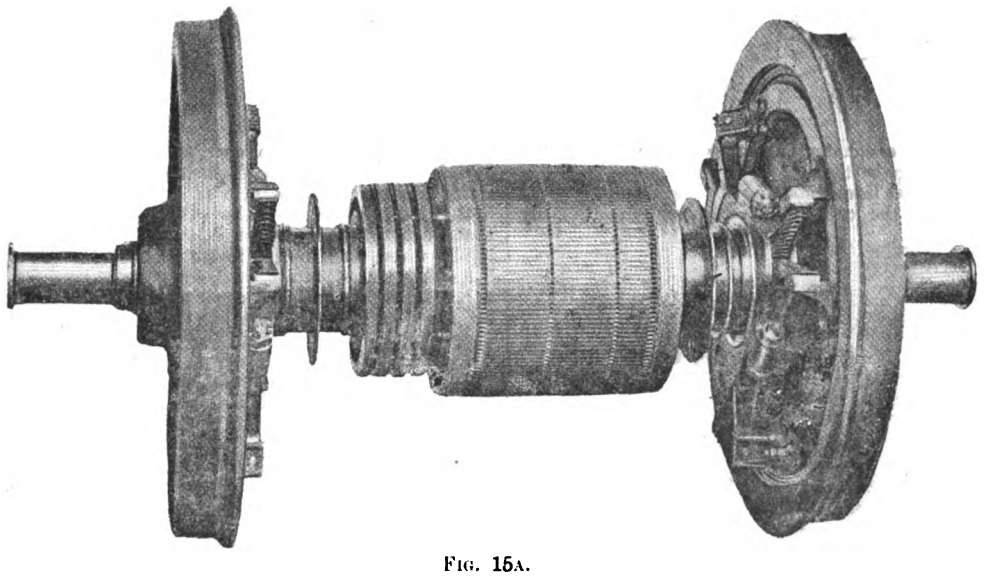

FIG. 15A.

Experiments were made at speeds varying from 2m. (the normal speed) to 25m. per second, and at pressures ranging from 2 kg. to 5 kg. per square centimetre, to ascertain the relation between speed, bearing pressure, and temperature. Full particulars of these experiments will be published at some future date; meanwhile, the following three-dimension diagrams indicate sufficiently well some of the results obtained.

3. *Starting Devices.*—In the investigations relating to the main

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division of the car and to the arrangement of the electrical parts to ensure the attainment of the minimum weight, it was mentioned that the starting apparatus was mounted in the middle of the car so as to allow of the cables being as short as possible. The laying of the high-tension cables, and the arrangement of the fuses and switches in the primary circuit, will be described in the account of the car in Part 2. In the present section reference is made only to the resistance appa-

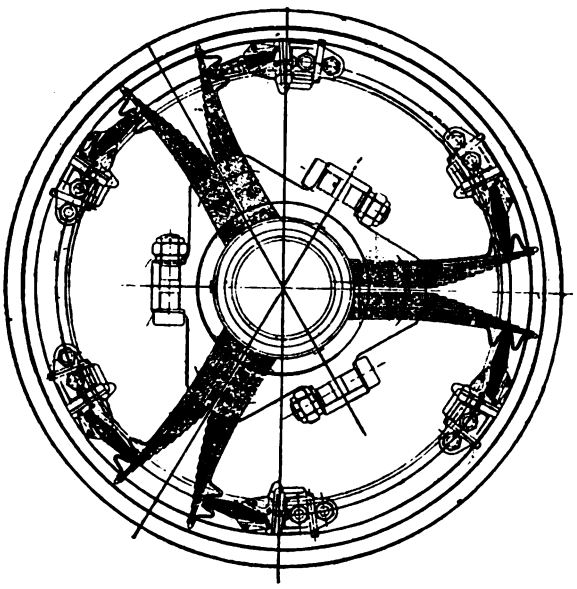

FIG. 15B.

ratus adapted for regulating the speed and for starting and braking. From the very first the primary circuit of the motors was provided with a switch to reverse the direction of running, and to cut out and brake the motors, either by a counter current or by connecting the stator windings with a storage battery.

It was at first intended that liquid starting devices should be used in starting and regulating the current, the construction ordinarily

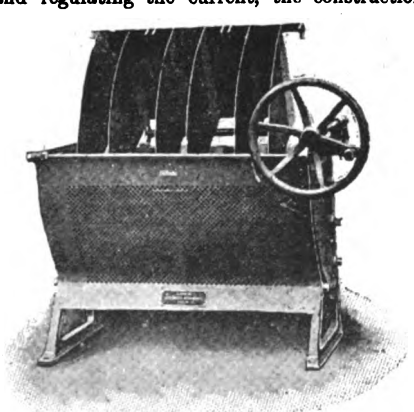

FIG. 18.

used for starting either small or large motors being employed. Thus, wrought-iron sheets were to be inserted in the armature circuit of the motors in such a manner that connection would be established by the liquid, and the armature circuit would thus be closed. It would then be opened by withdrawing the sheets from the liquid. The resistance becomes smaller or larger according to the area of the immersed electrode surfaces and consequently the slip of the armature relatively

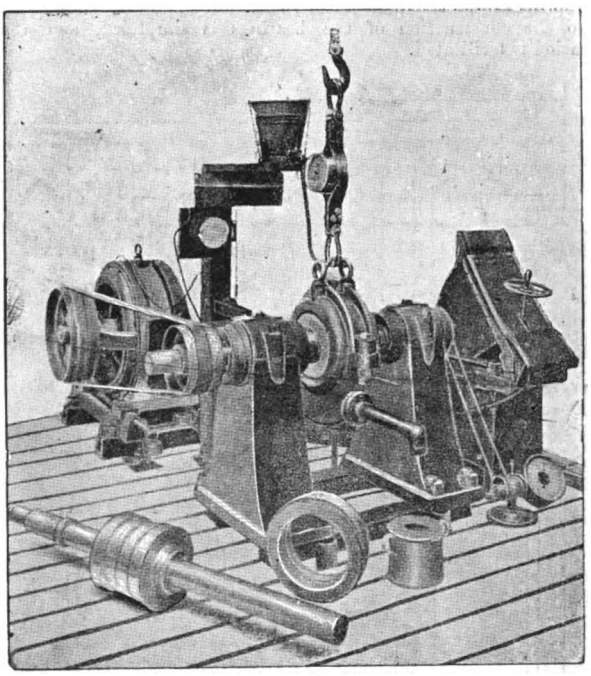

FIG. 16.

to the theoretical number of revolutions also becomes correspondingly smaller or greater. In other words, at the commencement the speed of the motor is small and increases as the surface of the iron plates

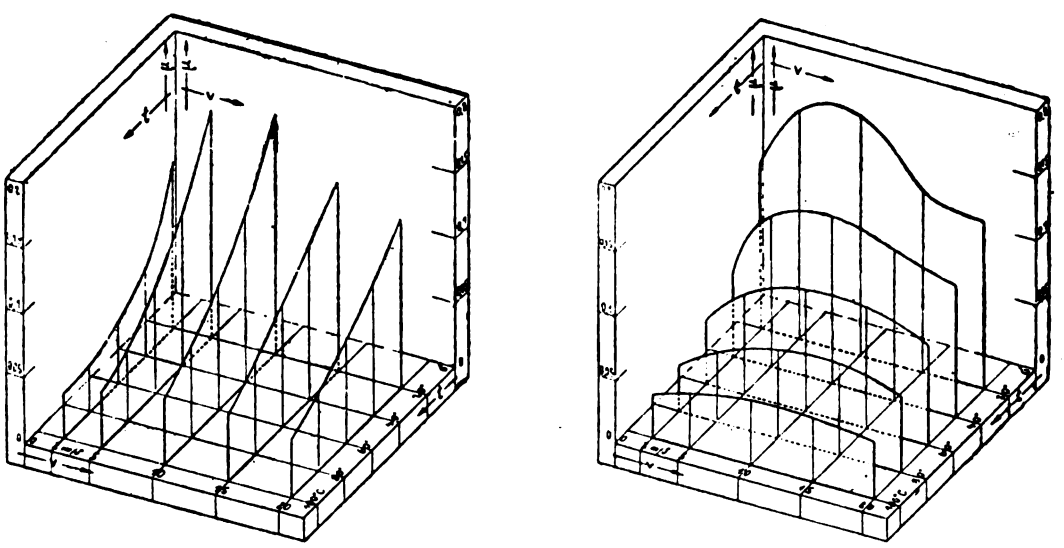

FIG. 17.

immersed in the liquid becomes larger. Fig. 18 shows such a starting device, the disadvantages of which are sufficiently known. The liquid closes the circuit, but introduces a resistance, and thus becomes heated. The heating of the water takes place rapidly because the heat imparted to it cannot be conducted away, but remains in the liquid, which soon begins to froth and boil. Hence, as the name "starting device" indicates, it can only be used for starting, and not as a speed regulator. For constructive reasons, the electrodes cannot be placed sufficiently close together to produce a short-circuit even when totally submerged, and it is, therefore, necessary to use a metallic short-circuiting device. Further difficulty in the case of large motors is that involved in the movement of heavy electrodes. The Allgemeine Electricitäts-Gesellschaft have constructed such liquid starting devices for large motors up to several hundreds of horse-power. Other methods of construction were also tried, in which the electrode plates were stationary, and the liquid passed from a separate reservoir into the electrode receptacle. Such an arrangement, using compressed air for raising the liquid, was also proposed for use on the express railway car; but the above-mentioned drawbacks necessitated the employment at first of metallic starting devices. The special requirements of the case—namely, the provision of a very small floor space, and of means for permanent regulation, the arrangement of contacts and connections clearly in view, and the certainty of easy and safe manipulation from the driver's platform—created a difficult task for the designer, in view of the unusual output of 3,000 h.p. to be employed. The starting and regulating apparatus had to be proportioned for this maximum output, because during the time of switching motors have to develop their full power. The regulating apparatus must also be calculated for the full load. Separate cylinders were used for each motor and for each rotor circuit, and in order to minimise the number of the

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cylinders corresponding to the four motors, two-phase wound rotors were adopted. The result was that eight cylinders were used instead of 12. When starting the motors a large number of resistance coils must be switched into the armature circuit, so that the motor gradually receives its full rotor voltage and the full current. The larger the number of steps, the more inconvenient are the connections of the cables and the many resistances. Fig. 19 shows what an enormous number of cable connections must be used for a starting apparatus built for a hauling engine of scarcely 100 h.p. With the

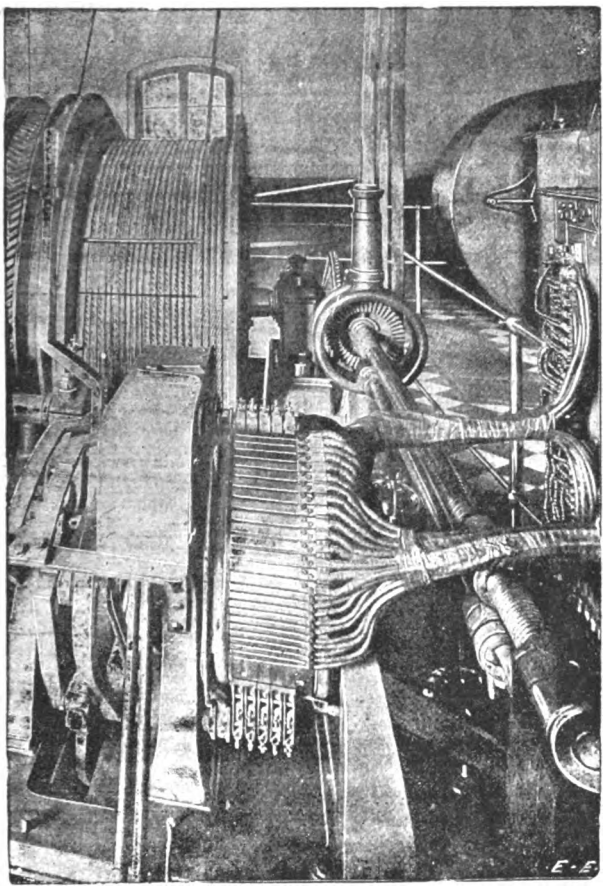

FIG. 19.

present output of 3,000 h.p., it appeared almost impossible to ensure that the necessary connecting cables should be accessible. The minimum number of the steps to be used is determined by the volume of the armature current and by its voltage. The difference of potential from one step to the next—*i.e.*, from one contact of the switching cylinder to the other—must be kept within certain limits, in order to avoid sparking at the contacts, even though provision be made for the extinction of an arc. It had been assumed for the purpose of the experiments that the speed of the dynamo supplying the current could be considerably reduced, so that there would be a proportionate reduction in the speed of the car;

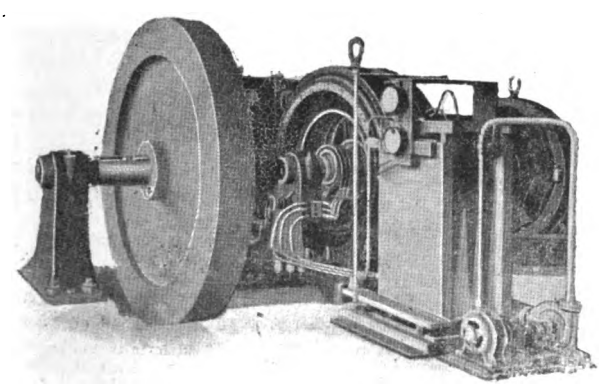

FIG. 20

but this is insufficient, because, although it is possible to run at half-speed, a speed even of 100 km. per hour is too fast for the commencement of the trial runs. It was thus necessary to rely on permanent regulation—*i.e.*, on the permanent introduction of resistances. Of course, only the resistance coils so switched in are subject to heating, and the resistances previously cut out are not used.

While making these investigations, the task of constructing, starting, and regulating appliances for large hauling machinery presented itself to the Allgemeine Electricitats-Gesellschaft. It seemed impossible to apply the existing types of small hauling machinery, whether of the Allgemeine Electricitats-Gesellschaft or of any other maker, with a maximum output of about 100 h.p., to plant using 3,000 h.p. All these hauling engines, with the exception of a plant of about 80 h.p., which has been working for the past six years in the pit Hollertzug, near Herdorf, with an economical method of regulation—*i.e.*, without any current being converted into heat—are constructed throughout with resistance regulating devices, whether they are driven by direct current or by three-phase current. The problem was finally solved by a liquid starting device on an entirely new principle. Fig. 20 shows an experimental arrangement of this device. A three-phase current motor of 200 h.p. to 400 h.p. is coupled direct to a very heavy flywheel. In order to bring this up to full speed in 15 seconds, a torque corresponding to an output of 400 h.p. must be attained. With the same output another heavier flywheel was made to run at full speed in 1½ to 2 minutes. The former meets the requirements of a hauling engine, the latter those of the high-speed car. The high-tension switchboard at the back is arranged to allow of reversing the fields. A combination of these connections with the starting device proper was omitted in the experimental arrangement.

The photograph shows in the foreground a small centrifugal pump driven by an electromotor, which raises the liquid from a reservoir in the basement, and continually delivers it into the tank in which the electrodes—*i.e.*, the terminal or end plates of the opened armature circuits—are located. The pump operates continuously; hence a constant renewal and mixing of the liquid takes place, and the electrodes are thus suspended not in stationary but in moving water. By shifting the somewhat primitively arranged vertical rod to the right, a valve in the bottom of the tank is closed, by which the water would otherwise have been continuously discharged. The liquid now begins to rise in the tank, and the armature circuits are closed, so that the motor starts, but of course with a considerable resistance in circuit. As the liquid rises in the electrode tank, the interposed resistance decreases, and the motor runs more quickly. Consequently, for a certain load, each level of the liquid represents a certain speed of the motor. By means of a regulated overflow in the electrode vessel, the level of the liquid can easily be adjusted, and consequently the motor can be run at any required speed, as, for instance, in the case of a winding engine when an inspection of the mine-shaft is taking place, or when men are being conveyed in the cage, or, in the case under consideration, when it is required to make the high-speed car run at 50 km. or 60 km. per hour. The electrode plates are very wide apart at the lower end, and are made with prong-like extensions of different lengths. The arrangement is such that the longest prong of the first plate is situated diagonally opposite the longest prong of the other electrode; thus, at first, not only are the dipping surfaces small, but the distance between them—that is to say, the path of the current through the liquid—is very considerable. The immersed surface of the plates can, therefore, on account of the great distance, be considerably larger than might be the case for the passage of the same quantity of current through a small distance. In consequence of this, any overheating of the points or tips such as occurs in the old form has become impossible. On the other hand, the electrode plates are placed very close to each other at the top, and a larger number of plates than formerly are used in order to keep the conducting surface for the current very large, thereby reducing to a minimum the resistance of the liquid to the passage of the current, and obviating the use of metallic short-circuit contacts.

The essential difference between the new starting device and those previously used consists in the maintenance of the liquid in constant motion—a fact which alone suffices to ensure its use. The heated liquid does not remain at the point where heat is being generated, but is constantly circulated and mixed afresh. It is easy to calculate what amount of heat is communicated to the liquid by the resistance at any given load or for a given decrease in the normal speed; and the use of water in motion renders it easy to conduct away this heat. The cooling surface necessary to effect this may be readily calculated; and in the present construction of the high-speed car (Fig. 4) systems of serpentine copper tubes of small diameter are provided, through which the heated water has to pass after leaving the electrode vessel and before it is used afresh. Consequently the new liquid starting device enables any suitable large resistance to be brought permanently into the circuit, and the motor can be run continuously at any slow speed that may be required. The starting period of the motor—viz., the period from rest up to the time at which the resistance is entirely cut out—is determined by the speed at which the liquid flows to the vessel. By inserting an adjustable valve in the pipe leading from the centrifugal pump the speed at which the liquid is delivered (and consequently the starting period) can be regulated at will. By this construction it is therefore rendered possible to prevent the driver from reducing the time required for starting, hence the acceleration, and therefore the torque, can never prove greater than the overloading capacity of the motor permits. On the other hand, the driver can, by a corresponding slow or incomplete closing of the foot valve, decrease the speed for starting and braking to any desired extent. In a similar manner the driver can run the car at any desired slow speed by keeping the foot valve partly opened. Consequently the speed is under perfect control. This new arrangement when contrasted with metallic starting devices also shows the great advantage of a continuous, as compared with an intermittent, switching in or out of the resistance; it ensures that the starting and braking are effected smoothly, and not by jerks. Anyone who has experienced the jerking motion of tramway cars can realise how greatly the above arrangement will be appreciated by the passengers. Owing to the great simplicity of the apparatus it can be readily operated from a distance, as the power required is excessively small. Consequently, the provision of compressed air or electricity in the car, as a means of operating the reversing mechanism, is rendered unnecessary; all that has to be done is to provide a connecting shaft operated by a handwheel from each driver's platform. When using the new system of liquid starting device, the metallic arrangement is no longer needed, and the several hundred contacts and cables are dispensed with. In regard to maintenance, no fear need be enter-

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tained, since of course the maintenance of plates not liable to become rusty, immersed in a soda solution, cannot be compared with that of many and large controller cylinders, contacts, contact brushes, cable connections, and pieces of resistance material.

(To be continued.)

ABERDEEN ELECTRICITY ACCOUNTS.

From the accounts of the Aberdeen Corporation electricity department for the year ending July 31, 1901, it appears that the total expenditure on capital account to date amounts to £114,503. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given herewith:

Dr. Revenue Account.	£	s.	d.
Fuel	4,697	18	9
Oil, waste, water, and engine-room stores	384	5	0
Wages at generating station	1,146	0	0
Repairs on buildings	86	1	5
Repairs on plant	526	14	10
Main and service repairs	610	7	3
Meter repairs	13	9	1
Rents and feu-duty	78	3	11
Taxes	718	12	3
Management	83	11	8
Engineer's salary (proportion)	295	16	8
General charges and engineer's travelling expenses	263	1	1
Stationery and printing	250	10	10
Insurance	39	12	6
Inspector's wages	36	3	6
Auditor's fee	15	0	0
Compensation for damages	12	12	0
Bad debts	54	10	7
Abatements	211	0	4
Special services and repairs on motors	229	14	4
Cost price of lamps sold	62	10	4
	9,815	16	4
Balance carried to net revenue account	9,360	8	0
	£19,176	4	4

Cr.	£	s.	d.
Sale of current	18,551	5	9
Sale of lamps	68	5	1
Hire of motors	54	7	11
Attendance on harbour lamps	400	0	0
Attendance on additional lamps	102	5	7
	£19,176	4	4

General Balance-Sheet.

Liabilities.	£	s.	d.
Amount borrowed on mortgage	105,418	0	0
Amount of mortgages redeemed by sinking fund	6,892	0	0
	£112,310	0	0
Reserve fund	4,844	2	5
Amount due to sundry creditors	1,756	8	6
Amount deposited in security for current	183	18	0
Temporary loans	357	0	0
Balance due to bank	8,385	4	7
	£127,816	13	6

Assets.	£	s.	d.
Amount expended on Cotton-street works — less depreciation	92,086	10	6
Amount expended on Ferryhill works	22,416	19	4
Sundry debtors for current supplied and miscellaneous	8,482	1	10
Stores on hand at July 31, 1901	2,221	4	10
Reserve fund invested	2,609	17	0
	£127,816	13	6

Statement of Electricity Generated, Sold, etc.

Quantity generated in Board of Trade units			1,389,385
Quantity sold: Public lamps	156,248		
Traction	250,489		1,199,913
Private consumers by meter	793,176		
Quantity used on works			61,054
Total quantity accounted for			1,260,967
Quantity not accounted for			128,418

Number of public lamps: arc, 145; incandescent, 56.

NEW COMPANIES.

Millennium Motorcar Syndicate and Agency, Limited.—Capital, £1,500. Object: to adopt an agreement with F. Bryan and A. H. Bayley for the acquisition of certain inventions in relation to electric ignition for explosion engines, etc.

British Arc Carbons Manufacturing Company, Limited.—Capital, £6,000. Object: to manufacture carbons, carbon rods, and candles for electric arc lights, filaments for incandescent lamps, carbon plates, batteries, cells, accumulators, and other articles for general and special electrical purposes.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

Questions.

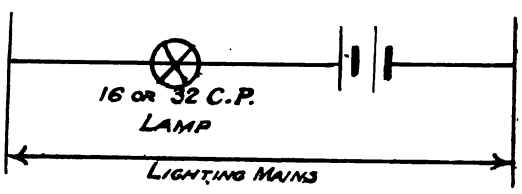
411. Six steel-armoured concentric feeders are drawn into iron pipes; they have no exterior distinguishing marks of any kind, and cannot be traced. Their inners carry an alternating current at 5,000 volts, their outers being earthed at the station as usual. A "short" develops in one and it is rendered dead. What is the best way to identify the faulty cable at any draw-box along its route? Telephone methods have been tried and found useless.—E. H. G.

412. What is the best way of cleaning and polishing switchboards? (1) White or grey marble panels; (2) enamelled slate panels; (3) instrument cases and glasses; (4) bus bars, switch contacts, and arms; (5) keeping the "back" clean.—P. T. K.

Answers.

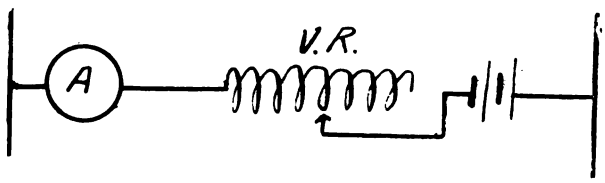
Question No. 405.—In a central station an increasing demand is made to get accumulators charged. What would be the best method of catering for such customers supposing the required charge ranges from ·5 to 5 Board of Trade units, and the voltage from 4 to 50 volts?

Best Answer to No. 405 *(awarded* 10*s.)*.—There are several methods employed for charging the various cells sent to stations for that purpose, and are described here. The first and simplest method, and one which is often used for small pocket and hand-lamp accumulators, is to put them in series with a 16-c.p. or 32-c.p. lamp (see sketch). For large



accumulators, taking a charging current of 10 amperes by 2 to 6 volts, the cells may be put in series with the station arc lighting. This will not materially affect the lights, and provides a ready means of quickly charging the cells.

A second method is to take a pair of leads off the mains, and having in series an ammeter, a variable resistance, and the accumulators to be charged (see sketch). By this



method any required current can be obtained for any number of cells in series. With a large number of cells, the combined voltages of which nearly equals the voltage of the lighting mains, this is a good method, but where there are only a few cells it is wasteful, as the energy used in the variable resistance is lost. This resistance must be large enough to stand the maximum charging current without overheating.

A third method is to use the hospital cells of the main battery. Thus, say there are eight cells connected to a board on which by means of plugs they can be joined in series, or used in separate pairs, the eight cells might be used to charge six cells in series, or separate pairs of cells might be used for charging single accumulators.

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A fourth method is to use those regulating cells on the main battery, which are rarely in use. Care must be taken, however, not to use these cells for charging separate cells while they are in circuit with the main battery.

Where the number of cells sent to the station for charging is large, the best method is to use a small motor-generator having a variable voltage ranging from 0 to 50 volts, with a current from 0 to a maximum which is determined by the maximum charging rate of the cells that are sent to the station. In this manner any current and any voltage can be obtained to suit the varying charging rates and the number of cells. It is an economical method, as the efficiency of the motor-generator can be high. It is also applicable to an alternating as well as a continuous-current station. If the station possess a milking booster this might be used, or the main battery charging booster might also be utilised for this purpose.

Cells being charged should always have an ammeter in circuit, otherwise it is impossible to see what is being done, and the cells might be ruined; it is also well to have fuses in circuit which will cut out the battery in case of overcharge or accident. Cells should be examined before charging, to see they have the right quantity of electrolyte; for this purpose a small two-volt lamp is useful. Small quantities of electrolyte should always be kept at hand having a specific gravity of 1,200; also a supply of filtered rain or distilled water.

To prevent complications some system of checking should be introduced, and sheets of instructions provided with every cell or set of cells. The writer would suggest something as follows:

..... Electricity Works.		
Battery Charging Sheet		
Owner of battery { Name ..... Address		
No. of cells.	Max. charge amps.	Amp.-hours charge.
Connected up by ..... Disconnected by ..... When required		Cost of charging.

In the past, the few small cells sent to stations to be charged were looked on as a nuisance, and not worth troubling with, but now electric propulsion for launches, automobiles, etc., is so rapidly gaining ground, that battery charging may soon be turned to profitable account, especially in small stations.—E. T. W.

Answer to No. 405 (*awarded* 5*s.*).—The best way of catering for outsiders who wanted batteries charged would be to build a well-ventilated room outside the station, convenient to the road, where the batteries could be left and charged. The most economical way of charging them would be to use a motor-dynamo, the current in the shunt windings of the motor being capable of regulation, so that the voltage at the terminals of the dynamo could be adjusted to anything between 20 and 70 volts. In alternating-current stations a single-phase induction motor whose speed could be regulated by the exciting current could be used. Of course, it could be wound for any convenient voltage. The stock sizes of the Crocker-Wheeler motor-dynamos for direct current are wound for 115, 230, or 500 volts respectively. The efficiency of the combination varies from 80 per cent. for a 10-h.p. machine to 85 per cent. for a 100-h.p. machine at full load.

If, for example, we received a battery of 25 cells which required a charge of five Board of Trade units, it would be necessary to supply it at 20 amperes for five hours. This would mean that the motor would be taking about 2·5 amperes at 500 volts all the time. It will be seen that very moderate-sized cables would be sufficient to carry the current to the charging room, and hence this room need not necessarily be very close to the station, but can be built in the place most convenient to the majority of the customers.

In practice economies could be effected in special cases. If, for instance, a 10-ampere and a 20-ampere battery came in at the same time, then the two halves of the 10-ampere battery could be put in parallel and charged in series with the 20-ampere battery, etc. Still, it would hardly be equitable to charge four-volt electrolytic batteries at the same rate as 50 volt traction batteries. It might be so ultimately, when one could be sure of always arranging the batteries so that they could be charged at 60 or 70 volts, but at the start a certain amount of wasteful resistance would have to be employed.—J. C. R.

Answer to No. 405 (*awarded* 5*s.*).—Since the introduction of so many electrical appliances on the market, portable accumulator charging has become quite an important item in several central stations, where, in some cases, special charging sets have been erected. Small pocket accumulators (four volts pressure) such as are used for scarf pins, hand-lamps, etc., only require a charging current of about ·5 ampere, and can be easily charged by placing in series with a lamp across the mains. Accumulators such as are used for phonographs, medical coils, electric ignition for motorcars, etc., are of a fairly large size, requiring a discharge current of nearly 20 amperes. A good method of charging such accumulators, would be to charge them from a "milking set," as shown in Fig. 1, where B is a battery of 12 cells, A an ammeter, and Z the accumulators to be charged. The current can be regulated by means of either the switching in or cut of cells by means of the regulating stop, C, or by adjusting with the resistance, R.

For larger cells requiring a pressure of 50 volts, the best method to charge them would be from a small motor-generator, the motor running from the supply mains and the generator developing a pressure of about 50 volts,

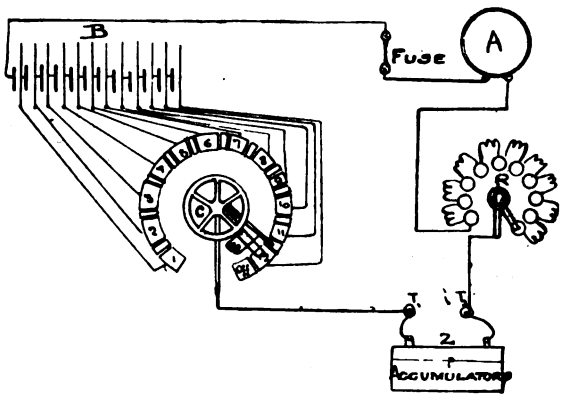

Fig. 1.

the charging current being regulated by means of the shunt resistance of the motor or by means of a resistance in series with the generator circuit. This motor-generator could be used for charging the milking set already described. In some stations small accumulators are charged from cells of the main battery, which, I think, is not a very good method, as it is liable to destroy the regular efficient working of same.—L. B. H.

Answer to No. 405 (*awarded* 5*s.*).—This question does not present any serious difficulty, as there are in most electricity supply stations various ways of charging accumulators—*e.g.*, for a small battery requiring a small current and little E.M.F., an exciter might be useful, or the battery might be put as a shunt across the terminals of an arc lamp in the station, or it might be included in the field-magnet circuit of a shunt-wound dynamo. Again, a battery of larger capacity but small E.M.F. might be put on any circuit which happened to be carrying about the required current, and the E.M.F. of the dynamo increased accordingly. Shunt-wound dynamos are most suitable for charging accumulators, and if one of these should not happen to be in the station, it would be best to provide one with an E.M.F. adjustable within wide limits for the purpose, and as the business increases and several batteries of different capacities and E.M.F. have to be charged simultaneously, then resistance coils of galvanised iron wire should be provided as required to enable different batteries to be put on to suitable circuits. All this could be quite easily and cheaply arranged, and I know from experience that it works quite satisfactorily. Some people advocate water resistances, but I do not like them, because they are apt to boil and make a mess. Their

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resistance falls as the temperature rises, and, again, if acid is used, the resistance falls off as the water evaporates; and, further, the gases, oxygen, and hydrogen given off are a source of danger, because they are explosive. Therefore, I do not consider them suitable for this work, and I prefer the galvanised iron wire done up in spirals, which lasts for years, is always the same, and gives no trouble, because it requires no attention when once put up in an out-of-the-way place. I generally find that people who bring these batteries have no idea as to the charging current. I, therefore, allow one ampere to every 90 square inches of surface of plate as a rough estimate to start at. Larger batteries will take more, and small enclosed (pocket) batteries will require rather less. Batteries should not be heated by the charging current. Enclosed batteries often blow out a lot of acid in charging, and almost all batteries brought in for charging require some more acid put in.

The price to charge for this work must vary a little, but a general basis might be fixed at 3d. per kilowatt during convenient hours of the day, and double this at other times. Small pocket batteries being extra trouble, should pay 6d. as a minimum. It is advisable to provide an insulated stand to put the batteries on in a place where leakage of acid is of no consequence. Galvanised iron wire resistance coils will easily and safely carry 1,000 amperes per square inch of section without getting dangerously hot if uncovered and in open places where the heat developed can easily escape.—F. G. A.

Question No. 406.—Having nearly completed a four years' apprenticeship: (1) wiring (indoor and overhead), (2) turning, (3) erecting and fixing gas-engines, dynamos, and motors, (4) winding, I desire to enter a central station. Could I start as junior assistant, or is further experience required? As such, what would be my duties and salary?

Best Answer to No. 406 (*awarded* 10*s.*).—I should say that "E. A. L." would have considerable difficulty to get into a central station as junior assistant with the experience he has had, unless the firms he has served with are of very high standing, and even then he would not, I think, find it easy. What the chief of a station wants is a man who knows exactly what his duties will be, and one who can go about his duties straight away. It will be seen, therefore, that a young fellow who may be very much inferior in all-round knowledge and experience, but who has been pupil or improver in a station for a year or two, will get the post before one who has not been in a station. "E. A. L." cannot do better, if he is going in for central-station work, to get in as soon as possible either as pupil or improver. A very good way, if he is able to work for another six months to a year for nothing, would be to write to several engineers of stations (preferably a small station) stating his qualifications, and offering to work for, say, six months for nothing. This would not debar him from applying for any likely post advertised in the technical Press, and he must not be disheartened at an enormous amount of non-success; he may console himself that those who apply for superior posts to those they are in (especially the more important ones) do not get so much as an answer to more than about one in six, even when they have been for many years in a central station. As to the duties of a "junior assistant" (the title "junior assistant" is rather vague), so I will start with the pupil or improver, who nearly always start on the switchboard, and in a three-wire station I think that "E. A. L." will find that he has got a lot to learn. In a small station an improver may be called upon to do a little drawing or assist the mains superintendent by testing consumers' installations, etc., and he may also be called upon to help the fitter or jointer. As to pay, the improver who works for six months for nothing would get about 10s. a week for the next six months, and if satisfactory might get another 5s. a week at the end of a year. A switchboard attendant who has had previous experience would get from £1 to £1. 10s.; the shift engineer from about £1. 10s. to £2. 5s.; the mains superintendent from £100 to £120 a year; chief assistant from £100 to £175 a year. These are the average salaries generally offered in small starting stations and medium-sized stations respectively, but these can only be taken as an example, as salaries offered for exactly similar posts in similar stations vary within wide limits.—X.

Answer to No. 406 (*awarded* 5*s.*).—This question is one to which no decided answer can be given, so much depending on opportunities and the circumstances arising in each case. It is one, however, which young engineers are constantly asking, often of people who are unable or unwilling to enlighten them; to these anxious enquirers this answer may be of some assistance. In these days "specialisation" is recognised to be an essential of success in the majority of cases—that is, the acquiring of special knowledge in any particular branch of a trade or profession. A youth entering the electrical profession should receive a training—preferably mechanical as well as electrical—on general lines, after which he should choose one particular branch and devote himself assiduously to the study and practice of that branch, at the same time keeping in touch with the general advancement of his profession. It is often at this turning point mistakes are made, and when a little advice and assistance are invaluable.

One of the favourite branches which young men in the profession are aiming for is central-station work, and this branch is often looked at through rose-coloured spectacles, which become clear when once they have entered a station—often at a considerable sacrifice. The writer does not wish to appear pessimistic about central-station work, and it cannot be denied there are good openings as there are in other branches, but it is unwise to look on the matter with undue optimism. Central-station work means—often for a number of years—unsettled hours, shift work, night work, and Sunday labour; also, there is a certain amount of monotony in the routine work which to some natures is oppressive. It is important, too, a man for this work should have good health, for the varying hours, the tension of working eight to twelve hours and sometimes longer without a break, often in badly-ventilated engine-rooms having a high temperature in summer and a low one in winter, are all a strain which probably weak health could not stand. Before entering the work, then, it is well to realise what all this involves, and each point should receive due consideration.

And now a word as to the requirements of a central-station engineer. He has the working and care of boilers, economisers, pumps, piping, engines, generators, switch gear, and accumulators, and should have at least an elementary theoretical knowledge of these things, besides experience of their use in practice. He is expected to be able to draw up log sheets, cost sheets, load curves, and sometimes plans and designs; in small stations he may be called upon for testing and work on the mains, and sometimes to assist with the commercial work of the department. He must have tact in dealing with workmen, and nerve and resourcefulness so as not to be lost in case of breakdown. As competition for central-station work increases, efficiency in these qualifications becomes more necessary every day. After only the four years' training, as given in the question, it would be unreasonable to expect the young engineer would have these qualifications, nor is it likely he could get into a station as junior assistant. If he did so his duties would probably be to take an all-night shift, or act as assistant on a day shift under an "engineer in charge." In this capacity it is not likely he would be able to live on his salary. The best thing to do, if he could afford it, would be to go to a good station as a pupil, where he could spend some time in each department. He would thus acquire an all-round knowledge of the work, and this, with his previous experience, should fit him for a responsible position in a station. An alternative course would be to go as an improver, when he would receive little or no salary, and might have to pay a small premium. A third plan would be to try and get a position as switchboard attendant, trusting to his ability to fit him for a higher position when an opportunity came. In this position he might get anything from 10s. to 35s. per week, according to the size of the station and the length of time he remained on this work.

A further course would be to get on to a large private plant job, and when he felt qualified apply for a position in a central station. Even then he would probably have to make a sacrifice in position or salary or both to get into a station. It might be mentioned that Mr. John F. C. Snell,

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borough electrical engineer, Sunderland, has a system in his station for enabling young engineers to qualify for central-station work. This is the arrangement in Mr. Snell's words: "Four youngsters, who have served three years at least in the shops, and have regularly attended college, are given a 12 months' finish off here, either on switchboard work, in the mains department, the drawing office, or on the repairing staff. We have our own fitting shops, of course, and they really do get a good 12 months' experience, and several of them have left here to take up good junior assistants' posts." Other stations may have other systems for the same object, but none are known to the writer.

Once established in central-station work, the questioner would certainly find his four years' varied training useful. Should he have to wait for a position after completing his apprenticeship, it would be a wise plan to fill in his time in the office of a commercial or business house; there he would see business system and methods, and the importance of the financial questions would be brought home to him—this experience, however short, would be invaluable to him in after-life. In conclusion, this answer may appear to be an expansion of the question, but the writer has tried to put into a few words some of the conditions of central-station work, and the possible ways of entering it, in the hope that it might be helpful to those interested.—E. T. W.

Answer to No. 406 (*awarded* 5*s.*).—There are hundreds who have commenced in central stations as "junior assistants" with less experience than is stated above; nevertheless, without a certain amount of other knowledge is added to this, together with a capacity for gaining knowledge, few station engineers would have the heart to rob a contractor of such an employé. As one, presumably, without a knowledge of boilers or working machinery, with only vague ideas as to the handling of a switchboard, and utterly unacquainted with the vagaries of and the testing on a cable network, the likeliest post to get would be an improver, or maid-of-all-work in dungarees, at about 5s. per week, if sufficient influence could be brought to bear on the chief engineer to grant a salary. The neophyte would sweep up, polish brass and steel work, and perhaps hunt voltmeter fingers with rheostat handles when occasion demanded. From this position it would depend upon the youth himself how far and how fast he will go, and if vacancies occurred on the assistants' list after he had been in harness a year, he would have himself to blame should he not be offered the run of the switchboard promenade.

If, however, he should find it an impossibility to get inside a station within a reasonable time, let him swallow his pride and get a job as jointer's mate outside. If steady and painstaking he will in due course become a jointer, and afterwards (if a decent fellow and opportunity offers) assistant to the mains superintendent, eventually becoming a mains super. himself. And, let it be remembered that many once-time mains supers. are now full-fledged chiefs of stations. The duties of a mains super. are never so engrossing as to keep him from looking around the engine-room and becoming *au fait* with the inside working, while it is seldom that an inside engineer troubles his head about the mains, except to invent approbrious epithets when shorts occur. A knowledge of the mysteries of the 'spider's web" is, therefore, to be encouraged early in the professional life of central-station engineers.—B. C. H. J.

Answer to No. 406 (*awarded* 5*s.*).—I do not think you could successfully undertake the post of junior assistant without you have served some time in a central station. The most suitable post you could take would be that of switchboard attendant, and when you have gained enough experience in that position you would be quite capable of taking the post of junior engineer. The duties of junior engineers is to take entire charge of a shift, that means in small undertakings the boilers, running plant, and switchboard. A junior engineer must have a good knowledge of running plant, also of the switchboard connections; he must also have great presence of mind to enable him to do the right thing at the right time in case of a breakdown, paralleling and withdrawing machines, also withdrawing feeders, etc. In a large station the engineer on duty may only have the switchboard to be responsible for, while the foreman driver and foreman stoker will be responsible for their respective duties. The duties of a switchboard attendant are the following: taking readings, regulating the voltage, and possibly to attend to one or two dynamo bearings, also the cleaning of the board. In most stations the working hours are in three eight-hour shifts—namely, 12 midnight to 8 a.m., 8 a.m to 4 p.m., and 4 p.m. to 12 midnight, arrangements being generally made to minimise Sunday labour as much as possible. The salaries are from 25s. to 50s. for engineers, and 12s. 6d. to £1 for switchboard attendants.—E. E.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bray.—The Urban District Council invite tenders for electrical supplies. Particulars may be obtained from Mr. MacDonnell, clerk, Town Hall, Bray, Ireland.

Poplar.—The Libraries Committee invite tenders for the installation of electric light in four public libraries. Tenders by Oct. 1. Details in our advertisement columns.

Ashton-under-Lyne.—The Corporation invite tenders for a surface condenser of about 1,000 square feet, with pumps. Tenders by Sept. 18. Details in our advertisement columns.

Huddersfield.—The Corporation invite tenders for the supply and erection of one 600-kw. alternating-current generating plant. Tenders by Sept. 30. Details in our advertisement columns.

Listowel.—The Urban District Council are desirous of treating with a responsible firm for the supply of electricity for street-lighting. Tenders by Sept. 30. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of arc lamp-posts, wall brackets, and switch boxes. Tenders by Sept. 16. Details in our advertisement columns.

Whitehaven.—The Water and Lighting Committee invite tenders for the supply of incandescent lamps for a period of six months from October 1, 1901. Tenders by Sept. 16. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply and laying of cables. Specification, etc., can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by Sept. 25.

Poplar.—The Electricity Committee invite tenders for the supply of multiple-core, covered, lead feeder and network cable and accessories for mains extensions. Tenders by Sept. 18. Details in our advertisement columns.

Blackpool.—The Tramways Committee invite tenders for the construction and delivery of 20 tramway carriages. Specification, etc., can be obtained from Mr. John Lancaster, manager, Tramway Department, Blundell-street, Blackpool. Tenders by Sept. 21.

Doncaster.—The Corporation invite tenders for the supply, delivery, and erection of one high speed 220-kw. steam dynamo for traction and lighting purposes, together with steam pipes, steam valves, etc. Tenders by Sept. 27. Details in our advertisement columns.

Paris.—The Department of Postal Telegraphs invite tenders for 145 km. submarine cable, in three lots; 35,000 kilos 2½mm. iron wire; 295,000 kilos ·5mm. to 3mm. iron wire, in five lots; 4,500 kilos 3mm. jute thread, etc. Tenders to be addressed Rue de Grenelle, 103, by Sept. 24.

Kingston-upon-Hull.—The Electric Lighting Committee invite tenders for two high-speed three-crank compound steam-engines, 800 i.h.p. each, and four steel Lancashire boilers, 30ft. by 8ft., for 150lb. steam pressure. Tenders by Sept. 26. Details in our advertisement columns.

Madrid.—The Department of Agriculture invite tenders for the installation and working of an electric tramway for not more than 60 years. The route is from Linares to the mines of San Rogue and Tortilla. The deposit is 11,105 pesetas provisional, and 55,526 pesetas finally. Tenders by Oct. 17.

Sheffield.—The Corporation invite tenders for boilers (type left open), induced draught, air heating tubes or economisers, motors, fans, iron chimneys, brickwork or iron flues, and all other accessories for evaporating 120,000lb. of water per hour. Tenders by Sept. 30 Details in our advertisement columns.

Leeds.—The Lighting Committee invite tenders for the supply of a main switchboard to deal with the output of three 1,500-kw. 50-period two-phase alternators, and comprising dynamo panels, feeder panels, synchronising apparatus, etc. Tenders by Oct. 8. Details in our advertisement columns.

Salford.—The Corporation invite tenders for the lighting of the new generating station, Strawberry-road, Salford. Specification, etc., may be seen at the offices of the consulting engineers, Messrs. Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Tenders by Sept. 2.

Newport (Mon.).—The Corporation invite tenders for the supply and erection of winches, cables, overhead construction, complete electric motorcar, and repair shop equipment. Specifications, etc., can be had on application to Mr. H. F. Parshall, consulting engineer, 8, Princes-street, Bank, London, E.C. Tenders by Oct. 21.

London, W.C.—The British Electric Traction Company invite tenders for the supply of about 5,000 tons of steel grooved girder

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tramway rails, fishplates, etc. Specifications, etc., can be obtained on application to the Chief Engineer of the Company, Donington House, Norfolk-street, London, W.C. Tenders by Sept. 20.

Bournemouth.—The Town Council invite tenders for steel grooved girder rails, etc.; conduit permanent-way construction and rail bonding, etc.; ploughs and carrying attachments to cars; wood block, tar macadam, and granite sett paving. Specifications, etc., may be obtained from Mr. W. Lacey, M.I.C.E., borough engineer, Municipal Offices, Bournemouth. Tenders by Sept. 16.

Reading.—The Corporation invite tenders for the construction of new tramways and the reconstruction of the existing tramways, including the electrical bonding of the rails, the provision and laying of conduits and drawing-in boxes for the underground work, etc. Specification, etc., may be obtained on application to Mr. John Bowen, A.M.I.C.E., borough engineer and surveyor, Town Hall, Reading. Tenders by Sept. 28.

Blackpool.—The Tramways Committee invite tenders for all or any of the following materials in connection with extensions: 550 tons of rolled-steel girder rails; 27 tons of fishplates; 10 tons of bolts, nuts, and washers; 21 tons of crucible cast-steel points and crossings, and other materials. Specification, etc., can be obtained on application to Mr. John S. Brodie, borough engineer and surveyor, Town Hall, Blackpool. Tenders by Sept. 21.

East Ham.—The District Council invite tenders for the construction of the permanent-way works on their tramway extensions along the Manor Way towards Woolwich and across the Wanstead Flats to the City of London Cemetery (together about 1 mile 4 furlongs in length). Specifications, etc., may be obtained on application to the engineer and surveyor (Mr. A. H. Campbell, A.M.I.C.E.), Public Offices, East Ham. Tenders by Sept. 17.

Maidenhead.—The Corporation invite tenders for supply and erection of three 60-kw. steam dynamos (vertical enclosed high-speed engines); two boilers of the Lancashire type, with fittings; and economiser, with dampers, etc. Specifications, etc., can be inspected and all information obtained at the office of Messrs. Burstall and Monkhouse, consulting engineers to the Corporation, 14, Old Queen-street, Westminster, S.W. Tenders by Sept. 23.

London, S.W.—The London County Council invite tenders for track rails and fastenings, slot rails and fastenings, tiebars and conductor tees, and roadwork and platelaying required for the construction on the conduit system of the tramway routes between Westminster Bridge, Blackfriars Bridge, and Waterloo Station respectively, and Tooting. Specifications and other particulars may be obtained from the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

London County Council.—The County Council invite tenders for work to be done in supplying, fitting, and fixing lifts, motors, pumps, ventilating fans, lamps, cables, wires, conductors, switchboards, and columns, together with all supports, apparatus, fittings, and accessories which may be necessary or required for the electrical equipment of the Greenwich footway tunnel and its approaches. Specifications, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

Willesden, N.W.—The District Council invite tenders for the erection of main generating station and sub-station and offices in connection with proposed electric lighting scheme for their district. The works will consist of the following—viz.: (1) main generating station, Taylor's-lane, Willesden (a) engine-house, boiler-house, battery rooms and offices, etc., (b) chimney shaft; (2) sub-station, Salusbury-road, Kilburn, consisting of transformer and converter house, administrative offices, workshops, etc. Specifications and all further particulars may be obtained upon application to Mr. O. Claude Robson, M.I.C.E., engineer to the Council, Public Offices, Dyne-road, Kilburn, N.W. Tenders by Sept. 24.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a continuous-current 1,500-kw. dynamo working at from 550 to 625 volts, and the erection of these sets in the generating station of the South London Electric Supply Corporation, near Loughborough Junction. Also for three auxiliary 250-i.h.p. vertical high-speed enclosed steam-engines, each coupled direct to a continuous-current dynamo working at from 200 to 225 volts, and for the erection of these sets in the Council's generating station at Greenwich. Specifications and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a three-phase 1,500-kw. generator working at from 6,500 volts between conductors, each with an exciter, and for one 750-kw. reversible synchronous motor-generator, with exciter, designed so that either the low-tension or the high-tension side of the set will act as generator, and for the erection of these sets in the Council's generating station at Greenwich; also for nine 300-kw. synchronous motor-generators, working at from 550 to 600 volts on the low-tension side, each with an exciter, and for three 50-kw. induction motor-generators, working at from 200 to 225 volts on the low-tension side, and the erection of these sets in sub-stations provided by the Council. Full particulars may be had at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

RESULTS OF TENDERS.

St. Annes-on-the-Sea.—The Urban District Council have accepted the tender of Dick, Kerr, and Co. for steam dynamo.

Burnley.—The Corporation have accepted the following tenders in connection with the works required in the erection of an electric power station: A. and R. Parker, excavator, mason, and bricklayer's work, £2,490; Exors. of Thos. Boothman, carpenter and joiner's work, £335; A. Shackleton, plumber and glazier's work, £117; J. Shuttleworth, painters' work, £31; W. Foster and Sons, plasterers' work, £27; W. Stanworth and Son, slaters' work, £114. 6s.; J. Pollard, cast-iron cistern, £170.

Bradford.—The Corporation have accepted the following tenders: Witting Bros., Limited, London, for 100 car bodies and 100 electrical equipments; and Hurst, Nelson, and Co., Limited, Motherwell, for 100 trolleys. Trucks not yet dealt with. It has also been resolved that, subject to the Tramways Committee sanctioning the necessary expenditure and to the approval of the Council, the offer be accepted of the British Insulated Wire Company, Prescot, for the supply, for the sum of £13,474, of cable and other materials required in laying and fixing the same for the tramways in Manchester-road, Leeds-road, Sunbridge-road, Wakefield-road, and Manningham-lane.

Yarmouth.—The Tramways Committee have accepted the following tenders for various plant necessary for tramway work: British Insulated Wire Company, poles, overhead equipment and electric bonding, £5,369; Doulton and Co., Limited, earthenware conduits, £449. The Committee on the advice of Major Cardew have decided to invite fresh tenders for storage battery, booster, and switchboard, the lowest for this work being in excess of the amount allowed. Askham Bros. and Wilson, points and crossings, £1,127; Telegraph Manufacturing Company, cable, £1,993. 3s. 11d., accepted, subject to the proviso that they conform to the terms of the conditions of contract with respect to arbitration, failing which the tender of Johnson and Phillips, at £2,012 18s. 6d., subject to a similar proviso, failing which the tender of the British Insulated Wire Company, at the sum of £2,041. 13s. 6d., they not having in any way modified the conditions of contract.

Thorpe (Norfolk).—The following tenders have been received for plant, etc., at the Norfolk County Asylum:

Electric plant.			
Scott and Mountain, Limited	£2,858	0	0
Royce and Co., Limited	2,762	10	0
Crompton and Co., Limited	2,657	0	0
Holmes and Co.	2,638	0	0
Alliance Electrical Company	2,612	9	8
Siemens Bros. and Co., Limited	2,595	10	6
Reavell and Co., Limited	2,500	0	0
Laurence, Scott, and Co., Limited (accepted)	2,456	6	0
Wiring and fittings.			
Hemingway and Pritt	6,654	1	2
Crampton and Co.	4,750	0	0
Alliance Electrical Company	4,224	14	9
Hall and Hackblock	4,061	9	7
Furse and Co.	3,964	6	6
S. H. Heywood	3,749	2	10
Mann and Co. (accepted)	3,484	11	7

BUSINESS NOTES.

TRACTION.

Brighton.—The electrical engineer is engaging the working staff for the new tramways.

Beeston.—The Urban District Council will shortly approach the Nottingham Corporation with a view to extending the electric trams to Beeston.

Branksome.—The Urban District Council have approved the draft by-laws proposed by the Board of Trade with reference to the electric tramways.

Halifax.—Ten of the new tramcars are to be fitted with automatic circuit breakers, on the advice of Mr. A. S. Giles, electrical engineer, Blackburn.

Rochdale.—The Board of Trade have consented to the substitution of double for single lines in Edenfield-road opposite the junction with Bagslate Moor-road.

West-end Motor Service.—It is announced that Monday next will witness the inauguration of a regular service of motor omnibuses between Piccadilly and Putney.

Nelson.—Application will shortly be made on behalf of the Corporation for sanction to borrow £8,700 in respect of the reconstruction and equipment of the tramways in the borough.

Aberdeen.—Lieut.-Colonel von Donop, Board of Trade inspector, visited Aberdeen on Saturday for the purpose of inspecting the bathing station and Mannofield sections of the tramways.

Leigh.—The Corporation have unanimously passed a resolution that it is not expedient to apply during the ensuing session of Parliament to construct and work electric tramways in the borough.

Newcastle.—At Wednesday's meeting of the Town Council reports of the New Tramways Committee relative to sections and fares, and to the appointment of a general manager and staff, were adopted.

Prestwich.—The District Council have passed a resolution calling upon the Manchester Corporation to complete the agreement for lease of tramways in Prestwich forthwith, or to explain their reasons for the delay.

Wigan.—The construction of the New Springs route of electric tramways has now been going on for some three or four weeks. Conveyances have been signed for the purchase of land for a tramway car-shed.

Hendon.—At a special meeting of the District Council it was reported that during the Council's recess the Hendon Tramways Bill had come before a committee of the House of Commons, and had been thrown out.

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Birkenhead.—Two recommendations for the doubling of tramway tracks about to be constructed—those along Park-road South and the Deck line to the boundary of the borough—have received the approval of the Town Council.

Dudley.—It has been decided to improve the tramway service by extending the double line from Queen's-cross to the Plume of Feathers, placing a turnout in the middle of High-street, and two sidings on the upper side of the Fountain.

Perth.—A letter from the secretary of the tramway company requesting the Corporation to grant a lease for 32 years, on condition that the company adopted electric traction, was referred to the committee at the the last Town Council meeting.

Bexhill-on-Sea.—Drawings showing the proposed construction of the permanent way for the Hastings, St. Leonards, and Bexhill tramways have been submitted to the Urban District Council by Messrs. Kincaid, Waller, and Manville.

Grimsby.—All is now ready for the inspection by the Board of Trade of the completed portions of the Grimsby and Cleethorpes electric tramways, and as soon as that authority has given the necessary sanction, the electric cars will start running.

Portsmouth.—The 19th inst. has been fixed for the formal inauguration of the new electric tramways. The lines were taken over by the Corporation from the Provincial Tramways Company only in January last, and over £600,000 has been spent in purchase and equipment.

Leeds.—The next lines to be electrically equipped are the Armley and Wortley sections. It is also proposed to lay lines through West-street and Bishopgate-street, which will give a very much-needed diversion of the traffic both along Wellington-street and over Leeds Bridge.

Ayr.—The Corporation tramways have now practically been completed, and the first car has been run over a section of the route—viz., from Prestwick Toll to St. Leonards Church, a distance of about 2½ miles. The Board of Trade have been notified that the undertaking is ready for inspection.

Bradford.—The Idle and Thackley sections of the Corporation electric tramways were inspected by Major Druitt, R.E., on Tuesday on behalf of the Board of Trade, and, conditional permission having been given to open the lines for traffic, the service was in full operation during the afternoon and evening.

Maidstone.—On the 25th inst. the Corporation will receive a ratepayers' deputation regarding the proposed electric tramway scheme. Notice of motion has been given that application be made in the next session of Parliament for a Bill authorising the Corporation to construct and work electric tramways in the borough.

Musselburgh.—At an interview between the Provost and Law Committee of the Town Council and Mr. Allbright, manager of the company promoting the electric lighting and tramways scheme, it was stated that the delay was entirely due to the difficulty the company had in financing the schemes, which hang together.

Bedford.—The Corporation have received an order from the Board of Trade extending the time limited for the commencement of the construction of the tramways and the time for the completion of the works authorised by the Bedford Corporation Tramways Order, 1900, until Aug. 6, 1902, and Aug. 6, 1903, respectively.

Stourbridge.—The electric tramway company are now running their cars to the new terminus in Hagley-road. The lateral branches from the High-street extension, *via* Foster-street to Lye, and *via* Enville-street to Wollaston will, it is understood, shortly be begun. No addition has been made to the fares for the additional distance passengers are now carried.

Sunderland.—We note that a special meeting of the County Borough Council has been summoned for Oct. 9, at which will be submitted a resolution in favour of an application to the Board of Trade for a provisional order under the Tramways Act, 1870, authorising the Corporation as the local authority to construct new and additional tramways within the borough.

Tramway Defined.—In the Standing Orders of the House of Lords relative to the bringing in and proceeding on private Bills, which have just been published, there is an interesting interpretation of the words tramway and tramroad. The term "tramway," it shows, means a tramway laid along a street or road; "tramroad" means a tramway laid elsewhere than along a street or road.

London-to-Tunbridge Wells.—It is reported that the motorcar service between London and Tunbridge Wells has been abandoned after a six months' trial. The difficulty in the collection of goods in London and the frequent breakdowns of the cars are said to be the chief causes of the abandonment. The service, however, was locally regarded as a great boon to the tradesmen of Tunbridge Wells and Sevenoaks.

Northfleet.—The District Council are insisting upon the tramway company at once discontinuing to lay down granite setts on the outside edge of their wood paving, and requiring them to take up the setts that had already been laid down. The Council have notified the company that they will not approve of granite setts being substituted for wood paving on the lower portion of Dover-road and over the railway bridge in that street.

Ramsgate.—The Corporation have resolved to join with the Corporation of Margate and the Urban District Council of Broadstairs in engaging the services of an expert in the construction and working of electric tramways to report on the subject of the complaints of nuisance and annoyance from vibration and noise, caused "by the apparently improper manner in which the Isle of Thanet Light Railway is constructed and worked."

Nottingham.—In the last few days several of the new bogie cars for the Trent Bridge route of tramways have been tested on the section from Bulwell to Nottingham, and in the majority of cases the trial trips were successful. The cars, though of the same type as those already in use, each provide seating accommodation for 75 passengers, and are fitted with eight bogie wheels instead of four, used in the construction of the majority. Over 70 of the 87 cars ordered by the Corporation have already been delivered.

Stockport.—A somewhat serious accident occurred to an electric tramcar on Tuesday. A car containing a number of passengers was coming down Lancashire-hill, and when at the steepest part the brakes, it is said, failed to operate, and the car, jumping the metals, dashed into a bootmaker's shop. The passengers had no time to leave their seats before the crash came. The whole of one side of the shop was wrecked, and the persons inside had a miraculous escape. The driver was seriously injured, having his arm broken and his leg injured.

Wakefield.—The dispute relative to the tramways proposed under the Wakefield and District light railway order passing over Kirkgate Bridge still continues. The West Riding solicitor has notified his intention of again placing the matter before his committee, and he has asked the opinion of the Corporation on the point. The Board of Trade have written the Corporation that they propose to act upon the recommendations contained in the report of Lieut.-Colonel von Donop as to the construction of such railway. The question will probably be discussed at an interview to be arranged between the West Riding Highways Committee and the promoters of the scheme.

Bristol.—A big working-class meeting has adopted the following resolution: "That this meeting of Bristol citizens protests against the extraordinary action of the Lord Mayor and the town clerk of Bristol in refusing to place on the City Council's agenda a motion by one of its members to request the Board of Trade to hold an enquiry into the numerous tramway accidents occurring in our streets, those officials having neither moral nor legal right to dictate to the Council what business may or may not be considered by it." The Lord Mayor's explanation of his action is that as private citizens had already made representations to the Board of Trade, there was no need for him to move.

Warrington.—Tramway No. 10, for the construction of which the contract has been let to Mr. Ewart and Messrs. Blackwell and Co., Limited, is to be commenced forthwith, and Messrs. Preece and Cardew are preparing estimates and a report on the construction of tramways No. 4 (Scotland-road and Winwick-street), No. 5 (Winwick-street to Longford Bridge), and No. 6 (Buttermarket-street to Manchester-road). Application is to be made to Parliament in the next session for power to construct a tramway from Stafford-road to the Mulberry Tree Inn, Stockton Heath, and for a tramway along Grappenhall-road and Acker's-lane to join with tramway No. 11 in Knutsford-road.

Personal.—We are pleased to note that Mr. Arnold G. Livesay has been appointed assistant electrical engineer in the tramways department of the Leeds Corporation. As a member of the outside staff of the British Thomson-Houston Company for the past five years, Mr. Livesay has gained great experience in electric traction work, having been last engaged as chief engineer on the contract for the overhead equipment of the new Croydon electric tramways. Previous to this he occupied a similar position at Leeds and Huddersfield, and Mr. Livesay has therefore considerable local knowledge, and is eminently qualified for the new position he is called upon to occupy.

Darlington.—At the last Town Council meeting, a letter was received from the electric traction company intimating that they would have to reduce their service of cars between Longton and Stoke, owing to the fact that they could not come to terms with the Fenton Urban District Council for laying a certain additional loop there. The Council carried a resolution by 12 votes to 5, that application be made to the Light Railway Commissioners on behalf of the Corporation for an order to construct and work light railways in Darlington, in lieu of the present system of tramways worked by the Imperial Tramways Company, which the Corporation had contracted to purchase.

Glasgow.—There have been several allegations of excessive speed against the electric trams lately. Last week the complaint of a Pollokshields gentleman was dismissed on the ground of want of specification. Complainant sought to recover the penalty of £10 for each of the 28 occasions upon which the cars were alleged to have exceeded the legal speed of eight miles an hour, but failed. On Monday a further extension of the electric car service took place on the route from Bridgeton Cross to Alexandra Park *via* Clyde-street, Duke-street, and Cumbernauld-road. A committee is to be appointed to consider and report on the advisability of renting shops as tramway waiting-rooms at suitable points.

Isle of Man Tramways.—The liquidator of the Isle of Man Tramways and Electric Power Company having invited tenders for the purchase of the concern as a whole or in sections, five tenders have been received. On Wednesday the tenders were opened by the officials of the Manx Chancery Court. For the electric sections (Douglas to Laxey, Laxey to Ramsey, and Laxey to Snaefell summit) Harold Vickers offered £188,850, and for the Douglas cable and horse section the Douglas Town Council offered £40,000. The British Electric Traction offered £225,000 for the whole concern, and Kidson and another Manchester firm offered £210,000. It has not transpired whether any of the tenders have been accepted.

Croydon.—On Friday last a successful trial trip was made along the main base line of the new electric tramways with one of the cars supplied by Messrs. Milnes and Co. This week a certain section of the line has been devoted to the running of "school" cars for the training of drivers. The official Board of Trade inspection, we are informed, may be expected any day next week, and it is hoped to put a public service of cars on the line from Norbury to Purley by the 25th at latest. Under an agreement with the British Electric Traction Company the Corporation have leased the system to that company for a term of five years. The contractors for the overhead equipment are the British Thomson-Houston Company, Limited. When all the

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branch lines are completed it is estimated that the total capital expenditure will not be less than £100,000.

Southport.—On the recommendation of the Tramways Committee it has been decided to make application to the Board of Trade for a provisional order authorising the construction of a new tramline from Scarisbrick New-road along Ash-street, Cemetery-road, Duke-street, Shakespeare-street, and St. James-street, joining the present line at Eastbank-street. The fifth annual report of the electrical engineer shows that, owing largely to the high price paid for coal, the surplus for the year was considerably less than was anticipated, being, roughly, only £700. The gross profit for the year was £7,292, as against £6,384 the previous year, being a return of 5·5 per cent. on the capital invested at the end of the year. Since the inauguration of the undertaking the sum of £10,677 has been paid in reduction of debt.

Surrey Tramways.—Powers have already been granted to the London United Tramways Company for the construction of more than 60 miles of electric tramways in Middlesex and Surrey, some of which are now in operation. We hear that the company have in preparation for next session a further Bill seeking powers to construct between 40 and 50 additional miles of line, chiefly in the administrative county of Surrey. The company propose to go to Mortlake, Richmond, Petersham, Kingston Vale, Esher, Ewell, Wimbledon, Epsom, Merton, Morden, Mitcham, Carshalton, Croydon, Sunbury, etc. If carried out these lines would connect with Kempton Park, Sandown Park, Hurst Park, and Epsom racecourses. The Wimbledon Council have given a conditional assent to that part of the scheme which affects its district, but the Epsom Urban Council have decided by an almost unanimous vote not to support the proposed undertakings.

The District Railway.—According to a news agency report the District Railway Company have resolved to have nothing to do with the Ganz electric system for their section of the underground. Mr. Yerkes has seen the system at work at Budapest, and, it is said, has come back more strongly convinced than ever that it should not be taken up. The directors of the District Company have endorsed Mr. Yerkes's opinion. The Metropolitan Company, on their part, stand by the Ganz system, which their engineers recommend. The period of a month fixed by the Board of Trade in which the companies might come to terms has now expired, and the two companies have intimated that they are prepared to go at once before the tribunal appointed by the Department to settle the system to be adopted. At a meeting of the directors of the District Company this week the resignation of Mr. J. S. Forbes, the chairman, was accepted, and Mr. R. W. Perks, M.P., was elected to the position.

Scarborough.—The Town Council have referred back to the Tramways Committee a recommendation for the construction of that portion of the proposed system of electric tramways extending from Trafalgar-square along North Marine-road and St. Thomas and St. Nicholas streets to Harcourt-place, by reason of the narrowness of those thoroughfares. Mr. A. A. Campbell Swinton, on behalf of the private company who are to construct the new electric tramways in Scarborough, has written to the effect that he has no objection to the insertion of a clause in the Bill empowering the Corporation, if they should think fit, to invest £10,000 in the company, and providing for the representation of the Corporation on the directorate. The Corporation have informed Mr. Swinton of their desire that they should have the option of investing a sum equal to one-fourth of the total capital of the company, on loan to or in debentures of the company, subject to due representation on the Board.

Salford.—The authorities are making progress with their electrical equipment. The Higher Broughton route is to be ready by October. Poles are being fixed in Blackfriars-street, the road by Broughton Bridge has been widened to accommodate a double line of rails, and land has been acquired to allow of a better curve at the junction of Bury New-road and Great Cheetham-street, as well as at the junction of Great Cheetham-street and Great Clowes-street. Cables have been laid along the whole of this route, whilst those on the Pendleton route are also nearly completed. Several new cars are arriving at the depôt. A sub-committee of the Tramways Committee met on Monday to consider the resolution adopted by the General Purposes Committee as to the terms upon which the Salford Corporation are willing to enter into a working agreement with the Manchester Corporation for working the electric trams. The Corporation's proposals are now awaiting the consideration of the Manchester Council.

Tramway Fares.—We in this country are wont to regard our tramway fares as remarkably cheap. According to *Traction and Transmission*, however, we are far behind our American cousins in this respect. In Brooklyn and New York passengers on electric tramways are carried 15 and 20 miles for 2½d., or at the rate of half a farthing per mile. Taking 20 large American cities at random, there is found no less distance than 10 miles for 2½d., or ¼d. a mile; and the average would be 12½ miles—less than ¼d. a mile. The Municipality of Glasgow charges 3d. for less than six miles—½d. a mile; Liverpool, practically the same; Belfast, 3d. for five miles; Edinburgh, 7d. for eight miles; Manchester, 8d. for eight miles; and so on, not less than ½d., and in some cases 1d. a mile for long distances. Our contemporary therefore concludes that long-distance riders in America receive much better value than is the case in British cities. Short-distance travelling, however, is cheaper in Great Britain.

Buenos Ayres Tramways.—Presiding over the annual general meeting of the Buenos Ayres Grand National Tramways Company on Tuesday, Mr. N. G. Burch said that electrification had been very much in evidence in Buenos Ayres during the past year or two. The Anglo-Argentine Company had been electrifying their line, as had also the capitals, and—what was of more importance to this company—the Belgrano Company, which traversed for some distance a route of great value to the Grand National Company. Referring to the agreement with the Nueva Company, he said an object in acquiring the Nueva line, and having a pooling arrangement under which 4½ miles of line were to be electrified, was to have a practical and useful guide and test as to what electrification could do, and to what extent they could adopt the system with advantage on their own line. Furthermore, the Nueva line had been acquired by a highly influential group, and if those gentlemen had taken it into their heads to electrify the Nueva without this company having any co-operation in the matter, the Grand National would have been struck disastrously by the competition.

Sheffield.—During the month of August the total takings on all sections of the city tramways amounted to £15,414, and 3,997,027 passengers were carried. At Wednesday's meeting of the Corporation the general manager, Mr. A. L. C. Fell, reported on his visit to Germany, where the new 1,000-kw. generator for the power station is being built. In his opinion, the construction of the commutator of the new machine is a great improvement on those now running at the Kelham power station. Mr. Fell also reported at length on track work, rail bonding, overhead line construction, guard wires, the conduit system, cars, wheels, lifeguards, traffic regulations, and fares as carried out on the Continent. The Tramways Committee reported that Messrs. Milnes and Co. have delivered the whole of the 25 car bodies ordered from them, and the trucks and equipments are now being assembled, and Mr. Fell hopes to have some of these cars ready for operation early next week. The committee are purchasing machinery for the purpose of erecting cars by their own staff at the Nether Edge depôt. All the church cars are to be discontinued on Sunday mornings except the one running on the Nether Edge section.

French Electric Tramway Shares.—According to the latest reports the shares of French transport companies, and especially those of electric tramways, are at the present moment under a shadow. Electric tramways have of late been laid down with great activity, especially in or near Paris. Owing to the very exaggerated ideas that were formed as to the immediate future of these means of communication, it is said, the shares were issued at a very much too high rate. Speculation became rife before any of the constructive work was started, and long before any opinion could be formed with regard to traffic; possible disappointments were not taken into consideration at all. To-day the situation is reversed, and the speculators find they are out in their reckoning, for the time being at all events. Taking, for instance, the shares of the Compagnie Générale Française de Tramways, these had fallen a few weeks ago by about £24, when compared with the highest rates of 1900. The fall was about the same as regards the shares of the Compagnie des Procédés Thomson-Houston; it exceeded £20 for those of the Compagnie des Tramways de Paris and du Department de la Seine, and reached this amount also in the case of the shares of the Tramways de l'Est Parisien. In the same way the Compagnie Générale de Traction, which have furthered a large number of electrical undertakings, have seen their shares fall from £13. 15s. to £2.

West Riding Scheme.—The important scheme of tramway extension in the West Riding of Yorkshire came formally under discussion on Tuesday, at Dewsbury, at a conference between the promoters and the local governing bodies. The British Electric Traction Company already hold the necessary powers from the Board of Trade to construct lines of electrically equipped tramways, embracing such places as Dewsbury, Ravensthorpe, Batley, Cleckheaton, Gomersal, Thornhill, Liversedge, Huntsworth, Gildersome, East and West Ardsley, Morley, and Birkenshaw. Thus the system taps large centres of population, running to the verge of Leeds on the north-east, Bradford on the north-west, Halifax on the west, and Huddersfield on the south-west. These places cater for their own inhabitants within their own boundaries, but the British Electric Traction Company have an idea of running their cars over the lines of one or other of the towns mentioned—Leeds or Bradford for choice. But that is not within the scope of their order, and it must be a matter of friendly arrangement. Discussion turned on such questions as the position of the line in narrow thoroughfares, the construction of the line in narrow thoroughfares, the construction of road surfaces, the negotiating of curves and steep gradients, and whether the line shall be single or double in particular localities. An expenditure of something like £300,000 is involved in the scheme. According to the reports of the proceedings we have seen there appears to be a disposition on the part of the authorities to facilitate the scheme.

Manchester.—A deputation from the workmen employed on the city electric tramcars attended before the Traffic and Staff Sub-Committee of the Manchester Tramways Committee on Monday, to lay before the committee certain grievances which are alleged to have arisen since the Corporation took over the management of the trams. These, it appears, refer (1) to loss of pay in consequence of attending at the general office; (2) to the alteration of the men's time for Sunday after they had left off on Saturday night; (3) to the rule which prevents men from obtaining the maximum wage until they have served for three years; (4) to the practice of dismissing cleaners and replacing them by roadmen; and (5) to the manner in which one of the officials of the Corporation treats the men. One additional claim was added—namely, that the nine-hour day should include one hour for dinner. The sub-committee, having heard the views of the deputation, promised to consider the various questions brought forward, and instructed Mr. M'Elroy, the general manager, to prepare a report on the subject, referring especially to the hours of labour and the rate of wages paid. On Saturday morning an alarming accident occurred in Rochdale-road. A large bogie car, returning from town, approached the railway line which intersects the road opposite the Rochdale-road gasworks. A locomotive engine, drawing trucks laden with coal, started to cross the road, and when the car reached the crossing a collision occurred. The engine was fortunately proceeding at a very slow pace when the accident happened, but the front part of the car was partially telescoped, and the driver had a narrow escape. At the present time, in the absence of an official report, it is not possible to say upon whom the blame actually rests, but the matter will be investigated by the officials of the Corporation tramways department. The damage to the car is estimated at from £15 to £20.

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LIGHTING AND GENERAL.

Bangor.—It is proposed to borrow £2,000 for the purchase of a new dynamo.

Morecambe.—An estimate is to be obtained for the lighting of Carleton-street by electricity.

Sleaford.—The Urban District Council are raising a further loan of £4,000 for electric lighting purposes.

Worksop.—The opening of the Urban District Council's electricity works will take place on the 17th inst.

Blackpool.—We regret to learn that Mr. Quin has broken down in health, and has had to take a month's leave of absence.

Halifax Telephones.—The Council have decided to obtain powers for the establishment of a municipal telephone exchange.

Bacup.—Councillor Crabtree has been elected a member of the Electricity Committee in place of Councillor Hardman, deceased.

Mold.—The Highway Lighting and Watering Committee of the Urban District Council are enquiring as to the cost of lighting the town by electricity.

Thornaby.—The Town Council intend to apply for a provisional order enabling them to supply electricity for all public and private purposes within the borough.

Bradford.—The salary of Mr. R. A. Chattock, city electrical engineer, is to be advanced by £100 per annum as from July last, and a further £100 from July next.

Carnarvon.—We understand that the draft electric lighting provisional order will shortly be submitted to Sir W. H. Preece, who has promised to advise the Council.

South Yorkshire Electric Power Bill.—The first generating station under the powers obtained in this Bill will be built at Methley, and plans and specifications are now being got out.

Crook.—The Urban District Council have appointed a deputation to confer with the Helmington Row and Hunwick Parish Councils with regard to the provision of electric light for the three districts.

Spennymoor.—The Urban District Council are considering a letter from the Board of Trade in reference to the proposed supply of electricity by the Northern Counties Electricity Supply Company.

Football.—Glover's (Electric Cable) Football Club played Dowson-Taylor's (General Engineers) Football Club at Trafford Park on the 7th inst. The result was unfortunate for the latter by eight goals to nil.

Hastings.—The Town Council have received sanction to borrow £14,272 for the purposes of electric lighting (new mains, additional alternator, boilers, plant, etc., and cable), the authorised period being 21 years.

Personal.—Mr. H. W. Watts has been appointed resident engineer to the Weybridge electricity works, and Mr. Cuthbert W. Bentley succeeds him as resident engineer at the electricity works, Alderley Edge, Cheshire.

Yarmouth.—The electric lighting report of the past quarter shows that the income amounted to £1,152. 3s. 3½d., and the expenditure to £978. 13s. 11d. The committee have, therefore, earned £173. 9s. 4½d. beyond the cost of production.

Mexborough.—The Urban District Council's electric light cables are to be extended up Adwick-road, Victoria-road, Albert-road, and Cemetery-road, and lamps be erected thereon. An additional arc lamp is to be erected in Doncaster-road.

Longton.—The Council have resolved that on the formal opening of the electric lighting works the chairman of the committee (Alderman Bakewell) should be requested to start the first set of generating machinery, and the Mayor the second set.

Leamington.—The Electric Light Sub-Committee's report, which has just been adopted by the Town Council, states that they could not recommend the Council to lay down their own electric light installation for the town hall and other public buildings.

New Book.—Part II. of the "Indicator Handbook," a practical manual for engineers, by Charles N. Pickworth, Whit.Sch., has been published by Emmott and Co., and contains details and definitions of the indicator diagram—its analysis and calculation.

Sheffield Telephones.—The Electric Light Committee, to which Messrs. Fenton and Wheatley have been added, have been appointed a committee to make enquiries and report as to the advisability or otherwise of establishing a municipal telephone exchange in Sheffield.

East Grinstead.—After a long discussion on the question of introducing the electric light at a cost of £13,000, the Urban District Council have decided that a special meeting should be held, at which Mr. Medhurst, who had presented a report on the subject, should be present.

Harrogate.—The proposal of the Wilton Patent Furnace Company has been accepted, but only one boiler will be fitted up at present in accordance with their offer. The fitting of the second new boiler is to stand in abeyance until the working results of the Wilton furnace are ascertained.

Goring.—The Rural District Council have passed a resolution intimating that they would not put any obstacle in the way of the Caversham Council with reference to the opposed acquisition of electric light for public lighting of Caversham, and, if possible, Mapledurham.

Montrose.—It appears that a satisfactory agreement has been come to with the electric lighting company in regard to the upkeep of the trenches opened by them, and when any street is to be opened for the purpose of laying cables the works are to be carried out by the Council's own workmen.

Tunbridge Wells.—With regard to our note in last week's issue under this heading, we are now informed that the resolution referred to only applies to the borough which was then under consideration of the Council, and that Mr. Boot is still open (with the committee's permission) to take other work.

The Solent Tunnel.—The Central News is officially informed that the report which appeared in some quarters that unexpected difficulties have arisen in connection with the construction of the Solent Tunnel is quite unfounded. On the contrary, all circumstances point in favour of the construction of the tunnel.

Arc Lamps.—We are informed by Mr. G. Braulik, of 217 and 218, Upper Thames-street, E.C., that the agency which he had held for the past 10 years for Messrs. Koerting and Mathiesen's arc lamps terminated on Sept. 4 last, but that he will still continue to supply arc lamps of their make, besides other electrical accessories.

Morley.—The engineer (Mr. Drewitt) in his last report states that the output from the electricity works for the five weeks ending Aug. 17 was 4,416 units, as against 3,610 units for the same period last year, being an increase of 806. There had been 686 lamps connected during the month, the total number at the present time being 7,697.

Torquay.—The Electric Lighting Committee's last report states that enquiries had been made relative to the extension of the electricity supply to Torbay Hall. The extension would cost £520, and the committee have decided to defer the subject until the engineer can bring up a comprehensive scheme for lighting Chelston ward.

Anglo-Persian Telegraph.—A convention has been signed between the British and Persian Governments for the construction of a three-wire telegraph line from Kashan to British Baluchistan by way of Yezd, Kerman, and Bampur on conditions similar to those of the convention of 1872 for a telegraph line from Teheran to Bushire.

Oswestry.—The question of electric lighting has been referred to the General Purposes Committee. We understand that the only tender for fixing the electric light and two ventilating fans in the reading-rooms was that of Mr. E. M. Evans, of Manchester, the amount being £55. 10s. The committee have decided to do without electric fans.

St. Albans.—The Corporation at its last meeting discussed again the question of the installation of electric light for the town. Correspondence was received from the North Metropolitan Electric Supply Company, Limited, requesting an interview. It was decided that representatives of the company should be invited to meet the Urban Committee next week to consider the matter.

Abergavenny.—At last week's meeting of the Town Council a long discussion ensued, in which reference was made to the lighting of the town by electricity, and eventually a special committee was formed to prepare a case to be laid before an expert consulting engineer for a report upon the proposed extension of the gasworks, provided the proposed report can be obtained for a reasonable sum.

Shoreditch.—At the last meeting of the Borough Council it was decided to purchase 300 maximum demand indicators, at an estimated cost of £350. It was resolved to lay out the public garden in Hoxton-square at an estimated cost of £150. 8s. 6d. On the recommendation of the Baths Committee it was decided to acquire additional property in order to enhance the design for the new Haggerston baths.

Mentioned in Dispatches.—Lord Roberts, in his final dispatch, which has just appeared in the *Gazette*, mentions amongst those who, with their various units, have rendered special and meritorious service, Lieutenant-Colonel R. E. B. Crompton and Captain A. Bain, 6176 Sergeant W. S. Entwistle, 6203 Sapper R. W. Holliday, and 6186 Sapper J. Rook, of the Electrical Engineers Volunteers.

Sheffield.—On Wednesday the City Council decided to ask for sanction to the borrowing of £83,237 in respect of capital expenditure in connection with the electric light undertaking to June 30, 1901, and also a sum of £500,000, being the amount of the estimated capital expenditure on the mains and extensions of the undertaking up to June 30, 1902, and the purchase of land, erection, and equipment of the new power station.

Eastern Extension Cable.—The cable steamer "Anglia," carrying the first section of the Eastern Extension, Australasia, and China Telegraph Company's cable by way of Mauritius, Rodriguez, and Cocos Island to Perth, in Western Australia, arrived at Mauritius on Sept. 8, and at once started to lay its section. The cable steamer "Scotia" left Aden on Sept. 8 for Cocos Island. The "Scotia" carries the long section of the cable from Cocos to Perth.

Pemberton.—The question of free wiring and tenders for arc lamps has been referred to a sub-committee, consisting of Messrs. Sharrock, Ashurst, Clayton, Moorfield, Partington, and Britton, who are making enquiries as to the systems adopted in other districts. The engineer advises that two of the engine-beds be left over until the additional plant is required, and that the arc lamps, for which tenders have been obtained, be worked two in series instead of four.

Presentation.—The term of office of Mr. Hope Johnstone, the retiring electrical engineer to the Bedford Corporation, expired on Monday, the 9th inst. On the preceding Saturday he was presented by Mr. Barkham, the chief assistant, on behalf of the staff and employés, with a handsome travelling dressing case and an illuminated address, expressing their appreciation of him as chief and their regret at his severing his connection with the department.

National Electric Wiring Co.—We are informed that the Liverpool branch of the National Electric Wiring Company, Limited, of which Mr. J. Newton Stephens is the engineer and manager, have obtained the contract for the electric lighting of "Vickerstown," Barrow-in-Furness, for Messrs. Vickers, Sons, and Maxim, Limited. Amongst other large contracts in hand by this branch, there is the complete electrical equipment of the Grand Hotel, Llandudno.

Stock Exchange.—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: Electric Construction Company's further issue of 6,390 7 per cent. cumulative preference shares of £2 each fully paid, Nos. 25,001 to 31,390. Applications have been made to the committee to appoint a special

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settling day in and to grant a quotation to Crompton and Co.'s further issue of 31,000 shares of £3 each fully paid, Nos. 54,001 to 85,000.

Islington.—The Guardians of the Highgate-hill Infirmary will apply for sanction to the expenditure and borrowing of a further sum not exceeding £21,500, making a total sum of £31,377. 8s. 2d. (exclusive of the electric lighting) beyond the original estimate. The gross total will be made up as follows: site and building account, £268,496. 0s. 2d.; fittings and fixtures account, £21,213. 3s. 11d.; electric lighting account, £9,561. 7s. 5d.—total, £299,270. 11s. 6d.

Rural Night Telegrams.—The Post Office is about to try the experiment of giving the rural districts the benefit of a night service of telegrams. At present all our rural districts are shut off from telegraphic communication with the outside world from 8 p.m. till 8 o'clock next morning. The experiment is only to be tried in villages where the parish council ask for it and are willing to pay a guarantee fee against loss. A late fee for delivery on each message will be charged.

Bury St. Edmunds.—The Town Council have adopted the suggestions of the resident engineer—viz., that a cable be laid in the Fornham-road district for private consumers at the same time as the street-lighting cable is laid, and so save additional labour, the cost being estimated at about £140, and that a new scale of charges for motive power be fixed as follows: for consumption and energy up to 100 units per quarter, 3d.; from 100 units to 250 units per quarter, 2½d.; from 250 units to 750 units per quarter, 2¼d.; from 750 upwards per quarter, 2¼d.

Perth.—The Council have decided to grant a supply of current to certain churches, provided the consumers enter into a written contract with the Council to agree to pay for their supply for a period of at least two years of such an amount as shall not be less than 20 per cent. per annum on the outlay incurred in providing the necessary electric mains, the electric lighting department laying these mains free. The electric lighting main in York-place between Newrow and Caledonian-road has been damaged during the laying of the tar macadam there.

Leeds Telephones.—A discussion regarding the establishment of municipal telephones in Leeds took place at a meeting of the City Corporation last week. The appointment of a committee to visit other towns on the subject was moved. It was stated that a municipal telephone system in Leeds would save the traders £20,000 a year. An amendment was moved that the question be referred to the Parliamentary Committee. Twenty-one votes were given on each side. The Lord Mayor said he had not sufficiently considered the question to feel justified in giving a casting vote, so they would remain as they were.

Birkenhead.—In reply to a question, whether the Finance Committee considered the question of municipalising the telephone system in Birkenhead as many other places had done, as last year the Birkenhead Corporation paid £458 to the National Telephone Company for telephonic purposes, it was stated at last week's meeting that the subject had never been before the committee, but if it were the wish of the Council the committee would certainly consider it. No action was taken. At the request of a number of tradesmen, electric light cables are to be laid in Borough-road in the neighbourhood of Balls-road.

Wireless Telephony.—Sir William Preece's system of wireless telephony has been tried in Wales at the instance of the Post Office and with considerable success. So far as Sir William's experiments went, they were designed only to show the feasibilty of telephoning over a short distance without the use of wires, and the Post Office authorities were thoroughly satisfied with the results. Since then Sir William has been "resting" from independent investigations of this nature, and he has not pursued his enquiry further. But the method and the means are at hand if the officials at St. Martin's-le-Grand ever desire to use them.

Uckfield.—The Urban District Council are communicating with the Postmaster-General in regard to municipal telephones. They have also passed the following resolution: "That this Council, finding the municipal telephone system of the Tunbridge Wells Corporation is in operation at Crowborough, and that it is intended to carry it on to Mayfield and Hadlow Down, believe it will be a public benefit if it can be brought to Uckfield. They therefore resolve to request the Tunbridge Wells Corporation to take into consideration the advisability of extending the area so as to include the Uckfield urban district and such additional parts of the Uckfield rural district as they may deem necessary."

Wireless Telegraphy.—The Cunard Company are fitting an installation of the Marconi system of wireless telegraphy on board their Royal Mail steamer "Campania," in addition to the installation already fitted on the "Lucania." A further trial of the invention has been afforded in the case of Elder, Dempster, and Co.'s Beaver Line Royal Mail steamer "Lake Champlain," which left the Mersey on Tuesday with instructions to report her movements by wireless telegraphy when opportunity offered. On the following night information was received from the Cunard Royal Mail steamer "Lucania" that the "Lake Champlain" had telegraphed to her five miles outside the bar, "Bound north; all well."

London Gazette.—The partnership existing between Clarence M. Stead and F. Scott, electrical engineers, 3, Wade-street, Leeds, has been dissolved by mutual consent.—The partnership existing between A. Turner and H. Foster Clough (trading as the Virginia Electric Company), engineers and electricians, 10A, Virginia-street, Southport, has been dissolved by mutual consent.—The last day for receiving proofs in the estate of H. Sewell, 63, Birklands-road, Shipley, Yorks, is Sept. 14. Mr. J. A. Binns, official receiver's chambers, 31, Manor-row, Bradford, is trustee.—The partnership existing between A. Pollock and G. Belgowan (trading as the Pollock Electric Alarm Company at Middlesbrough and the National Electric Alarm Clock at Hull) has been dissolved by mutual consent.

Maidstone.—The Urban District Council have adopted a report of the Electric Light Committee in which they state that they have considered a circular prepared by the engineer showing the advantages of the electric light, and recommend that the same be printed and circulated in the borough; and also that the electrical engineer take the necessary steps to effectually light up the works, at a cost of about £120. The committee further presented the report of a deputation which had visited Ilford, and as a result of what they saw it was now recommended that one street (Earl-street) be lighted by incandescent lamps, as an experiment for lighting the less important streets. A notice of motion will come before the next meeting of the Council to consider the promotion of a Bill to authorise the Corporation to construct and work a telephone service within the borough.

Hebburn.—Last Thursday week a formal inspection took place of the new works of Messrs. A. Reyrolle and Co., electrical engineers and contractors, at Hebburn. This firm commenced operations at Whitsuntide. The particular kinds of work of which Messrs. Reyrolle make a speciality are high and low tension switchboards for electrical lighting and traction central stations. They have just completed one of these switchboards, 27ft. long, for the Newcastle Electric Supply Company for their Manors sub-station. The firm have also contracted for two similar switchboards for the sub-stations at Jesmond and Ouseburn, and others are to be made for places in the vicinity of Newcastle. The works are in close proximity to the railway, and therefore there is every facility for the quick dispatch of material. Mr. A. Reyrolle is the managing director of the company, and Mr. F. Coates is the assistant manager.

Rotherham.—Another £2,400 is to be expended on extension of the electric lighting plant. The present capacity of the works is equal to a demand of about 7,000 lamps of 8 c.p. at one time. The electrical engineer, Mr. Cross, states that the number of lamps already fixed is 5,224 8 c.p., the total number of consumers being 77. The number of consumers applying for the light is 103, with 7,520 8-c.p. lamps. It is proposed to put down a three-crank compound engine and a four-pole dynamo having a normal output of 165 kw., and which would be sufficient to supply a further additional 4,000 8-c.p. lamps. We learn that the present plant has proved to be an absolute success, and that the makers can supply the set required at a cost of £2,050. At the present rate of progress the Council expect by the end of the year to have from 170 to 200 consumers, with a possible number of 15,000 8-c.p. lamps.

Queensbury.—The clerk has reported to the Council that he had written the Halifax and the Bradford Corporations asking whether or not (and if so on what terms) they would be willing to fix the electric light—say on every third pillar—in the Queensbury district. The Halifax reply had not yet been received, but Bradford's was to the effect that they would agree to instal 14 lamps if Queensbury would bear the initial cost, which would be from £900 to £1,000, and pay £20 per annum for each lamp. The clerk calculated that if they had 14 lamps fixed on the Halifax side and 14 on the Bradford side the cost would be: for the initial outlay, Halifax £1,540, Bradford £980, a total of £2,520; the yearly maintenance would be about £720, and interest on a 3 per cent. loan, say, for 30 years, would be about £40, making an annual sum of £760, equal to about a 10d. rate. It appears that the general opinion of the members is that at present this sum is far too great, and no further steps have been taken.

Accidents.—A workman was severely burned on Tuesday in Fleet-street, at the corner of Salisbury-court, through the fusing of wires of the City of London Electric Lighting Company. The man was lying full length on the pavement with his head and shoulders down in the "box" repairing the wires, with a quantity of cotton waste in one hand and a lamp in the other, when the wires fused and fired the cotton waste.—At Stockport a tramcar left the rails and ran into a bootmaker's shop.—The Tunbridge Wells correspondent of the *Standard* says that a serious explosion took place the other afternoon at the electric light works of the Borough Corporation. The explosion was caused by the bursting of a superheater attached to a Lancashire boiler, recently laid by a London firm of contractors. Without any warning the superheater shot into the air, wrecking the roof of the engine-house. There were nearly 20 men about at the time. One of them named Young, of Willesden, was scalded about the face, arms, and legs; and James Nichol, of Willesden; William Jeffery, Highbrooke-road, Tunbridge Wells; and Thomas Foreman, Western-road, Tunbridge Wells, were cut about the hands and body by glass and *débris* from the roof. The injured men were conveyed to hospital in the police ambulance, and after treatment all except Young were able to leave. The cause of the explosion is unknown.—Two labouring men, named Joseph Keenan and Peter Kelly, were killed on Tuesday at Jarrow-on-Tyne. They were last seen alive looking at some new machinery at a forge which is worked by electricity. Here, some time afterwards, their dead bodies were found. It is supposed that they touched one of the wires charged with the current, and were instantly killed. There was a mark on Keenan's thumb as though caused by a slight burn, and it is thought that the current had been transmitted from him to Kelly, who was probably leaning over him.

Hackney.—At last night's meeting the Electric Lighting Committee reported as follows upon the approaching necessity for the appointment of an electrical engineer to take charge of the electricity and refuse destructor works, which are nearing completion: "We are of opinion that the engineer should have the control, under the Electric Lighting Committee, of the electricity supply and refuse destructor undertaking, including the management of the electricity generating works and refuse destructor, and the administrative departments connected therewith; that he should be a full member of the Institution of Electrical Engineers, and possess adequate experience of the low-pressure three-wire, direct-current system of electricity supply, working in connection with refuse destructors, that being the system in use at Hackney; that he should be required to devote the whole of his time to the service of the Council; and that the commencing salary should be £400 per

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annum, and the appointment determinable on six months' notice on either side." The committee recommended that a borough electrical engineer be appointed upon the foregoing terms and conditions, and asked for authority to issue an advertisement inviting applications for the appointment, and to submit the names of three candidates for the consideration of the Council.

Wolverhampton.—The Lighting Committee have just presented a report recommending a system of free or assisted wiring for electrically lighting houses in the town. It is proposed that the Corporation shall lay a service to the consumer's premises free of cost, provided the length of service main does not exceed 20 yards, and fix the necessary meters, indicators, etc., also the ordinary fittings, lamps, switches, etc., but only of a plain character; more expensive fittings may be purchased from the Corporation, and will remain the consumer's property. The consumer may also, according to this scheme, purchase the instalment on the hire system. In furtherance of this scheme the committee point out that it is proposed to give private householders the option of being charged under the present "maximum demand system," or at a uniform price of 4½d. per unit. If the Council decide to adopt a free-wiring system upon any basis, there will have to be some provision to meet the just cost of installation, and it is recommended that they be authorised to apply for the consent of the Local Government Board to the borrowing of the sum of £1,000 to cover such expenditure, but in the event of the Board not entertaining the application, then the committee recommend that the preliminary expense be borne by the revenue of the department. The report was adopted on Wednesday.

New German Liner.—The "Kronprinz Wilhelm," the new Nord-deutscher Lloyd steamer, arrived in the Forth on the 10th in the course of a trial cruise which she is taking preliminary to entering upon the Atlantic service. She is 663ft. in length, 66ft. in breadth, and 43ft. in depth. When fully loaded down to the water-line she draws 29ft. Her gross tonnage is about 14,800. She has two sets of six-cylinder quadruple-expansion engines, designed to develop 3,500 i.h.p. The steam is generated by 16 cylindrical boilers, all under natural draught. She is reckoned to consume about 500 tons of coal per diem, or 1½lb. of coal per horse-power per hour, and her bunkers will carry 4,400 tons. Her passenger accommodation is for 1,651 persons—namely, 593 first-class, 362 second-class, and 696 third-class. The electrical plant includes four dynamos of 100 h.p. each and 3,000 incandescent lights. The cold storage is on Linde's system and very extensive. Telephonic communication is installed between the captain of the ship and all his subordinates, and the chief steward has similar command over his own department. The condition of the bulkheads can be read from an electrical indicator in the chart-room, and the officer in command can close all open bulkheads instantly by an automatic mechanism. She has been built and engined by the Vulcan Company, of Stettin.

Nelson.—The work of laying the mains for the new installation of electricity commenced on Monday. The new works and machinery, it is estimated, will cost about £20,000, and the Local Government Board are asked to sanction a loan of £25,000, but the enquiry has not yet been held. Rapid progress has been made with the erection of the new works, which, as far as possible, are to be used in conjunction with the new refuse destructor. The buildings have been designed by Mr. Ball, the borough surveyor, in collaboration with Mr. Fraser. The engine-house is 88ft. long by 34ft. wide. In it there will be two 300-h.p. engines, by Willans and Robinson, coupled direct on the dynamos. Besides furnishing current for about 10,000 lamps, the machinery will generate current for the Brierfield and Nelson sections of the new electric tramways. This will entail an expenditure of at least 80,000 units per annum, which will be paid for by the Burnley Corporation. The price to be paid for this current has not yet been fixed, but it is hardly likely to be more, and perhaps less, than 2d. per unit. The following new scale of charges has been agreed to for lighting: from March next year consumers of 1,000 units will pay 4½d. per unit; consumers of 3,000 units, 4¼d.; 5,000 units at the rate of 4d.; 8,000 units at the rate of 3¾d.; and 10,000 at the rate of 3d.; while those requiring current for motor power will pay for it at the rate of 2½d. a unit. The inquiry will be held on the 18th inst.

Colne.—A meeting of the representatives of the authorities within the Burnley area will take place at an early date to consider the question of municipal telephony. The electrical engineer in his last report states that the whole of the work in connection with the laying of the conduits is practically completed, and the British Insulated Wire Company are at the present time busily engaged in drawing in the various cables for the supply of electrical energy. The greater portion of the cables are already laid, and only require jointing and connecting up. The balancer booster which Messrs. Siemens Bros. and Co. have on order is now in the engine-room at the electricity works awaiting erection. The 100-kw. steam turbine of Messrs. C. A. Parsons and Co. has been fixed at the refuse destructor. The engineer states that at a recent test the consumption of steam per kilowatt-hour came out lower than was guaranteed by the makers. The steam, water, and exhaust pipe arrangements at the destructor were well in hand, and the contractors for that work (Messrs. James Carter and Sons, Stalybridge) were proceeding with all possible dispatch. About two-thirds of the accumulator battery have been delivered and stored at the electricity works, and would be placed in position when the floor of the accumulator-house had been tiled. The temporary building for the reception of the switchboard was nearing completion, and he expected the board to be delivered during this week. The committee expect to be ready to supply current by the 16th inst.

St. Pancras.—At a meeting of the Borough Council last week a report of the Parliamentary and General Purposes Committee was adopted, which stated that the committee had considered the resolution of the Borough Council at the last meeting authorising application being made to Parliament in the next session for powers to enable the Council to acquire, compulsorily where necessary, a site or sites for the extension of generating stations in connection with the electricity undertaking. The sites recommended by the Electricity Committee, for which power should be obtained from Parliament to acquire any or all, were: (*a*) Harmood-street, bounded by Clarence-road (Nos. 56 to 74, even numbers), Harmood-street (Nos. 36 to 100, even numbers), Powlett-place (Nos. 21 to 33, and Nos. 12, 14, and 16), a pianoforte factory, Castle-road, and houses 83 and 85, Castle-road, for a new electric station; (*b*) King's-road generating station bounded by Great College-street, King's-road, Pratt-street, and Georgiana-street, all interests except those already in the possession of the Borough Council, for extension of the existing station; (*c*) Regent's Park generating station, houses numbered 35, 37, 39, 43, 45, and 49, Stanhope-street, east of present station, and property bounded by Longford-street, Laxton-place, and Wybert-street, north and west of the present station, all interests, except those already in the possession of the Borough Council, for extension of the existing station; and (*d*) Cumberland Basin (part of) of the Regent's Canal, and properties fronting Augustus-street, for a new station.

Walthamstow.—The electrical engineer in his last report states that the number of applications at present received was 120, being equivalent to 6,815 8-c.p. lamps, and 21 intending consumers were having their premises wired and would be ready for connection shortly. It was thought necessary to have the free-wiring scheme pushed forward as rapidly as possible, in order that there might be no delay in having a good load on the plant as soon as it commenced running. The three sets of gas dynamos had been running lightly now for some time, but had not yet been running on full load for any long period; there were several matters in connection with the electric fixing and compressed-air arrangements that required completing. He had prepared a pamphlet showing at what rates the Council were prepared to let out on hire motors of from ½ h.p. to 10 h.p. The system he proposed adopting was for the consumer to prepare his own foundation to receive the motor, to run the necessary cables from the Council's main cut-out boxes, and to fix any intermediate shafting that might be required; a charge was made for fixing each motor. The consumer paid 10 per cent. per annum on the capital outlay of the motor, and the Council's inspector examined the motor free of charge periodically. Notice has been given to the Lea Bridge Gas Company of the Council's intention to substitute electric lighting for gas lighting in the roads where arc lamps had been erected, and they are in communication with the company as to substituting incandescent glow lamps in place of gas in a number of ordinary street lamps. Application has been made for sanction to a further advance of £10,000, such sum to include the expenditure on the buildings at the electric lighting works beyond the original estimate. On Wednesday last week two sections of the arc lamps were switched on.

Leeds.—Important reductions in the prices of electric energy for lighting and power purposes are to come into operation in Leeds at the end of the present month. For lighting purposes the price will be reduced to 4d. per unit, whilst for motors used for less than 20 hours per week 2d. per unit will be charged, and 1½d. for full power for about 60 hours per week. All prices are subject to a discount of 5 per cent. for prompt payment. The recent improvements which have been made in single-phase motors have resulted in an increase in the demand for motive power during the year ended March 25 last by more than 100 per cent., and the electricity department have now orders in hand which will again nearly double the load. In order to meet all possible requirements the City Council have decided that extensions of the plant shall be on the two-phase system. Three large engines and alternators of this new type are being fixed at the works in Whitehall-road, and two-phase mains will in a few days be supplying energy in a large industrial district on the banks of the Aire. During the 2½ years that the electric lighting has been in the hands of the municipality the sale of current has more than doubled. Ten years ago the price for lighting was 8d. per unit, with a number of supplementary charges. Now the supplementary charges have been abolished, and the price reduced to half. A result of this has been that electric lighting, formerly the luxury of the rich, is now being introduced into the smaller villas and into terrace houses letting at £20 to £30 a year, as well as into small shops. The Corporation in 2½ years have spent £90,000 upon extensions of mains, against less than £50,000 spent by the old company in six years. When the undertaking was taken over the capacity of the plant installed was 4,300 i.h.p., or 2,400 kw. At present there are installed or on order engines and alternators of a total capacity of 8,740 kw., and when the extensions of buildings now in progress are completed there will be accommodation for plant of an aggregate capacity of 19,940 kw.

Plymouth.—The Electricity and Street-Lighting Committee have submitted a comparison of the estimated and actual cost of the first year's working. The estimated expenditure for the year was £3,815 and the actual £5,641, a difference of £1,826. On the other hand, the estimated revenue was £6,327 and the actual £6,834, a difference of £507, leaving a net deficit of £1,319. The total number of units generated during the year ended March 31 last was 543,250. The total number of units sold was 432,532, and the number of units used by the arc lamps 111,000. The leakage of about 20 per cent. is accounted for by the power used in the works and loss in the mains, in the transforming stations, and in the meters. The total of 20 per cent. compares very favourably with the leakage in other works. The committee regretted that the first year's working did not come up to their expectations, but the net deficit of £1,319 was easily accounted for. Coal had cost £679 more than was estimated. Then £120, proportion of general salaries, was not included in the estimate, because the estimate was based on the experience of Bolton, where it was not the custom to charge the salaries of the town clerk and general staff to the different departments. Then the late electrical engineer allowed £150 for rates and taxes, and that figure had been exceeded by £382. But their great difficulty was the mistake made in calculating the cost

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of the buildings at the electricity works. Their capital expenditure was nearly £1,300 more than was estimated, and consequently there were heavier charges for interest and sinking fund. The demand for electricity far exceeded their anticipations, and before they had been working three months they had to refuse a considerable amount of trade, and to incur fresh capital expenditure in enlarging the works. They had provided at large cost considerable additions to their plant, and were now ably to supply all their wants, and could supply current for another 6,000 8-c.p. lamps. But at the rate orders were coming in for increased supplies they would soon be working at their full capacity, and then as far as their present installation was concerned they would be able to meet their expenses. Moreover, they had not repeated the mistake which they made in the beginning of making the building too small, and in the new extension they could put in a large amount of additional machinery without any greatly increased capital expenditure. The work of placing the telephone wires underground is being actively proceeded with in the centre of the town.

Aberdeen.—The following report by Mr. J. A. Bell (referred to in our last issue) has been presented to the Corporation: "To the Gas and Electric Lighting Committee, Town House, Aberdeen. Gentlemen,—I have pleasure in submitting to you the following report dealing with the progress of the electricity undertaking during the past financial year. Before going into details, I would remind the committee of the general position of affairs in July, 1900. The department had just acquired the Dee Village property for a new generating station, and a start had been made, pulling down the existing buildings and preparing for the new works. The most important factor of supply at the time was the excessive price of coal. It will be remembered that some electricity undertakings raised the charge per unit to meet the increased price of fuel. To show how this has affected the department, it is only necessary to compare the coal costs for last year and this. For every unit sold during the year July, 1899, to July, 1900, coal cost ·69d. This year the corresponding figure is ·94d. In connection with this it is only right to mention that, in order to minimise the complaints as to the smoke nuisance at the works, coal having a lower calorific value than that formerly contracted for was used owing to the same producing less smoke. The year just passed has been one of extreme activity for the department principally due to the amount of new works in progress. To keep up with the routine work, in addition, has meant considerable overtime for the staff. I have pleasure in placing on record the way in which every member of the permanent staff has risen to the occasion and worked unceasingly in the interests of the department. During the past 12 months we have coupled up 176 new consumers, making the total number 778. Sixty-nine public and 31 private arc lamps have been added, making a gross total of 145 public and 271 private lamps. Thirty-three new consumers have taken advantage of the hiring out of motors by the Town Council, making the number now out on hire 60. This branch of the business is extending in a satisfactory manner. The motors connected during the year—private and hired out—number 66, of an aggregate horse-power of 286. This brings the total number of motors on our mains up to 126, representing 485 h.p. It is gratifying to have made this addition to our day load, and there is every prospect of the more general use of motors year by year. The motor consumption for last year was 42,326 Board of Trade units, and this year 67,244. Electrical heating has also increased this year by the equivalent of 413 33-watt lamps out of a total of 552 33-watt lamps coupled. Full advantage has not yet been taken of the moderate cost of energy for heating purposes. There can be no doubt that for bedrooms in private houses, offices, etc., the type of luminous radiant heaters now on the market is unsurpassed for cleanliness, absence of smell, etc. Their design lends itself to ready removal from one room to another, and the manipulation is simplicity itself. The total number of consumers coupled to our mains on July 31, 1901, for lighting motors, heating, etc., expressed in 33-watt lamps, was 79,663. Extensions of mains during the period under review have given us an additional 1·8 miles of frontage for supply. The mains laid in the West-end are becoming a paying investment as was to be anticipated, the number of consumers obtained in this district now being 84, and the revenue obtained this year amounting to £725 odd. The policy of the Council in extending mains where new residential property is being erected is justified by such instances as Bayview-road, where, out of 13 houses erected or in course of erection, nine take or have applied for electrical supply. The mains laid have been kept up to a high state of efficiency out of revenue; this year it has been a heavier item than usual, the chief outlay being for labour necessary for the inspection and cleaning out of road boxes, and connections used in the centre of the town, where we have copper strip laid in culverts, and the replacing of old rubber insulated service cables by lead covered cables. All the station plant is in good order, and in addition to the annual overhaul of all boilers, pumps, and generating sets, we have this year dismantled three of our largest engines for repairs. The plant used for tramway purposes has required considerable expenditure for repairs, and is largely responsible for the increased expenditure under this heading. This is to some extent due to the fluctuating nature of the load, which will be improved as soon as more cars are running and a steadier load obtained. Though starting late in the year (April 18) on the new generating station at Dee Village, good progress has been made on the buildings. Had we experienced bad weather during the summer, it would have been impossible to get ready for this winter without a further additional expense in temporary work. The temporary engine-room is now complete, and the temporary chimney is on the site. The plant is well forward, part of the storage battery being here and the remainder only waiting the completion of the battery-room. Two boilers are on the ground; one 300-kw. generating set has been tested and is now being delivered. Part of the replace 700-h.p. engine is delivered, and the remaining sets are well on to completion, another 300-kw. set being due for testing this week, and the new 420-kw. set in the second week in September. The Crown-street subway has cable drawn in up to Affleck-street, and this work is being pushed on as the contractor finishes ahead of us. In considering the question of the price per unit to be charged for the coming year, it is necessary to consider, first, the inefficient working due to temporary arrangements at Dee Village, which will prevail during the year, and, secondly, the increase in interest and sinking fund to be met, due to the erection of new works, etc., both of which will tend to increase cost of supply. After fully considering these points, I beg to recommend that the charges for private supply, for lighting, motors, heating, and cooking, remain the same as at present. Due to the long hours of public lighting, supply can be given cheaper, and I recommend that the charge be reduced for the Town Council street-lighting department, the price to be 6d. per Board of Trade unit for the first hour of maximum demand and 2d. for all subsequent supply. It will be remembered that this department attends to the harbour arc lamps. We have now had a full year's working to guide us, and I beg to recommend that the charge for the work be at the rate of £5 per lamp per annum. This price includes the supply of carbons, the necessary attendants for carboning, cleaning and switching on and off the lamps, replacing old globes, removing lamps from the harbour to works for testing and adjustment, and all wages connected therewith. This sum does not, however, include the supplying of any materials for repairs, but includes the supply of all necessary tools for the carrying out of the work, with the exception of trimming ladders.—I am, gentlemen, your obedient servant, J. ALEX. BELL."

Ayr.—The account of the electricity department appeared in our last issue. On Monday the burgh electrical engineer (Mr. A. J. Fuller) presented a report giving a summary of the year's progress, together with the technical and financial results of the Corporation electricity works. We quote the following from the report as it appeared in the *Ayr Observer*: "The whole of the machinery at the works has run perfectly satisfactorily throughout the year, and has been maintained in thorough condition. The boilers have also given satisfaction, and apart from a small increase in the stoker repairs, we have had very little to do to them, notwithstanding the fact that they were pressed during the heavy load last winter. I am glad to say that we have been particularly free from trouble in the outside work, having had only one slight mishap during the year. Our sub-stations are now in good order, and are being maintained as far as possible up to date with new apparatus. Several of the old ones, however, still remain to be overhauled, and these will be done as soon as possible. I attribute the satisfactory running of the outside work to the fact that we have now almost entirely done away with the troublesome underground transformer boxes. Two and a half miles of extension cable have been laid, and 94 connections have been made during the year. The consumers now amount to 450. As to public lighting, three additional arc lamps have been connected and 29 incandescent lamps, making a total of 85 arcs and 146 incandescents. During the year orders for extensions of plant and mains have been placed, amounting roughly to £17,000. These are now well in hand. Of the three 200-kw. continuous-current sets, two have been erected. The third, it is expected, will be here in two or three weeks. The main switchboard is now nearly completed. The engine-room is complete with the exception of the temporary end. The offices are well in hand, the only remaining part to be pushed on being the boiler-house. A sub-committee has been appointed to consider the best method of dealing with coal cartage, and I am sure it will lead to a very great saving in the future should an overhead system be adopted, and I have every reason to believe that such could be easily arranged. It is the more important that this should be carefully considered owing to the fact that our consumption amounts to 6,000 tons of coal a year. Financial results: Capital expended 1900-1901, £56,158 (1899-1900, £46,865); revenue from private lighting, £3,327. 2s. 6d. (£3,123. 3s. 8d.); revenue from public lighting, £2,065 (£1,932. 10s. 8d.); revenue from other sources, £198. 16s. 11d. (£189. 1s. 6d.)—total, £5,590. 19s. 5d. (£5,244. 15s. 2d.); gross profit before setting aside instalment for interest and sinking fund, £1,432 (£1,765); interest and sinking fund, £2,560 (£2,460); maximum load reached, 282 (256); number of lamps connected (arcs and incandescents), 20,069 (17,913); number of consumers, 450 (356); number of units sold, private lighting and power, 170,736 (168,039); ditto public lighting, 319,760 (257,600)—total, 490,496 (425,639); price charged for private lighting, 5d. (6d. and 4d.); ditto for power, 3d. (3d.); public lighting, arcs (per annum), £20 (£20); ditto, incandescents, 32 c.p., £2. 10s. (16 c.p., £2. 10s.). Analysis of costs: generation and distribution, 1900-1901—coal, etc., £1,193. 11s, 2d., ·97 per unit (£1,287. 15s. 6d., ·72); oil, waste, etc., £73. 17s. 3d., ·03 (£62. 7s. 6d., ·03); wages, £785. 15s. 11d., ·38 (£802. 2s. 3d., ·45); repairs and maintenance, £280. 13s. 8d., ·13 (£286. 3s. 7d., ·16)—works costs, £3,133. 18s., 1·51 (£2.438. 8s. 10d., 1·36); general costs—rates and taxes less property and income tax, £133. 14s. 10d., ·06 (£116, ·06); management expenses—insurances, establishment charges, etc., £646. 18s. 10d., ·31 (£678, ·38d.)—£3,914. 11s. 8d., 1·88 (£3,332. 8s. 10d., 1·80); financial results for 1900-1901—surplus in revenue account, £1,432. 17s. 4d.; amount provided for interest and sinking fund, £2,559. 19s. 10d.—deficit, £1,127. 2s. 6d. It will be noticed that the lamp connections have increased by about 2,000, and the number of consumers by 94, which shows that a steady rate of progress is being maintained. The past year's working does not show as much progress as I could wish. The financial result is very much affected by the high price we have paid for coal during the year, the extra cost of fuel for the previous year being 55 per cent., or £706, while the actual output has only increased 15 per cent. I am very glad, however, that the price has considerably lowered, and in the contract just entered into for 3,000 tons, we have practically a saving of fully £750 over this year's supplies. It is pleasing to notice that the costs of production and management for our unit output are among the lowest in the country, and work out as follows: works cost, 1·51d.; total cost, 1·88d. The total output from the works has risen from

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425,639 units to 490,496 units, being an increase, as already stated, of 15 per cent. The income from private lighting has not increased as much as formerly. I can only attribute this to the fact that our customers' bills show a decrease on the previous year, and this economy is doubtless due to experience in switching the light on and off as required. Under this heading I am pleased to be able to say that we have now few complaints from our private customers regarding their accounts. The average price from this source is 4·7d. per unit, which brings out the average price obtained for all units sold at 2·6d., a very low figure indeed. With these low figures we were, however, able to provide a surplus profit of £1,432 towards meeting the interest and sinking fund charges, amounting to £2,560, leaving a deficiency of £1,127. In considering these figures proper attention should be given to the average price mentioned above, because it is in this point that the secret of meeting all our charges lies. For private lighting we get 4·7d. per unit, and for public lighting 1·5d. per unit. It must not be forgotten, however, that this figure includes the sum of £248 charged for carbons, wages, etc., so that the actual price received per unit works out at 1·3d. If for the present we take the published accounts for five towns in Scotland, it will be seen that the average is 2·1d. per unit, the actual figures being as follows: Aberdeen, 3·69d.; Dundee, 2·25d.; Edinburgh, 1·26d.; Glasgow, 1·64d.; Leith, 1·83d. If from these figures you take away Glasgow and Edinburgh, which supply hundreds of lamps to our small number, the average works out at 2·5d., or 1d. per unit more than we are receiving. Taking the previous figures, and assuming that we are paid the average for Scotland, it would mean that we should receive from the Police Commissioners an additional £700, or sufficient to warrant me in saying that the works would year by year show a net profit instead of a deficiency, of course with coal remaining at the average price of this year. It is interesting to see that if we were receiving the average price obtained in the Scottish towns, omitting Edinburgh and Glasgow, we should this year have shown a net surplus of £205 instead of a deficiency. It is also interesting to note that the average price for public lighting spread over 67 English towns amounts to 2·42d. per unit. I sincerely trust that the committee will give this matter their special attention, as I am convinced, from our experience here, that unless the works be paid at least 2d. per unit it will be impossible for this department to show a net profit for a considerable number of years, and, in fact, it is absolutely impossible to make this profit until the number of units sold for private lighting is equal to that sold for public lighting. This is quite clear from the following figures: the total cost to us for one unit, including interest and sinking fund, amounts to 3·13d. per unit; price received for private lighting, 4·7d.; net profit, 1·57d.; total cost to us, 3·13d.; price received for public lighting, 1·5d.; net loss, 1·63d. I would recommend that the Lighting Committee should, if possible, obtain from the Police Commissioners at least 2d. per unit for street-lighting purposes. On the other hand, if they cannot obtain this figure and the old figure remains, it is evident that they must be prepared to face a deficiency for a number of years to come."

PROVISIONAL PATENTS, 1901.

SEPT. 2.

17518. Improvements in electric motors. James Paulinus Jones, 23, Frederick-street, Sunderland.

17538. An automatic two-instrument switch for electric purposes. Robert Tyndall Gibbs, 6, Vere-street, Oxford-street, London.

17539. An improved thermo-electric fire and temperature alarm. Marden Henry Humphrey, 20, Winsham-street, Clapham Common, London. (Louis Fitzgerald and Edward James Humphreys, United States.)

17556. Improvements in electromagnetic apparatus. Isaac George Waterman, 111, Hatton-garden, London. (Complete specification.)

17561. Improvements in electromagnetic spark-extinguishing or arc-preventing devices for electric switches. Hans Adolf Bertram, 6, Lord-street, Liverpool. (Complete specification.)

17565. Improved means for starting and working electrically-actuated lifts with two cages. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

17567. Improved combination of electric motors for starting and operating them. James Burke, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SEPT. 3.

17585. Improvements in switches or cut-outs for trolley and other overhead electric wires. Edwin Hopper, 6, Bank-street, Manchester.

17593. Improvements in electromagnets. Alexander Houston Weddell, Park Villa, Uddington, Glasgow.

15601. Improvements in apparatus and devices for controlling electric currents. Stephen Watkins, Prince's-chambers, Wolverhampton. (The Consolidated Railway Electric Lighting and Equipment Company, United States.) (Complete specification.)

17621. Improvements in or relating to apparatus for hauling electric cables. Henry Brightman Grinnell and Paul Goepel, Birkbeck Bank-chambers, Southampton-buidings, Chancery-lane, London.

17618. Improvements in and relating to current-distributing and collecting devices for use in connection with electric railways, tramways, and cranes and for like purposes. John Thomas Knowles, 11, Southampton-buildings, Chancery-lane, London. (Ernest Albert Stierlin, Italy.)

17641. Improvements in dynamo-electric machinery. Henry Metcalf Hobart, Bush-lane House, Cannon-street, London.

17656. Improvements in the manufacture of glass by electricity. Charles George Redfern, 4, South-street, Finsbury, London. (Société Anonyme de l'Industrie Verrière et ses Derives, Belgium.)

17658. Improvements in or relating to electric meters. Felipe Saldana, 111, Hatton-garden, London.

17660. Improvements in electric batteries. The Pile-Bloc Battery Company, Limited, 6, Bream's-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 30, 1901, being date of application in France.)

17664. Improvements in or relating to electric transformers, exciter coils, field magnets, and other inductors. Franz Pichler, 46, Lincoln's-inn-fields, London.

SEPT. 4.

17673. A trolley guide for the trolley poles of electric tramcars and similarly-propelled vehicles. Charles Middleton, 100, Wellington-street, Glasgow.

17676. Improvements in automatic guards or protectors for electric or other tramway cars and the like. William Dewar, 41, Reform-street, Dundee.

17684. Improvements in etheric or "wireless" telegraphy. Alexander Marr, 70, Market-street, Manchester.

17702. Improvements in the electrolytic refining of copper. The Metals Corporation, Limited, and Sherard Cowper-Coles, 85, Gracechurch-street, London.

17703. Improvements in the electrolytic production of tubes, sheets, and wire. The Metals Corporation, Limited, and Sherard Cowper-Coles, 85, Gracechurch-street, London.

17711. Improvements relating to the transmission of telegraphic and telephonic signals. Louis Maiche, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Feb. 19, 1901, being date of application in France.) (Complete specification.)

SEPT. 5.

17801. Improvements in transmitting telegraph keys. Charles Shirley and John Foster Skirrow, 37, Essex-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Feb. 6, 1901, being date of application in United States.)

17811. Electric clock. Oscar Axel En Holm, 40, Chancery-lane, London. (Complete specification.)

SEPT. 6.

17860. Improvements in electrical primers. Sir W. G. Armstrong, Whitworth, and Co., Limited, and George Stuart, 24, Southampton-buildings, Chancery-lane, London.

17877. Improvements in and relating to trolley wires for electric tramways and the like. Edward Galbraith Thomas, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SEPT. 7.

17896. Improvements in and relating to the production of copper telegraphic, telephonic, or cable wire from the copper rod. Henry Walker, 67A, Corporation-street, Birmingham.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 23.

1900.

15752. Electroliers, pendants, and fittings or connections therefor. Hirst and Ide.

15865. Shades for electrical and other lamps. Langdon.

15957. Electric motors. Contal and Gasnier.

15965. Electric barometers or barometric indicators. Boult. (Miglioretti.)

17289. Automatic electric switches. Adams.

18645. Electric furnaces. Parker.

19220. Unions or connections for electric light pendants and other fittings. Hirst and Collings.

19951. Dry-core cables and the like electric conductors. Heyl-Dia.

21815. Armatures and field magnets for dynamo-electric generators and motors. Feeny. (Allgemeine Elektricitäts-Gesellschaft.)

1901.

7641. Telephone exchange systems. Smith.

10951. Galvanic batteries. Schoenmehl. (Date applied for under International Convention, Oct. 30, 1900.)

13415. Holder for electric incandescent lamps. Wallace.

13663. Telephone transmitters. Fahnestock.

14996. Electric motors. Heany.

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14998. Electric arc lamps. Heany.

15369. Drivers' brake-valve apparatus for operating air-brakes for railway and like vehicles both by means of air pressure and by electricity. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

15370. Electric meters for measuring electromotive force or current strength. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

15753. Telephone exchanges. Stock.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	—	—	—	—	—	—
Birmingham Tramways	Sept. 7	4,827	4,635	+ 192	160,083	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 6	589	487	+ 102	17,828	16,092*b*
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 7	1,733	1,395	- 338	14,712	14,520
Bolton Corporation	,, 8	1,464	1,410	+ 54	52,256	42,133*b*
Bradford Corporation	,, 8	1,191	679	+ 512	29,963	16,155*b*
Bristol Tramways Company	,, 6	3,900	3,629	+ 275	—	—
Carlisle Tramways Company	,, 7	194	191	+ 3	2,170*b*	2,039
Central London Railway	,, 7	5,532	—	—	56,559	—
City and South London Railway	,, 8	1,834	1,487	+ 347	18,394	15,022
Cork E. T. and L. Company	,, 5	526	547	- 21	16,760	14,742*b*
Darwen Corporation	—	—	—	—	—	—
Dover Corporation	,, 7	290	292	- 2	7,867	7,416*b*
Dublin & Lucan Electric Railway	,, 8	131	130	+ 1	1,472	1,209
Dublin U. T., electric cars	,, 6	4,205	4,067	+ 138	—	—
Dublin S. District, Electric	,, 6	1,115	1,133	+ 17	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 7	13,435	9,664	+ 3,771	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 7	1,664	1,286	+ 378	17,441	13,325
Liverpool Corporation	Aug. 31	9,457	8,779	+ 678	310,844	269,285*b*
Liverpool Overhead Railway	Sept. 8	1,605	1,792	- 187	17,359	17,487
Oldham-Ashton-Hyde Tramways	—	—	—	—	—	— *b*
Portsmouth Corporation	,, 7	1,141	—	—	—	—
Potteries Tramways	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 8	3,661	—	—	—	—
Southampton Corporation	,, 5	1,062	793	+ 269	—	—
Southport Corporation	—	—	—	—	— *d*	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. *b* From Jan. 1. *d* From April 1. 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £777 decrease.
Barcelona Ensanche y Gracia, £30 decrease. Barcelona, £329 increase.
Brisbane, £324 increase.
Buenos Ayres and Belgrano Elèctric, £182 increase.
Calcutta, £134 increase.
Cape Town (month of Aug.), receipts, £14,799; expenditure, £7,009.
Mexico Electric (month of Aug.), receipts, £17,900; expenditure, £10,800.
Perth Electric, £216 increase.
Port Elizabeth (month of Aug.), receipts, £3,151; expenditure, £1,844.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	3/16
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	3/16
—— Ordinary, 1-125,000	1 ..	3/16
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6¾
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4¾-5¼
Brush Electrical Engineering, Ordinary	2 ..	1¼-1¾
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	110-114
—— Ordinary	5 ..	15-16
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	3¼-3½
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	1-1⅛
—— 5 per cent. Debentures	5 ..	1¼-2¼
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	85-90
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-2
—— 7 per cent. Cumulative Pref.	2 ..	2¼-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16¼-17¼
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21¼-22¼
—— 4 per cent. Debentures	100 ..	101-104
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10¼-11¼
—— 5 per cent. Cum. Pref.	5 ..	5¾-6¼
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	95-100
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10¼
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	7⅞-8¼
—— 7 per cent. Preference	5 ..	8¼-8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7⅛-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10½ xd
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105
Chelsea Electricity Supply	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	107-110
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	11¼-12¼
—— 5 per cent. Debenture Stock	100 ..	120-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-103
County of London and Brush Provincial, Ordinary	10 ..	8-9
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	103-106
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¾-6¼
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1¾
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13-14
—— ,, 85,001-98,769	5 ..	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-114
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6¾
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1¾
—— £5 Shares	5 ..	7¾-8¼
—— £4½ Shares, New	4½ ..	7-7⅛
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5¼-6¼
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	12-13
Electric Railways.—		
Central London, Ordinary	100 ..	102-105
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	99-102
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	52-54
—— Ordinary	10 ..	5¼-5¾
—— 4 per cent. Debenture Stock	100 ..	113-118
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	92-95
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4⅛-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	128-129
Blackpool and Fleetwood Tramroad	10 ..	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6-6¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14-14¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11¾-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅝-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5¾
—— 5 per cent. Deb. Stock, Red.	100 ..	103-105
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	1¼-2¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5¼-5¾
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22¼
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¾-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	105-107
New General Traction, Ordinary	5 ..	3-3⅛
—— 6 per cent. Cum. Pref.	10 ..	4¼-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-10¼
—— 4½ per cent. Debenture Stock	100 ..	105-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8s. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	3⅝-3¾
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅜-4¾
—— 4 per cent. Deb. Stock, Red.	100 ..	96-98
—— 3½ per cent. Deb. Stock, Red.	100 ..	96-98
Oriental Telephone and Electric Company	1 ..	⅜-1

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NOTES.

Franklin Institute.—The current number of the *Journal* of the Franklin Institute contains, among others, a paper by Prof. Joseph W. Richards on "Secondary Reactions in Electrolysis." Some interesting notes are also contributed, notably the following: "Commercial Aluminium-Zinc Alloys," "The Greatest Power Station," "Solders for Aluminium," and "Smokeless Flash Light."

Wireless Telegraphy in Canada.—It is reported that the Dominion Government of Canada will shortly be asked to instal a wireless telegraph station near Victoria, British Columbia, for the purpose of signalling incoming vessels, the Canadian Pacific officials having made an offer to equip their three "Empress" steamers with the Marconi system if the Government will erect a shore station for communication.

Magnetic Observatories.—Clashing of the interests of the electric tramway with those of the observatory in which magnetic and earth current measurements are made is not confined to England alone, and India has not escaped the unavoidable. We note that with the advent of electric tramways in Bombay and Calcutta fresh sites had to be found for the magnetic observatories, and the observatory in Rangoon is to be located far out of the town.

Acetylene Lighthouse.—For some months now experiments to test the efficiency of acetylene as an illuminant for lighthouses have been carried on in the harbour of Genoa, Italy. The apparatus used consisted of four separate generators, and for a period of 100 days of 10 hours each the lighthouse was worked with the new gas with satisfactory results. It is even stated that while the Tino electric light, which is 40 miles distant from Genoa, could never be seen from there, the Genoa acetylene light was quite visible at Tino.

"A Friend in Need . . . ."—That Americans are naturally resourceful is well illustrated by the following little incident: The electric light wire of a Congregational church at Stratford, Conn., had become disarranged by a storm, and the circuit was broken. A gentleman in the congregation, whose automobile was in a shed near by, ran the vehicle out close to a rear window, just behind the pulpit. He then connected the main feed in the church with the powerful storage battery of the machine, and turned on the power. Instantly, so the story goes, the interior of the church was brilliantly lighted.

Cape-to-Cairo Telegraph.—The building of the Cape-to-Cairo telegraph line has offered plenty of opportunity for the inventive mind. Difficulties of transport have perhaps never before been so keenly experienced, and have forced the engineers to fall back on many devices of their own in the absence of the regulation material. Live trees now take the place of telegraph posts, and, according to a Cairo correspondent, they offer more than one advantage over the dead-wood uprights. In particular, they afford protection against the swarms of white ants which infest the country. From time to time the branches are kept lopped sufficiently to preserve the wires from being too much enveloped in foliage. Cords of tarred hemp are used as insulators.

The Humming Telephone.—In the August number of the *Telephone Magazine* will be found an interesting description of the humming telephone by Mr. Gill. In the course of his paper the author refers to Hibbard's experiment in which a telephone is held against or near to the diaphragm of the microphone, and a hum or whistle is set up and continues. The microphone is in series with the battery, and with the primary of the induction coil. The telephone is in series with the secondary of the induction coil. The latter circuit also contains a reversing switch. A novel feature observed by him is that if the wires leading to the telephone are reversed by the latter switch while the instrument is humming, the note at once changes in a striking manner, and if the hum is stopped it will recommence again high or low, according to the side the switch is on.

Aluminium Conductors.—An installation for the transmission of electrical energy has just been completed near Naples, in the Valley of Pompeii, in which all the conductors used are of aluminium. This installation consists of three horizontal turbines of 150 h.p. working at 190 revolutions per minute. Each turbine drives a three-phase alternator, and the current at a tension of 3,600 volts is led along three aluminium lines to Pompeii, Sarno, and Torre Annunziata. The first of these lines has a length of about two miles, and leads to a sub-station of two three-phase transformers. The second line, leading to Sarno, has a length of about 10 miles; it conducts the current to a three-phase motor working at 3,500 volts and driving a continuous-current dynamo of 36 kw. capacity. This installation supplies a three-wire system at 240 volts. The third line, to Torre Annunziata, is just over two miles long, the current serving for motive power in the neighbouring macaroni factories.

Electricity in Mining.—The great advantages of electricity as applied to mining operations are becoming more and more evident every day. Addressing the students at the Otago University, N.Z., the other day, Prof. Park emphasised the fact that it is the highly technical studies of chemistry and electricity that modern mining and metallurgy demand the attention of their students. As to the study of electricity, the professor pointed out that it has not yet been established as the handmaid of mining to the extent that its growing importance deserves. He advocated that the study of electricity should take its place along with geology, chemistry, and mechanics as a compulsory subject in every mining school. That this new force could, in its immense variety of subtle forms, be applied in numberless ways to aid in gold extraction is certain. But to make the progress that it should there must be numbers of mining men with the necessary knowledge of electricity, so that they may be able to apply it to the mining difficulties they encounter.

Breakdown of the Niagara-Buffalo Transmission Line.—With a most ironical perverseness, the overhead transmission line between Niagara and Buffalo broke down on the evening of Electrical Day, Aug. 22, at the Pan-American Exposition. Special illuminations had been arranged in honour of the visit of the convention of the American Institution of Electrical Engineers, and these had scarcely been started when the whole of the supply failed. Except for the acetylene building and a few stray installations, energised by special steam and gas driven exhibits, the exhibition was in total darkness, while the public electricity supply and most of the trolley lines in the city of Buffalo were cut off for over two hours. A thunderstorm had been hovering round the neighbourhood during the day, making the lightning arresters at the Buffalo terminal station of the 22,000-volt line particularly busy, and possibly this furnished the primary cause for the unfortunate breakdown, although the Falls Company's engineers are very reticent on the subject.

American Submarine Boats.—According to the *Electrical World* of New York, extraordinary efforts are to be made to obtain the passage of a Bill in the next Congress authorising the construction of 50 submarine boats of the "Holland" type. The Navy Department Board on Con-

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struction unanimously advises that no further increase should be made in this direction pending the settlement by exhaustive tests of the efficiency of the "Holland" boat. The friends of this type of craft argue, on the other hand, that, inasmuch as they can be built in three months, whereas it takes five years from the inception of its design to completion to build a battleship, the naval increase of the United States for the next seven years should be almost exclusively confined to the submarine type. With this division of opinion, therefore, it has been decided to appoint a board of unbiassed officers this winter to test conjointly the "Holland" and the "Lake" boats. It is hoped that the general and individual questions relating to submarine boats in the States will thus be finally settled.

"Tube" Vibration Remedied.—The final official experiments with the special train and the two improved locomotives constructed with a view to diminishing the vibration on the Central London Railway have just taken place with gratifying results. The object of the tests was to enable Mr. Mallock, the technical adviser to the Vibration Committee, to make a special series of observations for presentation to the committee. The section of the line under observation was that between the Lancaster-gate and Bond-street stations, Mr. Mallock taking up a position with a seismograph and other instruments in an empty house in the Bayswater-road. For the purposes of the tests the "multiple unit" train, one of the new type geared engines, and an ordinary locomotive with a train of six coaches, made the journey between these two points several times one after the other, while Mr. Mallock noted the amount of surface vibration in each case. Records were taken for a period of about three hours. It is stated that Mr. Mallock was quite satisfied that the remedy for the vibration has been found.

Magnetic Survey of India.—We understand from the *Times* that, following their acceptance of the proposal of the British Association for an ethnographic survey of India, Lord Curzon's Government have adopted the suggestion of the Royal Society for the carrying out of a magnetic survey. The existing magnetic observatories at Bombay and Calcutta are considered inadequate as base stations for the vast area the survey will cover, and similar observatories are now in course of construction at Dehra Dun, below the Himalayas, at Kodarkanal, in the Madras Presidency, and at Rangoon. The survey and meteorological departments will be jointly responsible for the investigations The field observations will be carried out by six or seven detachments of the survey department, and arrangements are being made in England for the purchase of the necessary instruments. Sind and the Punjab will first be taken in hand; and, as the country is now intersected with railways in all directions, enabling field detachments to quickly cover the distances from one observing station to another, it is anticipated that five years will suffice to complete the field work of the preliminary magnetic survey.

Flame Discharge. The flame discharge produced by Spottiswoode by means of an alternate current consuming 5 h.p. and transformed to some 120,000 volts shows some peculiar spectroscopic properties, which have recently been studied by Messrs. A. W. Wright and E. S. Downs, and described in the American *Journal of Science*. The discharge consists of a light nebulous flame of a whitish colour, with a slight tinge of yellow or green, rising gradually from the horizontal terminals and meeting at the centre, where the colour changes to a reddish hue. Besides a number of lines extending from 6,127 to 6,269, photographed by means of plates stained with erythrosine, the authors observed some 60 lines comprised between wave-lengths 3,063 and 3,134 in the ultra-violet. These lines are the same whether the electrodes are copper or platinum, and therefore they must belong to some gas or gaseous combination within the spark-gap. A jet of steam blown through the flame greatly enhances the brightness of the lines. The authors, however, consider that they are not solely due to water vapour, but rather to combinations of gases, such as oxides of nitrogen, facilitated by its presence.

Electrical Development in Greece.—A United States consular report from Patras gives a good idea of the progress being made with electricity in Greece. The development of communication within Greece at present is marked, and promises in the near future to bring conveniences of travel to a level with those of any country in Europe. The Greek Electric Company, otherwise known as the Thomson-Houston Company, is now completing in Patras the first electric tramway in Greece. The same company operates the electric light plants of Athens and Piræus, and of four or more other cities, and is now negotiating with the Athens-Piræus Tramway Company to supply motive power from a central electric station at Phalerum, near Athens. This proposed power station, if constructed, will be on a scale sufficiently large to supply power for manufacturing purposes as well as for the lighting of Athens, Piræus, and Phalerum. Speaking more particularly of the street railway in Patras, the system will be similar to that found in general use in France and Italy. The motive power will be furnished by gas-engines of German construction. The main stem of the road is constructed through the length of the city, parallel with the sea, and extends some distance beyond the city limits.

Prospectuses. — The sixth session of the Royal Technical Institute, Salford, has just opened for both day and evening classes. As usual, special arrangements have been made for instruction in physics and mechanical and electrical engineering. These include courses of lectures on alternating currents (with practical work); dynamo and electrical machinery design; electric traction, transmission, and distribution of power; electric wiring and house fitting, etc. In the chemistry branch a special course on gas analysis will doubtless prove very instructive, while the course of lectures on engineering estimates arranged in the mechanical engineering branch embraces a subject of exceptional importance to coming engineers. The Northern Polytechnic Institute have also sent us their prospectus for the session 1901-1902, which opens next Monday. Our attention is called to the recent development of the institute's day school work. Two of these day schools are open to students specialising in science and technology. The instruction staff has been reorganised and strengthened, and all members, it is pointed out, have technical training as well as educational. Mr. Mundella is the lecturer in electrical engineering. Most of the classes meet for two or three hours, or even more, weekly, and practical work in the laboratory is a necessary complement of the lectures.

Motorcar Restrictions in France.—Whatever may be said of the recent motorcar racing in France, it has at least had one good result—viz., that of calling the attention of the authorities to the great danger to human life of excessive speeds in road travelling. We note with satisfaction that an official decree has been issued settling provisionally the question of the speed of motorcars. For the time being the authorities have only dealt with the problem of checking exaggerated speeds by facilitating the identification of automobiles, and hence the decree does not pretend to forbid the construction of motorcars capable of making more than 20 miles an hour. From this time forward, however, all motorcars are to be divided into two classes—those capable only of a speed under and those capable of a speed over 20 miles an hour. The latter must

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always carry in front and in the rear, by night and by day, a special number. The manufacturer must make a declaration as to the speed of every machine intended to travel on French roads. "Racing" on high roads is forbidden, but 20 miles an hour will be allowed in the open country, elsewhere not more than 13. It will be interesting to watch the results of these restrictions on automobile travelling in France. We are inclined to think that as at present framed the rules leave too much to the imagination of the automobilist. There is sure to be plenty of controversy as to what is "racing" and what is not.

Wireless Signal Service.—Yet another system of wireless telegraphy, which, naturally, is claimed to be "a great improvement over the Marconi system," is reported from Washington. The Signal Service of the United States Government are credited with having perfected this new method, which is to be put into practical operation on the Pacific Coast. Its usefulness will first be tried in connection with communications at San Francisco between shore stations and the Government transports. We understand from our American contemporary *Electricity*, that very shortly it is proposed to erect the necessary stations and to equip the transports with apparatus in accordance with the Signal Corps idea. At this stage of the project it is regarded as unwise to publish any details of the new system, but it is stated that the Signal Corps are satisfied that they will be able to receive signals from a distance of at least 30 miles. This, however, is only a beginning, and bigger things are looked for on the question of distance in the near future. The claim that there may be no limit to the communication can only be proved by time, but it is confidently believed, according to our contemporary, that there will be a very much greater extension of effectiveness than at present obtained. The general principle of the apparatus is merely that of the Hertzian wave, and it is not denied that the general plan as laid down by Marconi has been kept in mind more or less by the Government inventors. The system is already working at San Francisco effectively between shore stations.

Lindsay Memorial Unveiled.—The James Bowman Lindsay memorial to perpetuate the memory of the man of science was unveiled in Dundee on Saturday last. We have referred on more than one occasion to the movement in this journal, and are pleased to see that it has been crowned with the success it so well deserved. Sir W. H. Preece performed the ceremony of unveiling the memorial, which takes the form of a monument over the grave of the late scientist. It consists of a lofty column of grey granite, mounted on a graded base, with simple classical ornamentation. Surmounting the pillar is a bronze hand holding a thunderbolt, typifying man controlling electric energy. The front of the monument bears an inscription testifying to Lindsay's services as "a pioneer in electrical science," while passages from some of his own writings are engraved on both the south and north side. A large assembly of spectators watched the unveiling of the memorial on Saturday. At a meeting subsequently held, Sir Wm. Preece eulogised Lindsay's life and work, declaring that there was nothing in scripture so marvellous, so clear, and so well defined as the prophecy uttered by him 60 years since relative to the progress and development of science. There was, perhaps, no name that would shine in science more than that of James Bowman Lindsay when the true facts which had been brought out that day were more widely promulgated. Wireless telegraphy had "caught on" in the public mind. He was not sure that it was going to do much good, for nothing did much good unless it had the possibility of making dividends for capitalists. Sir John Leng, who has been associated with the movement from the beginning, also gave a reminiscence of Lindsay, whose claims as an inventor of wireless telegraphy he fully acknowledged.

The Nernst Lamp in America.—Mr. A. J. Wurts read a paper before the recent convention of the American Institute of Electrical Engineers on "The Development of the Nernst Lamp in America." He recapitulated its advantages as being absence of shadow, steadiness of light, simplicity, and low cost of maintenance, high efficiency of the lamp, and the fact that it is operative on 3,000 alternations. If the Nernst lamp as at present prepared, however, be compared with the incandescent lamp for purposes to which incandescent lighting is applied, the comparison can only be unfavourable to the new apparatus. An incandescent lamp is simplicity itself in so far as its connections with the mains are concerned, whereas the Nernst lamp requires an auxiliary heater, a ballast of hot iron wire, and a heater cut-out magnet. Another point is that the incandescent lamp is used in sizes down to 8 c.p., whereas the smallest Nernst lamp yet attempted in America is of 50 c.p. In this comparison with the incandescent lamp, the only offsets in favour of the Nernst lamp are its colour and its efficiency, which latter is considerably in excess of the efficiency of the incandescent lamp. Comparing the Nernst lamp with the arc lamp on the other hand, the former comes more into favour. It is likelier to be steadier in action than an arc lamp, and to require considerably less attention during operation, since there are no carbons to be renewed. It is capable of being operated directly from 220-volt mains without the insertion of several lamps in series, and also of being adapted to trolley-car lighting. As regards efficiency, expected cost price, and the colour of the light, there is great similarity between the two lamps. One advantage of the Nernst lamp in comparison with the arc lamp is that it may be operated on low-frequency circuits.

Testing.—The congress of the International Association for Testing Materials was held at Budapest on Sept. 9 to 14 under the presidency of Prof. L. von Tetmajer, and was largely attended by engineers from all parts of the world. The delegates present included 4 from England, 41 from Austria, 3 from Belgium, 9 from Denmark, 2 from the United States, 36 from France, 152 from Hungary, 70 from Germany, 3 from Norway, 12 from Italy, 26 from Russia, 1 from Roumania, 3 from Spain, 1 from Servia, 10 from Switzerland, and 5 from Sweden. After an inaugural presidential address and address of welcome from the Hungarian authorities, a representative of each country was elected an hon. president of the congress, Mr. Bennett H. Brough being chosen for England and Prof. H. M. Howe for the United States. The other English and American members present were: Sir William H. Bailey, Manchester; Mr. Bertram Blount, London; Dr. C. J. Renshaw, Ashton-on-Mersey; and Dr. R. Moldenke, New York. In addition to the various reports of committees dealing with technical problems, the following papers dealing with metals were read and discussed: "On the Measurement of Internal Tension," by Mr. Mesnager, Paris; "On the Forms of Carbon in Iron," by Baron Jüptner, Leoben; 'On Brinnell's Researches," by Mr. A. Wahlberg, Stockholm; "On the Testing of Metals by Means of Notched Bars," by Mr. H. Le Chatelier, Paris, by Mr. G. Charpy, Paris, and by Prof. Belelubsky, St. Petersburg; "On Micrographical Researches on the Deformation of Metals," by Mr. F. Osmond, Paris; on "Metallography," by Mr. E. Heyn, Charlottenburg; on "The Testing of Railway Material," by Mr. E. Vanderheym, Lyons; and on "The International Iron and Steel Labora-

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tory," by Prof. H. Wedding, Berlin. Several papers dealing with stone and mortars were also read, and an interesting lecture on "The Iron Industry of Hungary" was delivered by Prof. Edvi-Illes, Budapest.

Water Power in Ireland. — We have received, through the kindness of the author, Mr. S. M. Macrory, of Limavady, a letter which he has addressed to a local paper respecting the use of water power on the River Bann. This river, which runs out of Loch Neagh, has up to the present been used as a means of transport. In consequence of the competition from the surrounding railways, it has now been practically decided by the County Council to abandon the navigation works on this river. Mr. Macrory points out that if this be done, there would be an opportunity for the establishment of large electrical generating stations on this river. We gather from his letter that the fall, which occurs at four points along the river, is in all 42ft., and that even in the height of the summer a flow of 100,000 cubic feet per minute can be relied upon. This is equivalent to a theoretical horse-power of from 7,000 to 8,000 in the summer, and, of course, a much larger output would be obtained in the winter. The source of this river—Loch Neagh—is the largest lake in the United Kingdom, and acts as a good reservoir to even out the flow of the river in wet weather. Another advantage pointed out by Mr. Macrory is that the bauxite mines in Antrim would be conveniently situated to the horse-power obtainable, so that aluminium should be produced at a very cheap rate. It will be remembered that at present the British Aluminium Company get their supply of bauxite from these Antrim mines, and after treatment at Larne, take it by sea and canal to their power works at Foyers. We do not know how close together the falls referred to by Mr. Macrory are situated, but there would seem to be ample water power to justify the establishment of large works, and it is in every way probable that the present works for navigation purposes could be employed in order to reduce the engineering expenditure by utilising the falls.

The Platinum Danger.—We referred a short while ago in these columns to a proposed German law prohibiting the use of platinum where it can be replaced without serious inconvenience by some other metal, and to limit its consumption to cases where its employment is essential. Discussing the situation in a short article in *Feilden's Magazine*, the writer warns us against an impending platinum famine. The debate on the Bill in the German Reichstag, he says, struck a note of warning regarding an imminent danger, the full importance of which appears not to be fully realised even among those who ought to be most concerned, but the restriction of the use of platinum in one country alone is hardly a practical measure for averting the dreaded consequence of a platinum famine. The problem, he suggests, is one of those that are eminently fitted for an international agreement, and should be carefully investigated by a commission composed of experts from all civilised countries. On the many uses to which platinum is put, the writer points out the important part it plays in modern industries, although its extensive employment is only of recent origin. Thus, in the great chemical manufacturing processes there are operations in which it is practically indispensable, as, for instance, that of purifying acid, for which platinum retorts are used—each of which frequently represents a value of £2,000 or more—or various operations on which the accuracy of chemical analysis depends. Even more important is the use of platinum in electrical engineering processes, and in the manufacture of electrical apparatus. Also, as is well known, this metal has a very important function in incandescent lamps. It is, in fact, the only metal known around which glass can be fused. If it be added that it withstands abnormally high temperatures, and that no acids, excepting aqua regia, will attack it, it is easily comprehended that, unless a substitute combining these qualities be discovered, the exhaustion of its supply would have a serious effect upon more than one industry. We quite agree with the writer as to the great importance of taking steps to limit the use of platinum as far as possible, and think his suggestion that the matter should be carefully investigated by an international commission is worthy of earnest consideration.

Novel Electric Railroad.—In connection with the electric tramway system of Palermo, an inclined road of a particularly novel character has just been completed. A description of the new line appears in the *Scientific American*, which gives details of the system of traction employed. The problem to be solved was to bring the ordinary cars of the Palermo electric road up to Monreale without giving them additional motive power or providing them with special brakes necessary for the inclined railway. This has been accomplished by using a small electric locomotive, which carries an auxiliary motor to aid on the incline, as well as the powerful brakes that are needed. The incline proper is 3,300ft. in length, and has an 11 to 12 per cent. grade. The end sections of the line, above and below, are 2,360ft. and 627ft. long respectively, with grades varying from 4 to 8 per cent. On account of the steep grade of the middle section the simple adherence of the car is not sufficient, and it has been necessary to adopt the present system of auxiliary locomotives. By this arrangement the two cars, one mounting and the other descending, cease to be independent when they come upon the inclined section, and each is coupled to a locomotive. The locomotives form a fixed system, being united by a cable which passes over a system of pulleys at the top of the incline. Like the cars, they are provided with a trolley. It is, however, the downward car which supplies the power for the system. By this plan the weight of the descending train is utilised to haul up the ascending train. A simple manœuvre is employed to couple and uncouple the locomotives from the cars. When the ascending train has arrived at the upper end of the incline, the car leaves the locomotive and proceeds by its own motors to Monreale. At the same time, the descending train, arriving at the lower station, stops for a moment to allow the locomotive to run down into a pit and then proceeds on its way. The locomotive, which is, perhaps, the most interesting feature of the system, has two mechanical brakes, one of which is operated by hand and the other automatically coming into action if the tension of the rope should fail. They act upon the head of the rail. The brake is composed of an upper part, which comes down upon the rail-head, and a lower part, which comes up and grasps it on the lower side. A strong braking action is thus secured, and at the same time the vehicle is prevented from lifting. The two parts of the brake are brought together by turning a horizontal shaft to which they are connected by levers. In the case of the forward brake, this shaft is operated by a rod which passes to the conductor's handwheel. The rear brake is of the same pattern, but is made automatic in its action. The locomotive carries in the middle a four-pole motor of the Schuckert type, and at one end is the motorman's cab, having on the roof the trolley, and containing the controller and brake wheel. The rear box contains the resistance coils of the controller. The motor operates the wheels by a system of worm and ordinary gearing. To the shaft is attached a lever having at the end a heavy counterweight. This lever is held in the off position by the tension of the main cable, to which

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it is connected, but should the tension cease the weight descends and throws on the brake. The main dimensions of the locomotive are: total length, 15ft., or with the buffers, 16ft. 8in.; diameter of wheels, 28in.; distance between axles, 5ft. 4in. The electric cars of the tramway system have two Schuckert motors, and weigh about eight tons. The current is supplied from the large station which has been recently erected for the lighting and traction of Palermo.

Record Automobile Run on One Battery Charge. One of the disadvantages hitherto attributed to the electric automobile, and which has probably most to do in impeding the greater development of the vehicle for long-distance travelling, has been the fact that it has had to carry a heavy and bulky battery, which, under ordinary circumstances, and in the average vehicle, would drive the carriage only about 30 to 40 miles on one charge. The *Western Electrician* records a most gratifying long-distance test with an electric automobile which was made a few weeks ago over the boulevards of Chicago. The vehicle made a total distance of 187½ miles on one charge of its batteries. This record-breaking run is credited to an efficient combination of three features in the construction of the automobile—viz., the running gear, the motor, and the batteries. The main object sought in the construction of the running gear and the vehicle body has been simplicity and lightness, the wheels being of the bicycle type. The motor has been designed to operate on a 20-volt circuit, and is rated at ¾ h.p. It is a series-wound, four-pole machine, and an efficiency of 80 per cent., which is claimed for it, is regarded as exceptionally high for such a small size. The speed of the motor is about 1,000 revolutions per minute. The regular battery for the vehicle in question comprises 10 Porter cells, each cell consisting of 21 plates 5in. by 7in. in size. The plates are of the pasted form, the active material being compressed into the grids by a special process. The battery weighs but 350lb., and has a capacity of 250 ampere-hours. It occupies about one-half of the space beneath the seat of the carriage. In addition to the regular battery of 10 cells, a second set of 10 15-plate cells was carried in under the seat in the trial in question. This additional set had a capacity of 133 ampere-hours, and weighed 250lb., making the total weight of the battery equipment 600lb., which is precisely the weight of the carriage and motor also, bringing the total weight of the automobile up to 1,200lb. At intervals stops were made for meals, etc. The total time occupied in covering the distance of 187½ miles was 32 hours, and the actual running time about 23½ hours. An average speed of eight miles an hour was maintained throughout until about the last 20 minutes of the run, when the speed dropped to about four miles an hour. The two battery sets were used alternately, and were evenly discharged. The average draw was 18 to 20 amperes. At the start, however, when the vehicle made about 11 miles an hour, the motor drew about 30 amperes. It is estimated that 117 miles of the distance was covered by the regular set of 21-plate cells. When starting the automobile about 60 amperes was required, but the current almost immediately dropped down to normal. The successful issue of the trial in question speaks well for the possibilities of the electric automobile of the future.

Electrolytic Copper Refining.—It is to be gathered from an article by Mr. Geo. E. Walsh in the *Electrical Review* of New York that the advent of electricity is responsible in more ways than one for the marvellous development of the copper mining industry in recent years. In the first place, had it not been for the rapid expansion of the electric industries, which to-day use a large percentage of the purest copper, the advanced prices would never have stimulated the working of the new copper regions, especially in the United States of America. But the demand for copper for electrical purposes is not the only factor which has united copper mining and electrical development in a close relationship. Electricity has become necessary to the refining of copper. The first commercial refinery by the electrolytic process was erected in America some 20 years ago, and 10 years later there were only two such refineries in the States, with a total output of only 24 tons of copper per day. To-day there are fully two dozen electrolytic refineries, producing hundreds of thousands of tons of copper per day, besides several million ounces of silver and gold. Indeed, the author estimates that fully one-half and more of all the copper produced in the United States is refined by the electrolytic process, and about one-third of the world's whole output. From about £6 per ton, when the electrolytic process was first attempted, the cost of producing refined copper by this method now stands at from £1. 10s. to £2 per ton. Both the multiple and the series processes are employed in electrolytic copper refining in the lake copper regions of America, as well as in other parts of the country, and the relative importance of the two systems depends, in a measure, upon circumstances and topographical surroundings. The multiple system is, however, the most generally used, and it is of greater relative value. The difference between the two systems is chiefly in the mode of arranging the electrodes. In the multiple system the average electric current required for a refinery of 30 to 50 tons per day is about 10 amperes to the square foot, counting both sides of the anode plate, and the flow of this current varies considerably according to the quality of the anode. There is danger in employing a high current, for if the copper should have considerable silver and arsenic mixed with it the purity of the copper would be greatly lessened. Some copper, however, is so free from all impurities that as high as 15 and 20 amperes can be used without danger. One of the most annoying features of the electrolysis is the action of the impurities on the cathodes, which makes them unfit for use. Of the many methods to overcome this trouble, the one commonly resorted to is to purify the electrolyte by filtration through a bed of copper oxide, and another by boiling with meta-stannic acid. In the series system of electric copper refining in the States special cathodes are not used, but one side of the anode plate serves as cathode. The fact that a good deal of scrap copper is produced by this process makes it unpopular, and only a few refineries using it are in existence in America. The multiple process requires only half the anode copper used in the series system with the same cathode surface. The cost of maintaining a plant to the highest efficiency has been found to be greater in the series process than in the multiple, but the former saves somewhat in the less loss of energy. The location of the refinery is consequently a factor of some importance, for if fuel is cheap or the power is supplied by waterfall, the series system has little to show in its favour in the cost of the electric current. It is estimated on the whole by modern refiners that there is nearly a saving of 8s. per ton of refined copper in the multiple system. In some cases the saving has been as much as 14s. per ton where the refinery is a part of a converting establishment and run in conjunction with it. The average current efficiency of the multiple process is 95 per cent. as against 90 per cent. for the series process under similar conditions. The author's conclusion is that where the electric power is expensive or fuel high-priced, the difference in the current efficiency of the two processes must always decide in favour of the multiple process of refining copper.

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THE BRITISH ASSOCIATION.

Presidential Address.

BY PROF. ARTHUR W. RUCKER, M.A., LL.D., D SC., SEC.R.S.

(Concluded from page 377.)

Properties of the Basis of Matter.—It is easy to show that, whichever alternative be adopted, we are dealing with something, whether we consider it under the guise of separate particles or of differentiated portions of the medium, which has properties different from those of matter in bulk. For if the basis of matter had the same constitution as matter, the irregular heat movements could hardly be maintained either against the viscosity of the medium or the frittering away of energy of motion which would occur during the collisions between the particles. Thus, even in the case in which a hot body is prevented from losing heat to surrounding objects, its sensible heat should spontaneously decay by a process of self-cooling. No such phenomenon is known, and though on this, as on all other points, the limits of our knowledge are fixed by the uncertainty of experiment, we are compelled to admit that, to all appearance, the fundamental medium, if it exists, is unlike a material medium, in that it is non-viscous; and that the particles, if they exist, are so constituted that energy is not frittered away when they collide. In either case we are dealing with something different from matter itself in the sense that, though it is the basis of matter, it is not identical in all its properties with matter. The idea, therefore, that entities exist possessing properties different from those of matter in bulk is not introduced at the end of a long and recondite investigation to explain facts with which none but experts are acquainted. It is forced upon us at the very threshold of our study of nature. Either the properties of matter in bulk cannot be referred to any simpler structure, or that simpler structure must have properties different from those of matter in bulk as we directly knew it—properties which can only be inferred from the results which they produce. No *a priori* argument against the possibility of our discovering the existence of quasi-material substances, which are nevertheless different from matter, can prove the negative proposition that such substances cannot exist. It is not a self-evident truth that no substance other than ordinary matter can have an existence as real as that of matter itself. It is not axiomatic that matter cannot be composed of parts whose properties are different from those of the whole. To assert that even if such substances and such parts exist no evidence however cogent could convince us of their existence is to beg the whole question at issue; to decide the cause before it has been heard. We must therefore adhere to the standpoint adopted by most scientific men—viz., that the question of the existence of ultra-physical entities, such as atoms and the ether, is to be settled by the evidence, and must not be ruled out as inadmissible on *a priori* grounds. On the other hand, it is impossible to deny that, if the mere entry on the search for the concealed causes of physical phenomena is not a trespass on ground we have no right to explore, it is at all events the beginning of a dangerous journey. The wraiths of phlogiston, caloric, luminiferous corpuscles, and a crowd of other phantoms haunt the investigator, and as the grim host vanishes into nothingness he cannot but wonder if his own conceptions of atoms and of the ether

> "shall dissolve,
> And, like this insubstantial pageant faded,
> Leave not a wrack behind."

But though science, like Bunyan's hero, has sometimes had to pass through the "Valley of Humiliation," the spectres which meet it there are not really dangerous if they are boldly faced. The facts that mistakes have been made, that theories have been propounded, and for a time accepted, which later investigations have disproved, do not necessarily discredit the method adopted. In scientific theories, as in the world around us, there is a survival of the fittest, and Dr. James Ward's unsympathetic account of the blunders of those whose work, after all, has shed glory on the nineteenth century, might *mutatis mutandis* stand for a description of the history of the advance of civilisation. "The story of the progress so far," he tells us, "is briefly this: Divergence between theory and fact one part of the way, the wreckage of abandoned fictions for the rest, with an unattainable goal of phenomenal Nihilism and ultra-physical mechanism beyond." "The path of progress," says Prof. Karl Pearson, "is strewn with the wreck of nations. Traces are everywhere to be seen of the hecatombs of inferior races, and of victims who found not the narrow way to the greater perfection. Yet these dead peoples are in very truth the stepping-stones on which mankind has arisen to the higher intellectual and deeper emotional life of to-day." It is only necessary to add that the progress of society is directed towards an unattainable goal of universal contentment, to make the parallel complete. And so in the one case as in the other, we may leave "the dead to bury their dead." The question before us is not whether we too may not be trusting to false ideas, erroneous experiments, evanescent theories. No doubt we are; but, without making any insolent claim to be better than our fathers, we may fairly contend that, amid much that is uncertain and temporary, some of the fundamental conceptions, some of the root-ideas of science, are so grounded on reason and fact that we cannot but regard them as an aspect of the very truth.

Enough has, perhaps, now been said on this point for my immediate purpose. The argument as to the constitution of matter could be developed further in the manner I have hitherto adopted—viz., by series of propositions, the proof of each of which is based upon a few crucial phenomena. In particular, if matter is divided into moving granules or particles, the phenomenon of cohesion proves that there must be mutual actions between them analogous to those which take place between large masses of matter, and which we ascribe to force, thereby indicating the regular, unvarying operation of active machinery which we have not yet the means of adequately understanding. For the moment I do not wish to extend the line of reasoning that has been followed. My main object is to show that the notion of the existence of ultra-physical entities and the leading outlines of the atomic theory are forced upon us at the beginning of our study of nature, not only by *a priori* considerations, but in the attempt to comprehend the results of even the simplest observation. These outlines cannot be effaced by the difficulties which undoubtedly arise in filling up the picture. The cogency of the proof that matter is coarse-grained is in no way affected by the fact that we may have grave doubts as to the nature of the granules. Nay, it is of the first importance to recognise that, though the fundamental assumptions of the atomic theory receive overwhelming support from a number of more detailed arguments, they are themselves almost of the nature of axioms, in that the simplest phenomena are unintelligible if they are abandoned.

The Range of the Atomic Theory.—It would be most unfair, however, to the atomic theory to represent it as depending on one line of reasoning only, or to treat its evidence as bounded by the very general propositions I have discussed. It is true that as the range of the theory is extended the fundamental conception that matter is granular must be expanded and filled in by supplementary hypotheses as to the constitution of the granules. It may also be admitted that no complete or wholly satisfactory description of that constitution can as yet be given, that perfection has not yet been attained here or in any other branch of science; but the number of facts which can be accounted for by the theory is very large compared with the number of additional hypotheses which are introduced, and the cumulative weight of the additional evidence obtained by the study of details is such as to add greatly to the strength of the conviction that, in its leading outlines, the theory is true. It was originally suggested by the facts of chemistry, and though, as we have seen, a school of chemists now thrusts it into the background, it is none the less true, in the words of Dr. Thorpe, that "every great advance in chemical knowledge during the last 90 years finds its interpretation in [Dalton's] theory." The principal mechanical and thermal properties of gases have been explained, and in large part discovered, by the aid of the atomic theory; and, though there are outstanding diffi-

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culties, they are, for the most part, related to the nature of the atoms and molecules, and do not affect the question as to whether they exist. The fact that different kinds of light all travel at the same speed in interplanetary space, while they move at different rates in matter, is explained if matter is coarse-grained. But to attempt to sum up all this evidence would be to recite a text-book on physics. It must suffice to say that it is enormous in extent and varied in character, and that the atomic theory imparts a unity to all the physical sciences which has been attained in no other way.

I must, however, give a couple of instances of the wonderful success which has been achieved in the explanation of physical phenomena by the theory we are considering, and I select them because they are in harmony with the line of argument I have been pursuing. When a piece of iron is magnetised its behaviour is different according as the magnetic force applied to it is weak, moderate, or strong. When a certain limit is passed the iron behaves as a non-magnetic substance to all further additions of magnetic force. With strong forces it does and with very weak forces it does not remain magnetised when the force ceases to act. Prof. Ewing has imitated all the minute details of these complicated properties by an arrangement of small isolated compass needles to represent the molecules. It may fairly be said that, as far as this particular set a phenomena is concerned, a most instructive working model based on the molecular theory has not only been imagined but constructed. The next illustration is no less striking. We may liken a crowd of molecules to a fog; but while the fog is admitted by everybody to be made up of separate globules of water, the critics of scientific method are sometimes apt to regard the molecules as mere fictions of the imagination If, however, we could throw the molecules of a highly rarefied gas into such a state that vapour condensed on them, so that each became the centre of a water drop, till the host of invisible molecules was, as it were, magnified by accretion into a visible mist, surely no stronger proof of their reality could be desired. Yet there is every reason to believe that something very like this has been accomplished by Mr. C. T. R. Wilson and Prof. J. J. Thomson. It is known that it is comparatively difficult to produce a fog in damp air if the mixture consists of air and water vapour alone. The presence of particles of very fine dust facilitates the process. It is evident that the vapour condenses on the dust particles, and that a nucleus of some kind is necessary on which each drop may form. But electrified particles also act as nuclei, for if a highly-charged body from which electricity is escaping be placed near a steam-jet the steam condenses, and a cloud is also formed in dust-free air more easily than would otherwise be the case if electricity is discharged into it. Again, according to accepted theory, when a current of electricity flows through a gas some of the atoms are divided into parts which carry positive and negative charges as they move in opposite directions, and unless this breaking up occurs a gas does not conduct electricity. But a gas can be made a conductor merely by allowing the Rontgen rays or the radiation given off by uranium to fall upon it. A careful study of the facts shows that it is probable that some of the atoms have been broken up by the radiation, and that their oppositely electrified parts are scattered among their unaltered fellows. Such a gas is said to be ionised.

Thus by these two distinct lines of argument we come to the conclusions: (1) that the presence of electrified particles promotes the formation of mist, and (2) that in an ionised gas such electrified particles are provided by the breaking up of atoms. The two conclusions will mutually support each other if it can be shown that a mist is easily formed in ionised air. This was tested by Mr. Wilson, who showed that in such air mist is formed as though nuclei were present, and thus in the cloud we have visible evidence of the presence of the divided atoms. If, then, we cannot handle the individual molecules we have at least some reason to believe that a method is known of seizing individuals, or parts of individuals, which are in a special state, and of wrapping other matter round them till each one is the centre of a discrete particle of a visible fog. I have purposely chosen this illustration because the explanation is based on a theory—that of ionisation—which is at present subjected to hostile criticism. It assumes that an electrical current is nothing more than the movement of charges of electricity. But magnets placed near to an electric current tend to set themselves at right angles to its direction—a fact on which the construction of telegraphic instruments is based. Hence, if the theory be true, a similar effect ought to be produced by a moving charge of electricity. This experiment was tried many years ago in the laboratory of Helmholtz by Rowland, who caused a charged disc to spin rapidly near a magnet The result was in accord with the theory; the magnet moved as though acted upon by an electric current. Of late, however, M. Crémieu has investigated the matter afresh, and has obtained results which, according to his interpretation, were inconsistent with that of Rowland. M. Crémieu's results are already the subject of controversy, and are, I believe, likely to be discussed in the Section of Physics. This is not the occasion to enter upon a critical discussion of the question at issue, and I refer to it only to point out that though, if M. Crémieu's result were upheld, our views as to electricity would have to be modified; the foundations of the atomic theory would not be shaken.

It is, however, from the theory of ions that the most far-reaching speculations of science have recently received unexpected support. The dream that matter of all kinds will some day be proved to be fundamentally the same has survived many shocks. The opinion is consistent with the great generalisation that the properties of elements are a periodic function of their atomic weights. Sir Norman Lockyer has long been a prominent exponent of the view that the spectra of the stars indicate the reduction of our so-called elements to simpler forms, and now Prof. J. J. Thomson believes that we can break off from an atom a part, the mass of which is not more than one-thousandth of the whole, and that these corpuscles, as he has named them, are the carriers of the negative charge in an electric current. If atoms are thus complex, not only is the *a priori* probability increased that the different structures which we call elements may all be built of similar bricks, but the discovery by Lenard that the ease with which the corpuscles penetrate different bodies depends only on the density of the obstacles, and not on their chemical constitution, is held by Prof. Thomson to be "a strong confirmation of the view that the atoms of the elementary substances are made up of simpler parts, all of which are alike." On the present occasion, however, we are occupied rather with the foundations than with these ultimate ramifications of the atomic thery; and having shown how wide its range is, I must, to a certain extent, retrace my steps and return to the main line of my argument.

The Properties of Atoms and Molecules.—For if it be granted that the evidence that matter is coarse-grained and is formed of separate atoms and molecules is too strong to be resisted, it may still be contended that we can know little or nothing of the sizes and properties of the molecules. It must be admitted that though the fundamental postulates are always the same, different aspects of the theory, which have not in all cases been successfully combined, have to be developed when it is applied to different problems; but in spite of this there is little doubt that we have some fairly accurate knowledge of molecular motions and magnitudes. If a liquid is stretched into a very thin film, such as a soap bubble, we should expect indications of a change in its properties when the thickness of the film is not a very large multiple of the average distance between two neighbouring molecules. In 1890 Sohncke detected evidence of such a change in films of the average thickness of 106 millionths of a millimetre ($\mu\mu$), and quite recently Rudolph Weber found it in an oil-film when the thickness was 115 $\mu\mu$. Taking the mean of these numbers and combining the results of different variants of the theory, we may conclude that a film should become unstable and tend to rupture spontaneously somewhere between the thicknesses of 110 and 55 $\mu\mu$, and Prof. Reinold and I found by experiment that this instability is actually exhibited between the thicknesses of 96 and 45 $\mu\mu$. There can therefore be little doubt that the first approach to molecular magnitudes is signalled

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when the thickness of a film is somewhat less than 100 $\mu\mu$, or four millionths of an inch. Thirteen years ago I had the honour of laying before the Chemical Society a *résumé* of what was then known on these subjects, and I must refer to that lecture or to the most recent edition of O. E. Meyer's work on the kinetic theory of gases for the evidence that various independent lines of argument quantities very much less than four millionths of an inch, which is perhaps from 500 to 1,000 times greater than the magnitude which, in the present state of our knowledge, we can best describe as the diameter of a molecule.

Confining our attention, however, to the larger quantities, I will give one example to show how strong is the cumulative force of the evidence as to our knowledge of the magnitudes of molecular quantities. We have every reason to believe that though the molecules in a gas frequently collide with each other, yet in the case of the more perfect gases the time occupied in collisions is small compared with that in which each molecule travels undisturbed by its fellows. The average distance travelled between two successive encounters is called the mean free path, and, for the reason just given, the question of the magnitude of this distance can be attacked without any precise knowledge of what a molecule is, or of what happens during an encounter. Thus the mean free path can be determined, by the aid of the theory, either from the viscosity of the gas or from the thermal conductivity. Using figures given in the latest work on the subject, and dealing with one gas only, as a fair sample of the rest, the lengths of the mean free path of hydrogen as determined by these two independent methods differ only by about 3 per cent. Further, the mean of the values which I gave in the lecture already referred to differed only by about 6 per cent. from the best modern result, so that no great change has been introduced during the last 13 years.

It may, however, be argued that these concordant values are all obtained by means of the same theory, and that a common error may affect them all. In particular, some critics have of late been inclined to descredit the atomic theory by pointing out that the strong statements which have sometimes been made as to the equality, among themselves, of atoms or molecules of the same kind may not be justified, as the equality may be that of averages only, and be consistent with a considerable variation in the sizes of individuals. Allowing this argument more weight than it, perhaps, deserves, it is easy to show that it cannot affect seriously our knowledge of the length of the mean free path. Prof. George Darwin has handled the problem of a mixture of unequal spherical bodies in the particular case in which the sizes are distributed according to the law of errors, which would involve far greater inequalities than can occur among atoms. Without discussing the precise details of his problem, it is sufficient to say that in the case considered by him the length of the mean free path is seven-elevenths of what it would be if the particles were equal. Hence were the inequalities of atoms as great as in this extreme case, the reduction of the mean free path in hydrogen could only be from 185 to 119 $\mu\mu$; but they must be far less, and, therefore, the error, if any, due to this cause could not approach this amount. It is probably inappreciable. Such examples might be multiplied, but the one I have selected is, perhaps, sufficient to illustrate my point—viz, that considerable and fairly accurate knowledge can be obtained as to molecular quantities by the aid of theories the details of which are provisional and are admittedly capable of improvement.

Is the Model Unique?—But the argument that a correct result may sometimes be obtained by reasoning on imperfect hypotheses raises the question as to whether another danger may not be imminent. To be satisfactory our model of nature must be unique, and it must be impossible to imagine any other which agrees equally well with the facts of experiment. If a large number of hypotheses could be framed with equal claims to validity, that fact would alone raise grave doubts as to whether it were possible to distinguish between the true and the false. Thus Prof. Poincaré has shown that an infinite number of dynamical explanations can be found for any phenomenon which satisfies certain conditions. But though this consideration warns us against the too ready acceptance of explanations of isolated phenomena, it has no weight against a theory which embraces so vast a number of facts as those included by the atomic theory. It does not follow that because a number of solutions are all formally dynamical, they are therefore all equally admissible. The pressure of a gas may be explained as the result of a shower of blows delivered by molecules, or by a repulsion between the various parts of a continuous medium. Both solutions are expressed in dynamical language; but one is, and the other is not, compatible with the observed phenomena of expansion. The atomic theory must hold the field until another can be found which is not inferior as an explanation of the fundamental difficulties as to the constitution of matter, and is, at the same time, not less comprehensive. On the whole, then, the question as to whether we are attempting to solve a problem which has an infinite number of solutions may be put aside until one solution has been found which is satisfactory in all its details. We are in a sufficient difficulty about that to make the rivalry of a second of the same type very improbable.

The Phenomena of Life.—But it may be asked—nay, it has been asked—may not the type of our theories be radically changed? If this question does not merely imply a certain distrust in our own powers of reasoning, it should be supported by some indication of the kind of change which is conceivable. Perhaps the chief objection which can be brought against physical theories is that they deal only with the inanimate side of nature, and largely ignore the phenomena of life. It is, therefore, in this direction, if in any, that a change of type may be expected. I do not propose to enter at length upon so difficult a question, but however we may explain or explain away the characteristics of life, the argument for the truth of the atomic theory would only be affected if it could be shown that living matter does not possess the thermal and mechanical properties, to explain which the atomic theory has been framed. This is so notoriously not the case that there is the gravest doubt whether life can in any way interfere with the action within the organism of the laws of matter in bulk belonging to the domain of mechanics, physics, and chemistry. Probably the most cautious opinion that could now be expressed on this question is that, in spite of some outstanding difficulties which have recently given rise to what is called Neovitalism, there is no conclusive evidence that living matter can suspend or modify any of the natural laws which would affect it if it were to cease to live. It is possible that, though subject to these laws, the organism while living may be able to employ, or even to direct, their action within itself for its own benefit, just as it unquestionably does make use of the processes of external nature for its own purposes; but if this be so, the seat of the controlling influence is so withdrawn from view that, on the one hand, its very existence may be denied, while, on the other hand, Prof. Hæckel, following Vogt, has recently asserted that "matter and ether are not dead and only moved by extrinsic force; but they are endowed with sensation and will; they experience an inclination for condensation, a dislike for strain; they strive after the one and struggle against the other." But neither unproved assertions of this kind, nor the more refined attempts that have been made by others to bring the phenomena of life and of dead matter under a common formula, touch the evidence for the atomic theory. The question as to whether matter consists of elements capable of independent motion is prior to and independent of the further questions as to what these elements are, and whether they are alive or dead.

The physicist, if he keeps to his business, asserts as the bases of the atomic theory nothing more than that he who declines to admit that matter consists of separate moving parts must regard many of the simplest phenomena as irreconcilable and unintelligible, in spite of the fact that means of reconciling them are known to everybody, in spite of the fact that the reconciling theory gives a general correlation of an enormous number of phenomena in every branch of science, and that the outstanding difficulties are connected, not so much with the fundamental hypotheses that matter is composed of distinguishable entities which are capable of

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separate motions, as with the much more difficult problem of what these entities are. On these grounds the physicist may believe that, though he cannot handle or see them, the atoms and molecules are as real as the ice crystals in a cirrus cloud which he cannot reach—as real as the unseen members of a meteoric swarm whose death-glow is lost in the sunshine, or which sweep past us, unentangled, in the night. If the confidence that his methods are weapons with which he can fight his way to the truth were taken from the scientific explorer, the paralysis which overcomes those who believe that they are engaged in a hopeless task would fall upon him.

Physiology has specially flourished since physiologists have believed that it is possible to master the physics and chemistry of the framework of living things, and since they have abandoned the attitude of those who placed in the foreground the doctrine of the vital force. To supporters of that doctrine the principle of life was not a hidden directing power which could perhaps whisper an order that the flood-gates of reservoirs of energy should now be opened and now closed, and could, at the most, work only under immutable conditions to which the living and the dead must alike submit. On the contrary, their vital force pervaded the organism in all its parts. It was an active and energetic opponent of the laws of physics and chemistry. It maintained its own existence, not by obeying, but by defying them; and though destined to be finally overcome in the separate campaigns of which each individual living creature is the scene, yet, like some guerilla chieftain, it was defeated here only to reappear there with unabated confidence and apparently undiminished force. This attitude of mind checked the advance of knowledge. Difficulty could be evaded by a verbal formula of explanation which in fact explained nothing. If the mechanical, or physical, or chemical causes of a phenomenon did not lie obviously upon the surface, the investigator was tempted to forego the toil of searching for them below; it was easier to say that the vital force was the cause of the discrepancy, and that it was hopeless to attempt to account for the action of a principle which was incomprehensible in its nature. For the physicist the danger is no less serious, though it lies in a somewhat different direction. At present he is checked in his theories by the necessity of making them agree with a comparatively small number of fundamental hypotheses. If this check were removed his fancy might run riot in the wildest speculations, which would be held to be legitimate if only they led to formulæ in harmony with facts. But the very habit of regarding the end as everything, and the means by which it was attained as unimportant, would prevent the discovery of those fragments of truth which can only be uncovered by the painful process of trying to make inconsistent theories agree, and using all facts, however remote, as the tests of our central generalisation.

"Science," said Helmholtz, "science, whose very object it is to comprehend nature, must start with the assumption that nature is comprehensible." And again, "The first principle of the investigator of nature is to assume that nature is intelligible to us, since otherwise it would be foolish to attempt the investigation at all." These axioms do not assume that all the secrets of the universe will ultimately be laid bare, but that a search for them is hopeless if we undertake the quest with the conviction that it will be in vain. As applied to life they do not deny that in living matter something may be hidden which neither physics nor chemistry can explain, but they assert that the action of physical and chemical forces in living bodies can never be understood, if at every difficulty and at every check in our investigations we desist from further attempts in the belief that the laws of physics and chemistry have been interfered with by an incomprehensible vital force. As applied to physics and chemistry they do not mean that all the phenomena of life and death will ultimately be included in some simple and self-sufficing mechanical theory; they do mean that we are not to sit down contented with paradoxes such as that the same thing can fill both a large space and a little one; that matter can act where it is not, and the like, if by some reasonable hypothesis, capable of being tested by experiment, we can avoid the acceptance of these absurdities. Something will have been gained if the more obvious difficulties are removed, even if we have to admit that in the background there is much that we cannot grasp.

The Limits of Physical Theories.—And this brings me to my last point. It is a mistake to treat physical theories in general, and the atomic theory in particular, as though they were parts of a scheme which has failed if it leaves anything unexplained, which must be carried on indefinitely on exactly the same principles, whether the ultimate results are, or are not, repugnant to common sense. Physical theories begin at the surface with phenomena which directly affect our senses. When they are used in the attempt to penetrate deeper into the secrets of nature it is more than probable that they will meet with insuperable barriers, but this fact does not demonstrate that the fundamental assumptions are false, and the question as to whether any particular obstacle will be for ever insuperable can rarely be answered with certainty. Those who belittle the ideas which have of late governed the advance of scientific theory too often assume that there is no alternative between the opposing assertions that atoms and the ether are mere figments of the scientific imagination, or that, on the other hand, a mechanical theory of the atoms and of the ether, which is now confessedly imperfect, would, if it could be perfected, give us a full and adequate representation of the underlying realities. For my own part I believe that there is a *vià media*. A man peering into a darkened room, and describing what he thinks he sees, may be right as to the general outline of the objects he discerns, wrong as to their nature and their precise forms. In his description fact and fancy may be blended, and it may be difficult to say where the one ends and the other begins; but even the fancies will not be worthless if they are based on a fragment of truth, which will prevent the explorer from walking into a looking-glass or stumbling over the furniture. He who saw "men as trees walking" had at least a perception of the fundamental fact that something was in motion around him. And so, at the beginning of the twentieth century, we are neither forced to abandon the claim to have penetrated below the surface of nature, nor have we, with all our searching, torn the veil of mystery from the world around us. The range of our speculations is limited, both in space and time: in space, for we have no right to claim, as is sometimes done, a knowledge of the "infinite universe"; in time, for the cumulative effects of actions which might pass undetected in the short span of years of which we have knowledge may, if continued long enough, modify our most profound generalisations. If some such theory as the vortex-atom theory were true, the faintest trace of viscosity in the primordial medium would ultimately destroy matter of every kind. It is thus a duty to state what we believe we know in the most cautious terms, but it is equally a duty not to yield to mere vague doubts as to whether we can know anything. If no other conception of matter is possible than that it consists of distinct physical units—and no other conception has been formulated which does not blur what are otherwise clear and definite outlines—if it is certain, as it is, that vibrations travel through space which cannot be propagated by matter, the two foundations of physical theory are well and truly laid. It may be granted that we have not yet framed a consistent image either of the nature of the atoms or of the ether in which they exist; but I have tried to show that in spite of the tentative nature of some of our theories, in spite of many outstanding difficulties, the atomic theory unifies so many facts, simplifies so much that is complicated, that we have a right to insist—at all events till an equally intelligible rival hypothesis is produced—that the main structure of our theory is true; that atoms are not merely helps to puzzled mathematicians, but physical realities.

RECENT TRAMWAY PRACTICE.*

BY JAMES MORE, JUN., M.I.C.E., F.R.S.E.

In this paper the writer has merely attempted what its title implies—viz., a review or record of present practice and such results of existing tramways as he could obtain,

* Paper read in Section VII. of the Glasgow International Engineering Congress.

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TABLE No. 4.—Physical Tests of Tramway Rails.

Name of tramway rails supplied to.	Year.	Weight of rail per yard.	Elastic limit per square inch.	Breaking stress per square inch.	Elongation in 2in. pieces.	Contraction of area.
		lb.	tons.	tons.	per cent.	per cent.
Glasgow	1891	79	30·33	46·69	11·00	31·90
,,	,,	,,	29·92	45·27	14·50	47·40
Toronto	1892	98	33·97	45·65	19·50	51·00
,,	,,	,,	32·33	45·27	17·50	36·90
,,	,,	69	30·73	44·06	16·00	36·00
,,	,,	67	28·25	44·44	20·50	45·20
,,	,,	,,	27·87	43·43	21·00	45·90
Glasgow	1893	79	29·56	45·90	15·00	26·70
,,	,,	,,	30·75	45·46	15·00	25·00
Huddersfield	,,	98	32·33	45·07	19·75	57·10
,,	,,	,,	33·82	45·05	15·00	60·14
Dublin	,,	66·5	27·90	45·88	15·00	41·50
Nottingham	1894	92	30·05	43·43	18·75	61·60
,,	,,	,,	28·32	42·16	17·75	60·90
Anglo-Argentine	,,	103	27·90	42·73	18·75	48·20
,, ,,	,,	,,	27·10	42·22	19·00	46·00
,, ,,	,,	,,	28 40	43·17	21·00	48·70
Toronto	,,	73	33·16	42·03	14·00	33·60
,,	,,	,,	30·33	41·46	23·00	45·90
,,	,,	86	28·31	40·76	20·25	60·90
,,	,,	,,	25·47	40·63	24·00	62·20
Dublin	1895	66·5	28·11	44·66	15·50	48·30
Bombay	,,	77	26·28	42·85	23·50	53·80
,,	1896	,,	28·30	44·89	17·50	45·20
,,	,,	,,	29·90	44·06	20·00	59·00
Melbourne	,,	61	32·32	44·25	15·00	59·60
					8in. piece.	
Glasgow	1901	98	—	45·00	17·00	43·40
,,	,,	,,	—	48·30	15·50	39·70
,,	,,	,,	—	46·40	12·50	32·30
,,	,,	,,	—	47·90	8·00	14·50
,,	,,	,,	—	46·60	15·00	41·70
,,	,,	,,	—	46·40	15·00	42·30
					200mm.	
Portsmouth	1901	96	31·30	47·50	13·50	26·90
,,	,,	,,	29·90	46·30	14·50	28·60
,,	,,	,,	28·30	47·50	12·50	27·70
					100mm.	
Portsmouth	1901	96	31·50	46·90	22·30	36·80
,,	,,	,,	34·90	47·70	15·00	25·20
,,	,,	,,	34·00	48·30	23·00	39·90
,,	,,	,,	28·70	45·40	21·00	31·90

with a few remarks on different methods. The records are unfortunately scrappy, and not by any means complete, but he hopes such as he has given will be of some interest to those associated with tramway schemes. In dealing with this subject, one has some difficulty in deciding what the term "recent" may mean. It may mean recent as compared with practice 20 years ago, which period covers many different systems of traction, or it may mean recent as compared with five years ago, which practically means electric traction, with a small amount of cable traction. Electric traction in this country can hardly be considered of much practical value longer back than five years, but it has greatly developed and matured in that time. The writer will, therefore, confine himself to a review of this method of traction, with a brief observation on the few cable lines in this country.

Permanent Way.

Regarding the permanent way, however, it is worth considering over a longer period, as it applies to all methods of traction in principle, only differing in degree as to stability under the different methods.

Rails.—During the last 20 years there has been a considerable change in the chemical composition, physical qualities, and section of tramway rails. Until about 1885 there were many built-up systems used, principally "T" and "channel" sections of rails carried on cast-iron chairs or sleepers, to which the rails were fixed by various methods, generally bolts or cotters. Some of these were fairly successful with the light cars used for horse traction, but failed completely when steam locomotives were used.

Steel.—Ten years ago the common percentage of carbon was 0·35, which was a very soft steel for the purpose of rolling friction, needlessly so for a tramway rail, which in most cases has a continuous bearing on a concrete foundation, and is subject only to compression and friction, in this respect differing from a railway rail carried on cross-sleepers, and acting as a girder, and subject to the various strains common to these. Railway rails, however, are being rolled of much harder steel than they were 10 years ago. At the present time the steel used for tramway rails contains from 0·55 to 0·65 per cent. of carbon, and is consequently much harder and more durable, besides being sufficiently tough. Such steel will stand an ultimate tensile stress of 45 tons per square inch, with an elongation of 15 per cent. and a contraction of over 40 per cent. in a 2in. test piece, ½in. diameter. This is a very great improvement and very essential for electric traction, which is particularly severe on the rails. Table No. 4 shows the actual tests of rails used at different places from 1891 to 1901.

Girder Rails.—About 1880 light sections of girder rails were used to some extent (about 58lb. to the yard), and in two or three years the weight was increased to about 75lb. per yard. In 1883 the girder rail was generally adopted, to the exclusion of most others, and the weight was increased to from 80lb. to 100lb. per yard. The fishplates, however, were, as a rule, much too light (Fig. 1). The usual standard lengths of rails at that time were 24ft., with 10 per cent. of shorts. Later on 30ft. lengths became the rule, and at the present time 45ft may be called the standard, although some are being rolled 60ft. long. These long lengths are, however, somewhat inconvenient, requiring vessels with long hatches, and on the railway, guard trucks, which increases the cost of carriage. They are also cumbrous to handle on the road, but as they save bonds and joints are a great advantage after they are laid. The sections have also much improved, owing to the Board of Trade relaxing to some extent its objection to wide grooves and broad treads. This has, in a great measure, been brought about by corporations constructing their own tramways, and adopting sections that would not have been allowed to a private company. Fig. 2 shows a good section of 6in. rail, with the patent "check" joint. This section has been used at Hartlepool, Ashton, Carlisle, the Potteries, and elsewhere with this joint, and it has given most satisfactory results. From the

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writer's experience it is more effective in keeping a tight joint than any form of soleplate. Most of the soleplates in use prevent the proper and effective packing of the joint with concrete where it is most necessary. Fig. 3 shows a very good 7in. section of rail, as adopted by the Glasgow Corporation.

Soleplates.—There are several devices in the form of sole or joint plates used to obviate the loosening of the rail joints, and consequent pounding of the car wheels in passing over them. It is evident that a flat joint plate bolted to the flange of the rail will not give much increased vertical strength to the joint. Their purpose seems to be

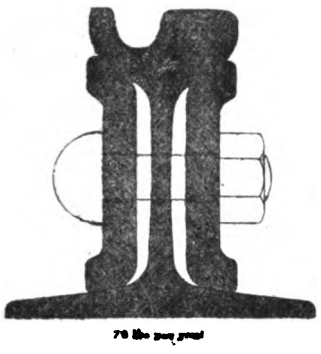

FIG. 1.

FIG. 2.

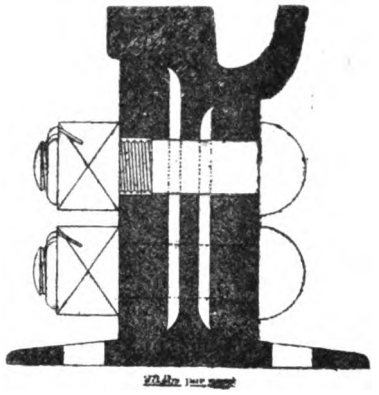

FIG. 3.

Fishplates.—Until recently rails were rolled with a much too obtuse angle at the shoulders, or fishbed. The writer pointed this out in a paper to the Institute of Civil Engineers before the year 1887, and when the Cape Town tramways were laid this suggestion was adopted, and

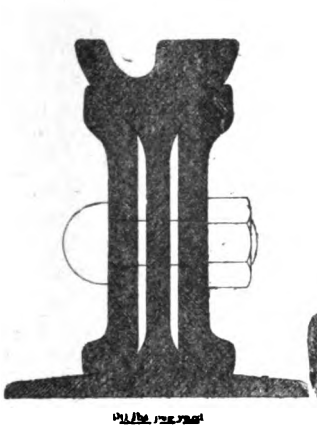

FIG. 5.

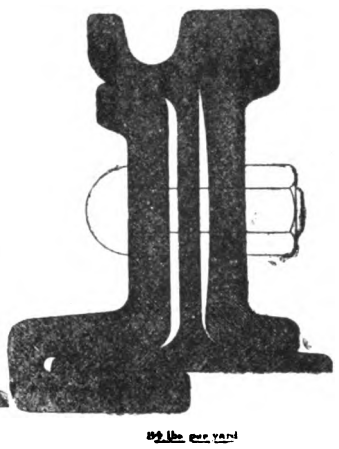

FIG. 6.

a rail similar to Fig. 2 was rolled, but with a narrower tread. This acute fishbed gives a much better support to the rail heads, and prevents the head wedging in between the fishplates. The difference between good and bad fishbeds will be seen by comparing Figs. 2 and 3, and Figs. 1, 5, and 8. No. 5 section was a most popular one, and largely adopted between the years from 1885 to 1895. Fishplates, besides being heavier now, are also used longer, the common practice being to have six 1in. fishbolts to each pair of fishplates. The writer thinks this is an improvement on the old practice of having four bolts, but can see no advantage in putting in more than six.

to prevent the rail ends working into the concrete foundation. This action does not occur, however, until the joint is already loose. These soleplates are nearly all too broad to allow of good, tight, solid packing with concrete, the bottom being broken up by bolt heads (Fig. 8). This section is a better arrangement than the ordinary soleplate, as the bolts pass through the rail and fishplate flanges. The real thing to aim at, in the author's opinion, is good, vertical stiffness, obtained by heavy fishplates with good fishbeds, and a tight, solid concrete bed under the plain rail flange. Figs. 6, 7, 8, and 9 show some angle fishplates and soleplates. They are all objectionable, in so far as they cannot be tightly packed, Figs. 6 and 7 being particularly bad in this respect. Fig. 6 is a development of the "check" joint, but the writer thinks it is not an improvement, and prefers the original Fig. 2 to this or any of the other arrangements.

Points and Crossings.—There has not been any improvement in these, excepting that at the present time the cast steel is somewhat harder by the addition of manganese, first adopted by Mr. R. A. Hadfield, M.I.C.E., of Sheffield. While the steel is harder, this end has been attained at the expense of soundness, the metal being more gassy and the castings rather liable to have a spongy structure. This, however, is not of great importance, provided the tread of the points—that is, the rolling surface—is kept sound and homogeneous for at least $\frac{1}{2}$in. from the skin. Certain American companies are making cast-steel points and crossings with special hard manganese steel filling

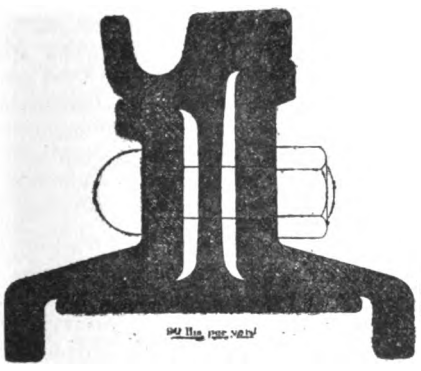

FIG. 7.

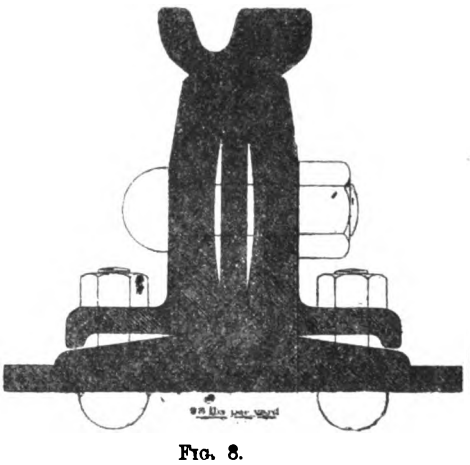

FIG. 8.

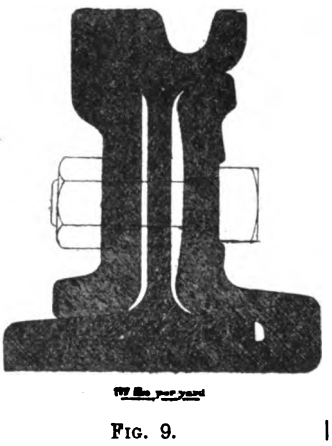

FIG. 9.

pieces where the wheels of the cars drop. They are very clumsy in appearance, and there is a very large surface of metal exposed with consequent danger, owing to horses slipping on them. In 1884 similar points with renewable filling pieces were used in a large steam tramway system in England, and before six months were over the filling pieces were loose. The car wheels dropped from the

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hard filling pieces on to the ordinary cast tread, with the result that the pounding caused a depression where it dropped on the body of the casting. After renewing the filling pieces, naturally this drop was accentuated, and ultimately the points and crossings had to be taken up and replaced by chilled iron and ordinary cast steel. The filling pieces in the American points of to-day are considerably larger and probably better fitted, and therefore may be an improvement, but the writer doubts if they will work properly for as long a life as an ordinary good cast-steel point. He also doubts whether the renewing of the filling pieces can be done and still allow sweet running to the cars. Chilled-iron points and crossings are becoming rarer every day for tramway purposes, and the author thinks this is only due to the makers not making their patterns to suit the heavy electric cars. Considering the fact that the authorities allow a much greater metallic surface on the road than they did, there is no difficulty in chilled-iron points being made with sufficient body of metal to withstand the lateral shocks from the heavier cars. There is no question as to its superior durability to cast steel. Originally, the points were made to the section of the rail used, and the small body of metal was too brittle to stand the shocks.

Foundation.—All tramway permanent way should have a foundation of Portland cement concrete not less than 6in. deep. There are several methods of laying this foundation, and the writer has tried them all. Probably the first method was to lay the 6in. layer as nearly as possible to the levels with a smooth top, and when the rails were laid to run in cement grout into the spaces left between the flanges of the rail and the hollows of the concrete This is a bad method, as it cannot be done tightly enough, and the rail is always bearing on the high points of the concrete. The second method was to get the rails blocked up to their level before the concrete was put in, and then the 6in. layer was put in in one mass, packing it under the rail flanges and finishing it off. This has a serious defect. It is not possible to pack a mass of plastic concrete 6in. thick so as to take the weight of the rails, the result being that the rails are only bearing on the original points of support. If it were possible to get it tight, the lightest tap with a hammer three or four rails ahead will cause vibration and the plastic concrete to sink under the level of the rail flanges. The method the writer has found to be best in every way is to put the 6in. layer in as truly to level as possible, but say 1in. lower than the finished level of the rail flange. After this has set, say two hours after laying, the rails are put in place and brought to a true level by cement packing at the joints and two intermediate places in a 40ft. rail; then two men are put on, one on each side of the rail, and the 1in. space thoroughly packed from both sides of the flanges. This packing should be composed of one part of ½in. shivers, granite if possible, two parts of sharp sand, and one part of Portland cement. It should only be damped slightly for packing, but after the packing is finished it should be well watered with a watering can through a rose. The writer does not float the surface of the concrete, but leaves it as rough as possible to make a bond with the cement bedding for the setts, which he has found to be a great advantage in economy in the maintenance of the paving.

Plastering Rails.—Some engineers are in the habit of plastering up the haunch of the rails with cement mortar. This was tried and abandoned in 1883 by tramway engineers. The writer could never see the object of it, unless it was to save pitch grout. This is not economy. The whole advantage of pitch grout is its elasticity, and it is of the greatest advantage at the joint next the rails, where the vibration occurs. The plastering of the rails most effectively neutralises this advantage, and facilitates the passage of water down the joint and under the paving. This loosens the bedding, and the setts subside and work loose.

Paving.—We have made considerable progress in paving these last 20 years as regards tramways. Pitch grout is now generally used, and is the best of all grouting for tramways. It was, however, used in Lancashire as far back as that time, although it was not known in the south. Its superiority to cement grout for tramways is due to the fact that it is more elastic, and, instead of breaking, yields to the vibration in the rails, and remains watertight. One notable difference is that the setts are now laid as closely as possible, whereas formerly a ¾in. joint was often insisted upon. This was supposed to give a better foothold for horses. The writer does not agree with this theory. With the wide joints the tops of the setts round very quickly, and a horse's foot slips from one joint on to the next, causing a sudden jar to his back tendons, and doing probably more damage to him than would a clean slip. Close joints also mean reduced cost of maintenance and repairs. Granite setts need not be discussed here, as everyone has his own ideas as to the best for street purposes. It may be said, however, that they cannot be too well dressed for tramway purposes, the courses being so short. They should, however, be varied in lengths from 5in. to 9in. Where setts are used nearly all about 7in. long there may be as much as 15 per cent. cut to waste for closers at the four straight joints at sides of the rails. It is very important that the setts should not be too deep, as they should have at least ½in. of bedding between the rail flange and the bottom of the set. Where a tramway is laid in a macadam road, the paving of the margins should be finished at the outside with a straight joint. This greatly facilitates the proper maintenance of the macadam next to the paving and the paved margin itself. The macadam can be rolled right up to the margins. Where the margins are toothed there is always trouble, as the macadam can only be rolled to the outside of the long tooth, and the space between the long tooth and the short tooth is left loose. As a matter of fact, what happens in practice is, that the roller-driver tries to roll into the short tooth by running the roller over the long tooth, thus loosening the setts and breaking the grout. The surface water then gets under the setts, and every passing vehicle rocks the outside setts, thus churning the water, grout, and bedding up, and ruining the marginal paving in a comparatively short time.

Cable Traction.

It is worth while just to mention this method, as notwithstanding the great advance in electric traction there are still routes that should be worked, owing to heavy gradients, by some method which is not dependent on adhesion between the car wheels and the rails. Even on the level, where there is traffic to justify a service of five minutes and under, a properly designed cable installation can be operated at 5·5d. per car mile, including all expenses. The total capital need not be much higher than for an overhead electric installation, owing to the lower cost of the cars. It is not far off the mark to say that, taking equipment and everything into consideration, for a five-mile tramway with, say, a four minutes' service, the total outlay should be about the same for both systems. The first cable line of any importance in this country was the Edinburgh Northern, then the Birmingham Central, then the line from Kennington to Streatham now owned by the London County Council, and the Upper Douglas line, Isle of Man. All these lines have been financial successes. Others at Highgate and Matlock have not been so successful, being so short. The Edinburgh Corporation cable lines, just being completed, have not so far paid their way for several avoidable reasons. This installation is perhaps the most substantial of any that have been made in this country or abroad.

Electric Traction.

Electric traction may be considered the traction of the present day, and excepting where the gradients are so extreme as to require a cable in the interests of safety and economy, the writer thinks it is unnecessary to discuss any other. There are, of course, various methods of adapting electricity to the propulsion of tramway cars, although all of them, excepting the overhead trolley wire, may be considered still in the experimental stage.

Storage Batteries.—Perhaps the earliest system tried on tramways in this country on an entire route was the Bristol-road route in Birmingham. This was until recently worked by storage batteries, and several different kinds of cells have been tried. All these, however, failed to make the line a financial success. This has been owing to several

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circumstances, including the time occupied in charging the batteries, the extreme weight of the cars with batteries and motors complete, and the short life of the batteries themselves. There are, of course, several minor objections, but if a light durable cell can be discovered that can be charged in, say, one-third of the present time, the writer thinks the secondary battery system will supersede all others. This is easily understood, as the track is practically the ordinary horse track laid in a more substantial and intelligent manner, and each car is a unit of power in itself and free to run anywhere that the rails are laid. This admits of great flexibility in a system, and facility of extension. The advent of a suitable primary battery is too utopian for consideration, at the present time at least.

Surface Contact.—The next method in inverse order as to practical application in the writer's opinion is the surface-contact system. This system, as everyone is aware, has studs or contact pieces between or alongside the track rails. These studs are dead, or outside the electrical circuit, until the car passes over them. When the car comes above them an electromagnet operates a switch, which completes the circuit through them and the motors of the car for a sufficient time to allow the car collecting bar to reach the next stud. When the influence of the magnet ceases to act the circuit is broken by the switch, actuated by a spring or gravity, resuming its natural position. Mechanically this system is undoubtedly a success in an exhibition or on a laboratory table, but the conditions are entirely altered in a public road, where there are circumstances which will interfere with the reliable working of the mechanism for switching the current off and on to the studs. The studs themselves are also a defect in the road surface.

Conduit.—The conduit system has yet to prove its financial advantages in this country. It is needless to mention the lines which have been laid and abandoned, as they were neither mechanically nor financially successful, although there is no reason why the former should not be attained. Everyone will be greatly interested in the result of Prof. Kennedy's experiment in the Clapham-road for the County Council. Prof. Kennedy, the writer thinks, has reduced the conduit to the minimum of cost and capacity. As regards the latter, the writer agrees with him, and considers the large conduits used in America unnecessary in this country. Every extra inch in the depth of the excavation involves an unknown amount of expenditure in alterations to gas, water, and drain pipes, thus adding dead-weight to the capital account, which in this system is already heavy enough. The writer wishes Prof. Kennedy all success with this experiment, and hopes the financial results will turn out to be better than the writer expects, as the system has much in its favour compared with the overhead system as regards public safety and amenity. The installation is being carried out in sufficient magnitude to give reliable and comprehensive results, in this respect differing from the others in this country.

Power-House Boilers.—In the modern power-house there are several kinds of boilers adopted, some of the tubular marine type, others of the water-tube type, such as the Stirling and Babcock and Wilcox boilers. These are specially useful where space is restricted, and where a lighting circuit is worked from the same station as the traction circuit. They are quicker in getting up steam, and where there is a combined depôt such as this, the maximum loads come on about the same time of the day, besides the sudden calls on the lighting plant due to fogs, etc. Steam is quickly got up in a spare boiler in this emergency. The thin tubes in these water-tube boilers are, no doubt, the reason of their quickness. They are also considered to be safer, being less liable to total destruction. Lesser accidents are, however, more frequent than in the Lancashire type. They are easily cleaned and readily repaired. In some cases the boiler-room is carried on a floor above the engine-house, and the ease in which their parts are handled is a great advantage in this case. This applies also to a case where a supplementary boiler has to be put into an existing boiler-house in full work. There are, however, many engineers who will, if it is at all possible, adopt the old-fashioned Lancashire boiler with Galloway tubes. The writer has had good results from these, but prefers the Galloway boiler itself as having a higher efficiency, and being quicker than the ordinary Lancashire type. In the Galloway boiler the circulation is most thorough, without the chance of the plate becoming dry, as in the tubes of the water-tube boiler, through forcing the generation of steam. They have a large steam and water capacity, which is all in favour of dry steam. In this respect they stand higher in the tests than any water-tube or tubular boiler. The heating surface is internal, and is very effective. As to the efficiency of the boiler, this has been proved beyond question. While most tubular boilers give 7lb. of steam to about 24lb. of coal per square foot of grate per hour, the Galloway boiler gives between 8lb. and 9lb. This boiler is also easily examined and cleaned, and is comparatively free from accidents of all kinds, and this at a comparatively low up-keep and long life. Another important point in its favour, as in other Lancashire types, is that it does not require such skilled attention as the tubular or water-tube boiler. It is advisable, and is common practice, to have two safety valves on each boiler. There should be a dead-weight valve (which is preferable to a lever one), and also a high-steam and low-water valve. The latter type blows off both for high steam and low water, as its name implies.

Economiser.—An economiser is considered a necessity nowadays, and properly so, to get the highest efficiency from an installation. This was realised many years ago by the Lancashire millowners. They had to bring their minds to bear on the question of cheap production of steam power, perhaps, before any other class of users, and it is to their and Messrs. Green's experiments we are indebted for the evolution of the modern waste gas economiser. The load in a mill is fairly uniform, and when the economiser was admitted to be a saving under these conditions it was readily seen that with varying loads and sudden heavy calls it would be of greater value still in saving time as well as money. There were various difficulties to overcome at first with these economisers, but the Messrs. Green have made a long study of the question and a speciality of their manufacture, with the result that they have evolved a most effective system, that will redeem its first cost in from five to eight years, dependent on the size of the installation. It is being largely used in this country and America in the power-houses of electric tramways, and actual practice shows most satisfactory results, varying in fuel economy from 15 to 20 per cent. The following table gives roughly actual results from Canada and America from reports by the engineer:

—	Feed water — In tank. Deg. F.	Feed water — After leaving economiser. Average deg. F.
Montreal Street Railroad	90	270
South Chicago City	90	219
Detroit Railway	80	246
Douglas Cable Tramways (pressure 96lb.).	46	238

The last, Douglas cable tramway, was erected by the writer, and he made various tests, which were all very satisfactory. One important advantage of an economiser is that it reduces the expansion and contraction of the boilers, thus saving them a considerable amount of wear and tear. There are also several useful exhaust steam heaters, which may be used in conjunction with the waste gas economisers for heating the water before it passes through the economiser tubes. Table 10 shows the kind of boiler, economiser, working pressure, and evaporation results of several existing overhead installations. The evaporation is taken from the coal and steam per indicated horse-power per hour, or per kilowatt per hour, from working results.

Conveyors.—The writer will only mention these in passing. There is no doubt that where there are a large number of boilers with a large consumption of coal, conveyors can be made to pay. In the majority of cases, however, expensive gantries to bring in the wagons, large storage hoppers, etc., have to be erected before the coal gets to the conveyors, and the writer is satisfied that in these cases the capital cost neutralises largely the economy, if any, in the stoking. Careful consideration on the part of the engineer is necessary as to site, consumption, etc., before deciding to put in conveyors.

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TABLE 10.—Boilers.

Name of town.	Type of boiler.	Working pressure per square inch.	Type of economiser.	Water evaporated per lb. of coal.
		lb.		lb.
Glasgow Corporation, Springburn	Babcock & Wilcox	175	None	2·76
Leeds Corporation	Lancashire	140	Green's	3·00
Sunderland Corporation	Galloway	130	Green's	2·75
Dublin United Tramways	Babcock & Wilcox	160	Green's	4·00
Aberdeen Corporation	Babcock & Wilcox	160	None	6·6

Mechanical Stoker.—These—and there are several good ones—have other advantages besides economy of stoking. They are particularly useful in avoiding black smoke, owing to the even firing. They also avoid the cooling of the gases due to the opening of the doors in hand-firing. Most electric traction power stations have mechanical stokers, and, on the whole, they are advisable where first cost is not an important consideration.

Steam-Piping.—For pressure up to about 100lb. cast-iron pipes are used. The modern practice is, however, to work with pressure considerably above this, varying from 120lb. to about 175lb. Steel steam-piping is therefore generally used now. In many cases they are in duplicate. This, the writer thinks, is not necessary, although very convenient for the purpose of making repairs, etc. With steel piping most repairs can be done during the night. Where rigid economy is not absolutely necessary in the capital account, it is well to have the piping in duplicate. With steel piping expansion bends are used, and it is well to have the pipes properly anchored between these bends, so that each bend may take its proportion of the expansion, otherwise too much may be thrown on one bend. All steam-pipes are, or should be, coated with a good non-conducting substance, of which there are several. The writer prefers those made in sections and fixed on with hoops; the section can be easily removed and replaced to admit of repairs to the pipes. It is of course understood that the steam-pipes should be fitted with automatic drainage traps, and that the pipes themselves should have a fall towards the traps for the purpose of collecting the condensed water.

Feed Pumps.—There are now many feed pumps of high efficiency, and it is hardly necessary to discuss in such a paper as this the various types. It is, however, worth remarking that some engineers are rather prone to use the generated electricity for every little purpose, including the driving of the feed pumps. The writer does not agree with this. The pumps are generally, or should be, in the boiler-house, and consequently near the boilers. Under these conditions the proper and economical method is to use the steam direct. They are generally some distance from the generators and switchboard, which is an argument against electrical driving, and lastly, the boiler-house is not a favourable place in which to run an electric motor.

Injectors.—Besides a feed pump, it is useful to have an injector. It can be used when the economiser is under repair, or the exhaust steam heater, as the case may be, and, of course, is better in such cases owing to the fact that the injecting of the feed water raises the temperature considerably. They can also be used to feed through the economiser, which considerably increases the efficiency and durability of the latter.

Engines.—Until about four years ago the usual practice was to have low-speed engines, with the generators geared up from the crank or countershaft, and driven by belts. Later on the generators were driven direct, the armature being keyed on to the crankshaft of the engines. These engines at first were high speed, about 400 revolutions, and were far from economical as regards coal and oil consumpt. Some were single and others double acting, the former, perhaps, being preferable as to wear and tear. Since they were first used there has been a notable improvement in their performance, alterations having been made in their designs and defects remedied. At the present time there are several high-speed closed engines which give satisfactory results as regards economy of working. Table 11 shows the consumpt of steam at different loads of a Belliss and Morcom 200-h.p. compound condensing engine.

TABLE 11.—Trial of Belliss 200-h.p. "Self-Lubricating" Compound Condensing Engine.
Steam Pressure, 120lb. per Square Inch.

Trial No. 1.

Load.	Maximum.	Normal full.	Three-quarter.	Half.	One-quarter.
Mean indicated horse-power .....I.H.P.	217·5	193·6	147·1	102·7	49·8
Mean brake horse-power .....B.H.P.	209·5	186·0	140·6	97·0	44·5
Mechanical efficiency $\frac{\text{B.H.P.}}{\text{I.H.P.}}$ .....per cent.	96·3	96·1	95·2	94·4	89·3
Water per hour per B.H.P. .....lb.	18·0	18·2	18·7	19·8	20·0

Trial No. 2.—*Coupled to Continuous-Current Dynamo.*

Load.	Maximum.	Normal full.	Three-quarter.	Half.	One-quarter.
Mean indicated horse-power .....I.H.P.	—	186·7	129·4	98·2	54·1
Mean electric horse-power .....E.H.P.	—	168·6	115·1	83·8	40·9
Combined efficiency $\frac{\text{B.H.P.}}{\text{I.H.P.}}$ .....per cent.	—	90·3	88·9	85·3	75·6
Water per hour per E.H.P. .....lb.	—	19·2	19·36	20·1	21·92

The efficiency is high, and the consumpt of steam is low for this type of engine. This engine also governs well under extreme variations of load, which will be seen from Table 12, which shows the results of three trials on the City and Waterloo Railway. The writer gives these results of the Belliss engines because he has the records by him, and does not mean to imply that they are the best, although he thinks that for an engine of this type they are satisfactory. Most engineers, of course, prefer a low-speed engine with an effective automatic expansion valve gear, and the problem was set for electricians to construct an effective generator to work direct from such an engine. The first of these large low-speed generators was, the writer thinks, made in Germany, but since then they have been constructed and largely used in America and this country. These engines are generally run about 90 revolutions per minute, and have Corliss, Proell, or other automatic expansion valve gear. They generally are slightly more economical in consumpt, but not invariably so. There are also some very convenient horizontal and vertical compound condensing engines made to run at 200 revolutions, and generators at the same speed, of capacities varying from 100 kw. to 300 kw. The question as to whether the high, medium, or low-speed engines are most suitable for supplying power for an electric tramway scheme requires careful consideration. It can only be answered when the whole of the conditions as to the distributing area, mileage, gradients, service and probable extensions, are known and carefully studied. The units in use should have capacity sufficient to meet

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TABLE 12.—Waterloo and City Railway (Half-Minute Readings).

No. 1 Engine. Date—May 22, 1899. Time—1.11 p.m. to 1.21 p.m. Mean Boiler Steam—160lb. Mean Volts—515. Tach.—384·5. Actual 388.		No. 3 Engine. Date—May 24, 1899. Time—11.50 a.m. to 12 noon Mean Boiler Steam—170lb. Mean Volts—512. Tach.—388. Actual 385.		No. 4 Engine. Date—May 24, 1899. Time—8.14 a.m. to 8.24 a.m. Mean Boiler Steam—155lb. Mean Volts—520. Tach.—381. Actual 391·5.	
Amperes.	(Tach.) Speed.	Amperes.	(Tach.) Speed.	Amperes.	(Tach.) Speed.
300	381	95	387	60	380
310	381	95	387	180	378
330	380·5	60	387·5	165	379
80	383·5	110	386	180	378·5
50	384	150	385	190	378
85	383	250	384	200	377·5
50	384	255	384	130	380
50	384	265	384	75	380
150	382	165	385	140	378
130	382·5	200	386	60	380
145	382	240	385	80	380
110	382·5	110	387	85	379
110	382	100	387	220	376
165	381	60	387·5	180	378
210	381	60	387·5	170	378·5
265	380	110	386	210	377
300	380·5	230	386	230	377
312	380·5	120	386·5	255	376·5
330	380	70	387·5	280	376
140	383	50	387·5	110	379
70	384	50	387·5	200	378

Note.—Deviation from mean speed less than ½ per cent. for any variation of load under actual working conditions.

all ordinary fluctuations of load due to extra heavy traffic. Of course, there must be one unit at least as a stand-by under ordinary circumstances, and also to act as an auxiliary for extra power during heavy loads during snowstorms, etc. The writer is of opinion, therefore, that it is better to divide the total ordinary load (with, of course, a margin for fluctuations) into two, and to have three units of this capacity. These two units would be in daily use, and the third would form a reserve. It must, of course, be taken into consideration that there may be future extensions and consequent increase in the ordinary load, and therefore due weight must be given to this in fixing the capacity of the units—that is, whether to divide them to suit the prospective or first load.

(To be continued.)

ELECTROLYSIS AND AMERICAN ELECTRIC TRAMWAY PRACTICE.

BY OUR SPECIAL CORRESPONDENT.

In connection with the recent proposals for the modification of Clause 7 of the Board of Trade Regulations under the provisions of the Tramway Act, the almost criminal negligence of our American cousins in the matter of track-return drop seems hardly credible. In comparison with our modest limit of seven volts, which many experts consider too high, a 50 or 60-volt track-return drop is quite a common occurrence on American trolley lines, and the use of negative boosters quite unheard of, in spite of the fact that electrolytic destruction of underground pipes is taking place with alarming rapidity.

Taking as an example the case of the Brooklyn trolley system, the following facts may serve to show the charming disregard for the public good displayed by engineers on the other side, who are practically uncontrolled by legislation.

The famous Brooklyn Bridge, about the safety of which there was some stir a few weeks since, is without doubt being secretly and rapidly weakened by electrolytic action at the anchorages, owing to the hundreds or perhaps thousands of amperes of track-return current continuously carried across from New York to the Brooklyn power station by the four large steel suspension cables, the ohmic resistance of which must be infinitesimal compared with that of the tracks as constructed.

Another instance is the unusually heavy return current which takes a short cut from the centre of the Brooklyn tramway system to the power-house by way of the United States Navy Basin, the potential difference between the two banks being so great that warships, anchored in certain positions, have their plates seriously affected. The gas and water companies are powerless in the matter, and the tramway company, with its overhead mains, being unaffected, there appears to be no remedy for this state of affairs. The Brooklyn Edison Company have recently laid some 6,000-volt lead-covered underground cables, and have bonded their lead coverings to earth-plates at frequent intervals. In several instances the heavy lead bonds have been found dangerously hot through the share they have been bearing of the track-return currents, and in some cases they have been disconnected altogether. How long will these lead-covered cables last under such adverse conditions?

But electrolysis is not the only trouble caused by the heavy earth currents wandering about under the city of Brooklyn. The telephone company also suffer by having their low ringing voltages seriously upset. In one case on record they have actually disconnected their own source of energy and utilised the tramway difference of track potential instead.

In England we are sometimes tempted to grumble at the somewhat onerous restrictions imposed on electrical enterprise by the Board of Trade regulations, but although our progress is perhaps a little impeded by them, they at any rate have the effect of making British work *thorough*, which cannot be said of the outdoor work of our American cousins.

WORKSOP ELECTRICITY WORKS.

The Urban District Council's electric lighting works were opened on Tuesday by the chairman of the Council, Mr. J. T. Shardlow. The works are situated close to the canal and to the Council's depôt, and present a quite formidable appearance, there being left plenty of space inside for extension of plant, which, judging from the number of applications already received, will not be long in being required. Mr. A. B. Mountain, M.I.E.E., of Huddersfield, was the consulting engineer. At these works, which are being worked on the three-wire continuous-current principle, the plant consists of three direct-coupled dynamos—two of 100 kw. and 160 h.p. and one of 150 kw. and 240 h.p. These were supplied by Messrs. Witting Bros. The engines were made by Messrs. Scott and Mountain. There are two boilers by Messrs. E. Danks and Co., Birmingham, each 30ft. by 8ft., capable of working at 125lb.

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pressure. A very fine switchboard by Messrs. Clayton and Co., Huddersfield, occupies part of the well-lit and lofty engine-room; 240 E.P.S. accumulator cells, with a maximum capacity of 70 ampere-hours, are placed in the accumulator-room. The British Insulated Wire Company laid the mains, and Messrs. Carter, of Stalybridge, supplied the steam-piping, exhaust piping, and condensing plant. At present there are 31 Stewart arc lamps and 2,000 8-c.p. incandescent lamps installed. The total capacity of the plant equals 6,600 8-c.p. lamps, reckoning the large machine capable of 5,000 8 c.p. as reserve. Forty-nine consumers are already connected, but a total of 72 applications has been received, accounting for another 1,600 8-c.p. lamps. Three applications for motors have been received. Mr. W. Hall, of Worksop, was the contractor for the building. The total cost of the scheme amounts to a little over £15,000. Mr. J. P. Crowther has recently been appointed resident engineer and Mr. Cyril R. Heron as secretary. It is proposed to charge 6d. per unit for lighting and 2d. for energy. There will be no free wiring.

The inauguration of this supply, virtually the first of its kind in the county, caused unusual interest in the surrounding districts. Amongst representatives from a large number of small towns, all on the eve of erecting works, or at least having obtained provisional orders, we noticed the mayors of Mansfield, Retford, and Newark, and councillors from Chesterfield, Gainsborough, and various other places, who all stated that they were watching the career of the Worksop works very closely. Mr. S. E. Fedden, the city electrical engineer of Sheffield, also came over to witness the proceedings. On Tuesday afternoon quite a large number of gentlemen assembled at the works, to find the resident engineer, Mr. Crowther, with his coat off, as busy as could be. They were at once pounced upon by Mr. Heron, the secretary, and deprived of their metallic substances in the shape of their watches to prevent the magnetisation of the latter. Punctually at 4.30 the chairman of the Urban District Council, Mr. Shardlow (who was presented by Mr. Mountain with a gold key bearing the emblems of the five dukes whose estates lie in the Dukeries around Worksop), welcomed the visitors. Councillor J. Thornton, J.P., a retired engineer and former chairman of the Council, then started the first engine and Councillor S. Box switched on the current. Mr. A. B. Mountain, the consulting engineer, then gave a short description of the station. He said that there was room for two additional boilers in the boiler-house, and for two more dynamos and engines capable of supplying an equivalent of 5,000 8-c.p. lamps each in the engine-room. The present plant consisted of one dynamo of 5,000 8-c.p. and two of 3,300 8-c.p. (each) capacity. The accumulator battery, which was capable of supplying 500 8-c.p. lamps for 10 hours, was only to be used for balancing, and would take the load only in cases of emergency. About 4,800 yards of mains had already been laid; they would carry a current of 440 volts on the outer and of 220 volts between the inner and outer wire. The visitors were then conducted around the building.

At 6 p.m. a somewhat larger party than the first met at dinner at the town hall at the invitation of the chairman of the Urban District Council. A very effective temporary supply of electric light had been laid on, which continued bright and steady without the slightest hitch during the whole of the evening. The toast list was rather a long one. "Worksop's Electrical Undertaking" was proposed by Mr. A C. Eborall, M.I.E.E., who laid particular stress upon the fact that the system just installed was particularly adapted for the supply of energy for motor power, and he also described some of the advantages to be gained by the installation of electric motors. The Chairman having in very complimentary terms proposed the toast of "The Consulting Engineer," musical honours were forthcoming, and Mr. Mountain rose to respond. He gracefully acknowledged the value of the work done by the resident engineer and the staff, the contractor, and especially the assistance of the Council's surveyor, Mr. Whittel. Other speakers were the Mayors of Retford, Mansfield, and Newark, Councillors J. Thornton, J.P., S. Box, Clark, Jones, and Dougall, Mr. C. E. Daffen, Mr. Sydney Smith, J.P., Mr. J. P. Crowther, and the secretary of the Urban District Council (Mr. Geo. H. Featherston), who supplied some very interesting Worksop statistics. The health of the chairman, proposed by Councillor Ilkett, very enthusiastically received and kindly acknowledged by Mr. Shardlow, brought the meeting to an end, after which all filed out to admire the well-lit streets and shops of the town.

JAMES BOWMAN LINDSAY.

On Saturday last Sir W. H. Preece unveiled an obelisk erected to the memory of this celebrated citizen at Dundee, and subsequently delivered an address to a distinguished company. We have room only for the following abstract, but must commend the citizens of Dundee upon their recognition of a celebrated thinker whose name will ever be connected with the history of their city.

Sir W. H. Preece said: Mr. Henderson, ladies, and gentlemen, I have just performed at the cemetery a most interesting operation—the unveiling of a monument to James Bowman Lindsay. Lindsay was long before his time. We heard this morning that he was a prophet that would compare with any of the prophets of old. Without in any way treading on dangerous ground—the ground occupied by the pulpit—I must say there is nothing in all scripture that is so marvellous, so clear and so well defined, and so precise as the prophecies uttered by James Bowman Lindsay in Dundee. The first was contained in an advertisement inserted in the *Dundee Advertiser* just two months after I was born. I was born in February, 1834, and on April 11, 1834, this marvellous prophet said: "Houses and towns will in a short time be lighted by electricity instead of gas, and heated by it instead of coal, and machinery will be worked by it instead of steam." I am not a lady—I acknowledge my age—and I am not ashamed to say that I am nearly 68; and here I am at this very moment now carrying out these suggestions of James Bowman Lindsay in every quarter of the world. The only thing which he proposed that I am not doing is that I am not using electricity for heating instead of coal, but I have a neighbour at my place in Wales who has a charming river passing through his grounds and a pretty fall. He is using that water to supply current to his house, and since he has utilised that water he has never required to buy a single pound of coal for the work in his house—cooking and warming are done by electricity. It is something to anticipate that we are not to be altogether dependent on coal in the future; but at the same time I am bound to say that at present in England our only source of electrical energy is coal, because there, unfortunately, we have no waterfalls. When we want water power we have to come to the Highlands, and then the amount of capital to be expended in utilising water is so great that it is cheaper to pay for coal for the generation of energy. One distinguishing feature—a typical feature—in the case of the Scotsman is that he is a man characterised by extreme modesty. It was Lindsay's modesty that kept him quiet indoors, that prevented him from lighting his light in public. His light was lighted inside a bushel. I want to assert that the chief reason that Scotchmen get on so well and are so distinguished is that on the subject of good education Scotland has been 200 years before the world. John Knox, when he asserted the doctrine that every man, woman, and child should be able to read and write, and when he established the parochial school system, laid a foundation of education which has been followed by this country, and by no other country until within the present generation. I do not say that Scotland is now before the world in education, but she has got some things that they have not got—the bursaries that are within the reach of nearly everyone, and that enable a poor boy to go to the university, and there obtain a degree. How many of those like David Livingstone, a poor weaver, or like Lindsay, were able, despite the penury of their parents, to go to school and acquire that knowledge that was of so much value? Again, the low fees of your universities enable this to be carried out in a way that is impossible within my

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experience in any other country in this world. But it is not the education of the boy that leads so much to the credit of Scotsmen; it is the education of the girl. It is the education of the mother; it is the accomplishments of the mother that react upon the boy, and are the real cause why Scotsmen are so much in advance of other countries. Then, again, in public schools it is not merely book knowledge, it is not merely the pursuit of languages, it is not even mathematics, or Latin, or Greek, or anything else that is so useful in after life. The true education of the boy is not in the schoolroom; it is in the playgrounds, where at games he learns discipline. Thus it is that both in the schools and in the fields boys are inculcated with desires and ambitions. It was enthusiasm of a similar kind that carried Lindsay over years of want through difficulties and through troubles until at last he died a pensioner of the Government—died full of enthusiasm for the future, after having done a magnificent work. There is no name that will shine in science more, perhaps, than that of James Bowman Lindsay when the true facts which are brought out to-day will be more widely promulgated. Now, I am a link with the past. His first prophecy, as I told you, was given out in the year that I was born. In 1851 I commenced my electrical career. I learned my electricity at the feet of Faraday. I entered the office of a very distinguished engineer—Mr. Edwin Clark—and he was appointed engineer to the Electric Telegraphs Company. I was attached to the engineering department, and there came up from Dundee a gentleman with a proposal to dispense with wires and to communicate across water. I was attached to Mr. Lindsay, and I made all the arrangements. I conducted all the experiments to illustrate his system in London. I was with him for two or three days, but, unfortunately, having to see so many people during my career, I cannot carry with me the slightest recollection of his personal appearance, and very sorry I am for it. But I do remember his enthusiasm; I do remember distinctly the deep insight he had into the theory and the character of electricity; and I remember well the conversations we had, and how, by a kind of electrical contact, he imparted to me a good deal of his enthusiasm. Unfortunately, it happened that there really was no necessity for the invention in those days. An invention to be of use must come at the proper time. There must be a want for it, otherwise it lies fallow and dies. That is the case with a great many. But it is very rare indeed to find an invention like wireless telegraphy coming to the front again. Wireless telegraphy, however, has been extremely fascinating, and has attracted a great deal of attention. In all these inventions and their application—and you know how many of them were shadowed forth by Lindsay (in 1845 he invented welding by electricity, and it has come greatly to the front in recent years—in Boston I saw them welding tramway rails by electric current)—there are three elements you must bear in mind. You have the philosopher, who elicits the facts from nature, who discovers new truths and establishes them as the basis of science. This gentleman philosopher is a kind of nominative case to the verb to know. Next you have the engineer. The engineer often finds the facts out for himself because no philosopher has been working in the same field, but he generally adopts the discoveries of the philosopher—he applies them to the wants, the efforts, and the purposes of man, and he then constitutes himself the nominative case to the verb to do. Then there is a very important gentleman who comes in in the third place, without whom we can do nothing, and he is the capitalist. The gentleman who finds the money is the nominative case to the verb to go, for without him we cannot go, although very often we aid him in making his money 'go.' We do want these three elements together. Science is like the principle of education I referred to in the early part of my remarks—it is the fascination of science, it is the fascination of new appliances and works, that makes all things spin and go, and I am sure that this system of wireless telegraphy which is now so intimately associated with the name of Lindsay has caught on principally through the fact that the Press have taken such notice of it and have brought to the knowledge of the public the interesting facts we read of from day to day—for example, that the news of the assassination of the President of the United States was read on board one of the "Cunard" ships nearly 100 miles before it reached the shores of America. Wireless telegraphy is producing a considerable amount of interest in the progress of science. I am not sure, however, that it is going to do much good, for nothing does very much good in this world unless it has the property of making dividends for the capitalist, who is employed by the engineer to enable him to spend his money. You must have a thing pay before it goes on. Look at the telegraph and the splendid progress it has made in this country. There is no system of telegraphs in the world to compare with our own, and there is no system under Government management more abused. When a thing is done well it is abused well, and the Government and its departments are quite accustomed to that sort of thing. But telegraphs, railways, Röntgen rays—all these branches of science which are being applied—are creating a species of education above the ordinary education in the mind of the British public, and you will, all of you, in spite of yourselves, become philosophers. You cannot help it. Now, there is a fourth and a last point, and that is, that without the capitalist, without the engineer, without the philosopher, there is something that makes us all hum occasionally, and that is patriotism—that patriotic feeling that we are proud of those who have been amongst us or about us, who have done something to make two blades of grass grow where one grew before and to shadow forth prophecies of what is to come. Now, in London, where I principally live, there is a total absence of patriotism. We have had great and distinguished authorities and scientific swells in London—Faraday, for instance. There is not a monument to Faraday in London; but come to Dundee, and here you find that pride in the celebrity of your fellow-townsman has induced you to put up in the Western Cemetery an extremely handsome and beautiful obelisk to perpetuate the memory and the work of your great townsman. I am proud that I have taken a part in the unveiling of that memorial, and I am glad that I have been able to say these few words about the work he did in his day.

CATALOGUES RECEIVED.

The fifth edition of Cox-Walker's catalogue of telephone apparatus has just been issued.

From Messrs. Jessop and Appleby Bros., Limited, we have received their latest catalogue of electric cranes and hoisting machinery. Incidental reference is also made in the pamphlet to the electric installations of various types and capacities which have been designed and carried out by the firm.

A postcard from Messrs. Royce, Limited, of Manchester, bears a good illustration of a couple of type "A" motor-starting switches as made by them. Strong and durable construction is among the special features of this type of switch.

The British Thomson-Houston Company, Limited, have issued their pamphlet No. 109, which deals exclusively with the British Thomson-Houston alternating-current generators. An excellent view of these machines as installed at the Croydon electricity works is presented with the front page.

The usual monthly General Electric progress sheet for August has reached us. The "Fibrophor" insulated staples, with the use of which there is no danger of cutting the insulation of the wire, as there are no sharp edges to damage it, is given first place. Among the other articles illustrated are continuous action and polarised relays, fittings for "Union" conduit and automobile accessories.

The Western Union Telegraph Company, of New York, are issuing a booklet in connection with the semi-centennial of its organisation, which occurred on April 8 last. It consists of a brief sketch of the growth of the company during the 50 years of its existence prepared by the secretary, Mr. A. R. Brewer. The booklet is handsomely illustrated.

APPOINTMENTS VACANT.

Electrical Engineers, Hackney Borough Council, £400 per annum, Sept. 23. Full particulars in our advertisement columns. Dewsbury Town Council, £350 per annum.

Switchboard Attendant, Perth Corporation Electricity Works, 25s. per week, Sept. 28. Full particulars in our advertisement columns.

Electrical Engineer and Manager, Southampton Corporation, £500 per annum, Sept. 30. Full particulars in our advertisement columns.

Chief Assistant in the Bradford Meter and Motor Department, £2 per week. Full particulars in our advertisement columns.

Traveller for Southern and Midland Counties for electric lamps accessories, motors, etc. Full particulars in our advertisement columns.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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LINDSAY.

More than two years ago Mr. J. J. Fahie—that indefatigable antiquarian in all matters electrical—contributed to our columns a brief account of the work of James Bowman Lindsay, of Dundee. Since that time, owing to the initiative of Mr. A. H. Millar and Sir John Leng, M.P., an obelisk has been erected over Lindsay's grave. The necessary funds were raised by public subscription, and the ceremony of unveiling the obelisk took place on Saturday last in the presence of a numerous company assembled to testify their appreciation of the merits of a man whose experimental work and knowledge enabled him to graphically foretell the position which applied electricity would take in the world's progress. Lindsay was born in 1799, and so was but a babe when Davy initiated experiments in electric lighting which were destined to make the later years of the nineteenth century the commencement of a new era in the history of artificial lighting. Davy's work attracted the attention of Lindsay when quite a youngster, for we find him early in the thirties possessing a far-sighted idea of the ultimate value of electric lighting, and evidently fully alive to the capability of parallel working. But we need not enter into fuller details of his work or of his prophecies; these will be found in the articles we have above referred to and the eulogy uttered by Sir W. Preece in the Technical Institute Dundee, where the company assembled after he had performed the unveiling ceremony. It is the way of the world that many people, so to speak, are born before their time—their work is in advance of the age in which they live, and can only be appreciated by future generations. Sir W. Preece rightly classified men as thinkers, doers, and goers, the ability to go being dependent upon the willingness of capitalists to find the money wherewith to proceed. Now, capitalists are a chary race—they care as much for scientific thought and experimental results as they do about land in the moon, unless careful investigation shows there is a great probability of obtaining a large percentage upon the money expended. They want to see a thing proved before they invest, or if they are of the promoting order want to see other folks speculate while they remain quiescent. Lindsay seems to have been a good thinker, a good experimentalist, but not a good business man; therefore, his ideas were never carried to maturity, nor did his experimental work fructify to any practical application. He satisfied himself that his views were correct, and troubled little further in the matter. Under other conditions of life, such a brilliant thinker would have had a world-wide fame, but he died almost unknown among men of science, though loved and honoured by those around him, who knew him best and appreciated his great talents and singleness of heart. In referring to the appreciation of Lindsay by some, at any rate, of the townsmen of Dundee, we cannot help emphasising the general forgetfulness of the British race. The labours of scientific men and of engineers meet with little or no recognition unless those labours result in getting great wealth; then the men are recognised, but not for the benefits they confer upon the world, only for the money they possess. The only measure of recognition is usually proportional to the amount of income. Faraday, Tyndall, Huxley, Darwin, are names of men of science; they are names almost forgotten by the multitude, only remaining a sacred memory among students who specialise in scientific work. It is therefore gratifying to see Dundee endeavouring to perpetuate the memory of a man whose work, modestly performed, will live in the history of applied science. Like Faraday, Lindsay sought to obtain facts, leaving others to propound theories or to apply those facts;

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and such men are really the salt of the earth. Their work lives, and though others obtain pecuniary reward, probably these great thinkers, these great workers, would be more than satisfied to find their honest labours duly appreciated by those who can understand their full value in the economical working of applied science.

HIGH-SPEED RAILWAY CAR OF THE ALLGEMEINE ELEKTRICITATS-GESELLSCHAFT, BERLIN.*

BY O. LASCHE, BERLIN.

(Concluded from page 384.)

4. *Brakes.*—The system of electrical braking with the aid of the motors was also tested by means of the same experimental arrangement that had been constructed for testing the starting apparatus. The car is equipped with a Westinghouse compressed-air brake, divided into two parts for each of the two bogies. The compressed-air cylinders are operated from the front driver's platform. The brake pressure is assumed to be very high, 170 per cent., because the coefficient of friction between the brake block and wheel at the high speed employed (above 50m. per second) is materially different to that at the usual lower speeds. In consequence of investigations that have been made, an appliance has now been devised for decreasing the brake pressure at a gradual slow speed. Notwithstanding the fact that to a certain extent the brake arrangement of the one forms the reserve for the other bogie, it was not considered admissible to dispense with a second brake. This additional braking action was imparted by the motors themselves, and not by special rail brakes or similar less approved apparatus. The braking or retarding action can be effected by means of an electromotor in one of two ways; either by eddy currents—namely, by energising the field of the motor with continuous current and short-circuiting the armature—or by reversing the direction of the rotation field. Both kinds of brakes are used in the high-speed car. After the armature circuit is opened by opening the outlet valve of the liquid starting device, the field is cut out and switched on to a storage battery placed within the car, or reversed to opposed current, with two of the three phases reversed, the series arrangement of the phases being changed from 1, 2, 3 to 1, 3, 2 and 3, 2, 1 respectively. After the switching has been effected in either way, the armature circuit is gradually closed again—*i.e.*, the inflowing liquid makes contact under very great resistance, and the level of the liquid is then raised or lowered according to the amount of braking action that may be desired. Braking by means of counter current alone did not appear to be sufficient, because the current was apt to fail for some reason or other, as, for instance, by the melting of a safety fuse at the very moment when the brake was applied. The use of a counter current has a further disadvantage. In consequence of the electrical construction of the motor and the potential of about 430 volts selected for the field, the armature has an electric pressure of about 325 volts on open circuit. After the reversal of the field, the tension in the armature increases at full speed to almost double this amount—viz., to about 650 volts. Although the liquid starting device is intended for this voltage and the motor armature is also fully capable of sustaining it—it was tested at 4,000 volts—yet it appeared unwise to allow the safety of the braking action to be dependent on an unusually high voltage just at the time when the brake is brought into action, and when there is a possibility of danger. These were the reasons which led to the provision of an eddy-current braking system, and for this purpose there were two entirely separate storage batteries, corresponding to the two separate air receptacles for the Westinghouse brake. It is here assumed that motor braking must be made use of at high speeds, and that the air-brake is only applied at the end of the run. For shunting service, a hand brake is provided to act on the front bogie.

5. *Trolley Bows.*—The current is led to the three vertically superposed wires, from which it is taken into the car through bow-shaped collectors. By this system of taking the current, in which a deflection of the trolley wire between the connecting points does not affect the bow, the jumping of the latter is more readily avoided than if it made contact from below. Notwithstanding this fact, the question of the trolley bows had to be very carefully studied, and although the requirements for a speed of 50m. to 60m. per second could only be very incompletely complied with, an experimental arrangement was nevertheless made. Three arms are arranged on the roof at each end of the car, one for each of the three phases. The distance between the arms is determined by the space required by the bows when being turned around their vertical axis. These distances are, however, made as small as possible, and the arms are located close to the pivots of the bogies, so that there may be no material change of the distance to the wires in passing around curves. Two systems of bows were considered necessary, so that in the event of one bow failing to act, the current would be taken from the other, and no sparking would occur. Further steps were then taken in the direction of increasing the number of contact surfaces, and of reducing as far as possible the mass of the metal which has to slide along the wires. A number of aluminium bows were connected to the trolley pole by plate springs of different lengths. The object of this elastic arrangement was to ensure a good permanent bearing on the wire; but in the event of one bow failing to make contact, the others must be sufficient to carry the current. In the event of greater deviations of the conducting wire taking place, the main spring arrangement of the whole arm will begin to act. Further particulars are contained in that part of the description which treats of the manner of taking and supplying the current.

* Paper read in Section IX. of the Glasgow International Engineering Congress.

PART II.—DESCRIPTION OF THE CAR AND ITS ELECTRICAL EQUIPMENT.

6. *The Body of the Car.*—The car specially constructed to suit the electrical equipment was built by the firm van der Zypen und Charlier, of Cologne-Deutz, to accommodate 50 passengers. The over-all dimensions of the body of the car (including the apparatus compartment and driver's cabs) are 21m. (69ft.), and the distance between the buffer plates 23·10m. (72¼ft.). The full width of the car is 2,600mm. (8ft. 6in.). The body of the car is within the standard profile throughout its length, but (especially in the middle part with its wide air-ports) there is not much margin to spare in this respect. The windows of the car are closed, ventilation taking place through the side windows of the lofty skylight. On either side, at the end of the car, doors are provided to allow of the entrance and exit of the passengers. The driving platform is separated from the passengers' compartment by a wide partition extending from the bottom to the top of the car and serving as a back support for the driver. At the sides of this partition are grated doors which, during stoppages at stations, are arranged in such a manner that the compartment remains shut off from the passengers, without interfering with the free access of the latter to the interior of the car. During the run these doors are so adjusted that they prevent the passengers both from reaching the exit and from disturbing the driver. The car is divided into two compartments by that containing the apparatus. The passenger can, however, freely pass from one compartment to the other, even when the car is in motion, as the apparatus compartment is protected in the same way as the driver's platform. Any portion that is liable to be touched from the gangway either does not carry current or is suitably insulated. As will be seen in the chapter devoted to the arrangement of the cables, neither the passenger compartments nor the driver's platforms are under current. The trolley bows on the roof of the car are fitted with two insulators connected in series, each of which is tested for a potential of 20,000 volts. The high-tension current passes from the bows to the transformers through high-voltage cables, which, in spite of their having been tested for 20,000 volts, are laid in high-tension insulators. Between the so-called apparatus compartment and the passenger compartments, and also between the latter and the transformers which are suspended below them, there are air-shafts, which form a double-walled enclosure. The storage batteries alongside the transformers are likewise separated off by double-sheet metal walls. The body of the car in its present form is not of the shape that would be expected for a vehicle running at a high speed. The car is slightly curved at the front, and not formed with a slope like the prow of a ship. The statements concerning the experiments which were made in this respect are contradictory, although they prove that a sloping arrangement is of no advantage. One object of the experiments about to be made is to clear up this point, and to ascertain the variation in the consumption of power at different speeds and when the car is exposed to head or side winds. A suitable screen can be constructed at any time.

7. *The Bogies.*—The two bogies which carry the body of the car are 13·3m. (43ft. 7in.) apart. The diameters of the wheels were assumed to be 1,250mm. (49·2in.), which allowed for a sufficient turning movement of the bogies below the car, without necessitating any alteration in the floor level at any part of the car. Each of the bogies has three axles, the two outer axles carrying the motors, while the middle axle allows the necessary space for the pivot and for the air-cylinders of the Westinghouse brake. The distance between the wheels measures 2 × 1,900mm. (12ft. 6in). Fig. 21 shows one of the bogies and the arrangements of the motors within it. The load for each axle is less than the maximum allowable, and amounted to a little over 14 tons. No springs bearing against the body of the car are provided. The bogies themselves are supported on the axles by two sets of springs; and each axle box carries a strong plate spring, to the heads of which are attached supporting springs carrying the frame. On these axle boxes rests the shoe of the axle springs; plate springs are provided to carry the motor. The connection between this spring and the motor frame is established by a curved block, against which the spring bears. By means of these shoes the spring action or its degree of elasticity can be varied. For the first few millimetres it acts as as a very mild spring, then it gradually becomes more rigid, and at a deflection of 8mm. to 10mm. it is quite stiff. In the almost impossible event of these strong springs breaking, the motor would be supported by the wheel axle with the interposition of a suitable metal packing, placed close to the side of the wheel hub. The conditions to be observed in the selection of material for this packing were that the material should be sufficiently soft to protect the axle and hollow shaft, yet of sufficient resistance to bring the car to a standstill before serious damage could be done. The motors are firmly screwed to a frame formed of rolled plates riveted together, and are protected against lateral movement by guide blocks, which bear against a corresponding guide on the frame of the bogie. The stator is prevented from turning round by bars which only allow of a vertical movement of the motor (Figs. 22 and 23). The transmission of the power from the motor to the wheels is effected, as already indicated in Part I., by an elastic coupling which is entirely independent of the bearing.

8. *The Motors.*—Each of the eight motors is adapted for a normal output of 250 h.p. and for a maximum output of 750 h.p. The speed of the motor is about 960 revolutions per minute, which corresponds to a car speed of 225 km. (140 miles) per hour. The tension of 12,000 volts, at which the current is supplied from the overhead wire, is reduced in the transformers to 435 volts. This voltage was adopted so as to permit of the motors being constructed with the bifurcated winding shown in Fig. 5. Although the motor, as above stated, is not subjected to severe

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mechanical shock, it was, nevertheless, deemed advisable, to ensure permanent safety in working, to have only one single bar in the separate grooves instead of a number of wires insulated from each other by cotton covering. The insulation of the bars from the iron is effected by closed micanite tubing. The armature winding (at the tension of the regulating apparatus), like the field winding (transformer low-tension) is also bifurcated (Fig. 24). For sake of convenience in the starting apparatus and the arrangements of the cable, the armature was wound for only two phases, and not, as is usual, for three phases. The stator (Fig. 25) by means of two bearings, carries the hollow shaft on which the rotor is built up. One of these bearings (Fig. 26) carries on its upper half the brush gear for making contact with the slip rings, and the connections for the cables of the armature circuit which lead to the regulating apparatus. The cables of the casing circuit are passed through the other bearing. The bottom halves of the bearings can be easily removed to allow of the removal of the brasses, and to give free access to the brush gear. In Part I. particulars were given as to the requirements to be fulfilled in arranging the journals for the hollow shaft. Fig. 25 indicates this construction and shows the method of oiling the bearings. The level of the oil is so regulated that when the motor is in full work, the disc which has to lift the oil dips into it to a depth of 30mm. to 40mm.

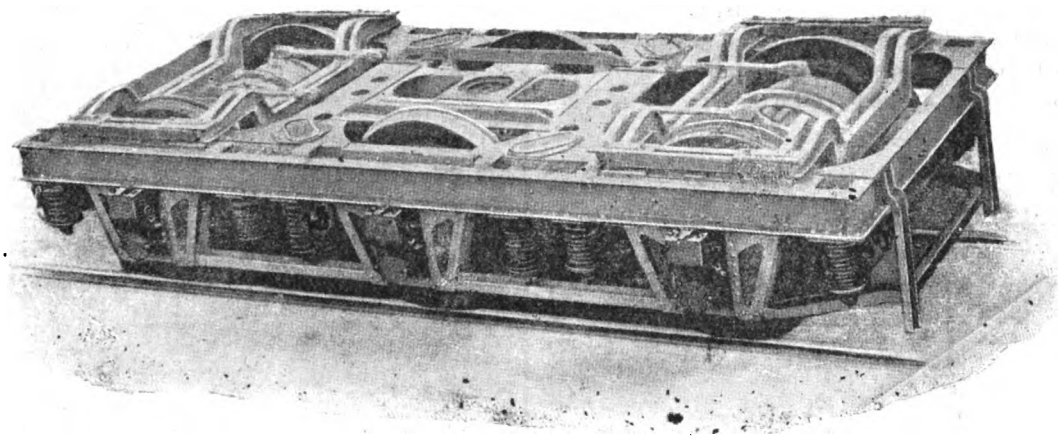

Fig. 21.

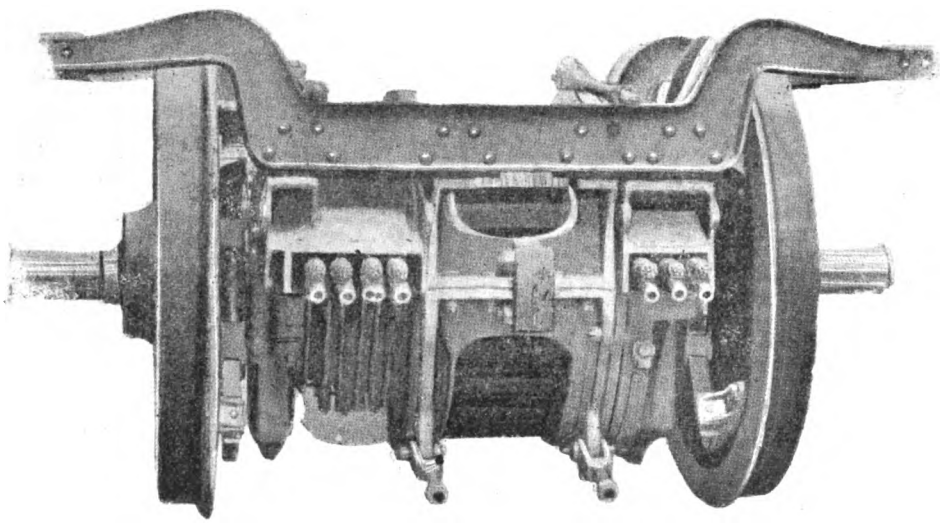

Fig. 22.

The material used for the bearings is the white-metal alloy usually employed on the Prussian State railways; nickel steel was adopted for the hollow shaft, both on account of its polishing capacity and of its great strength. The radial distance between this hollow shaft and the axle is 30mm. (1·18in.). As above stated, copper rings are forced into the hollow shaft at both ends close to the hub of the wheels. The hollow shaft is prevented from lateral displacement by one of the motor bearings, a guide is used against only one

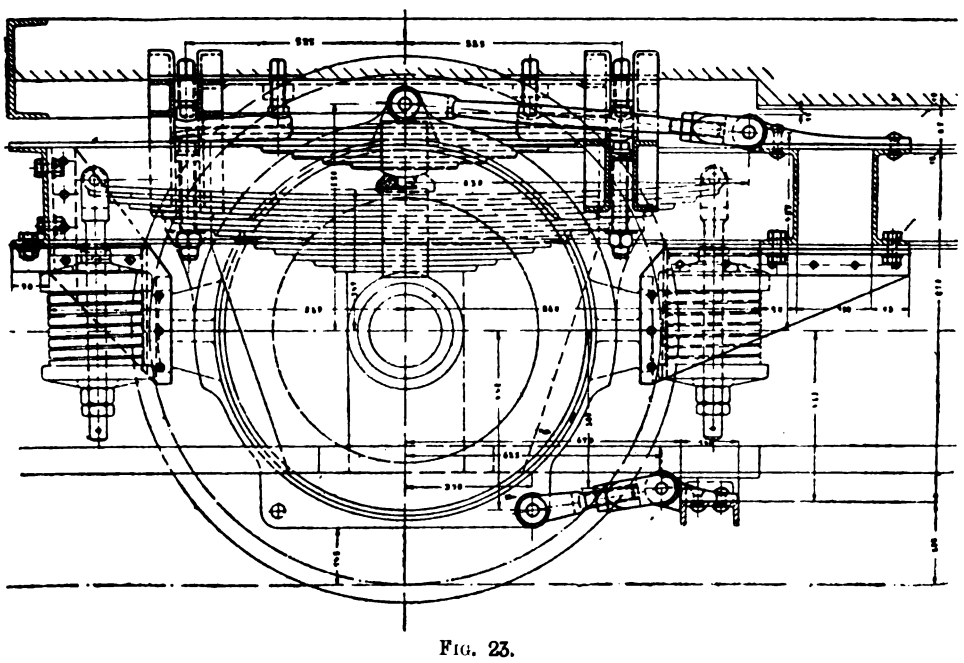

Fig. 23.

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of the bearings, so that expansion due to heating of the material may not produce binding between the axle and the bearing. The spring couplings are fixed to the hollow shaft at both ends. The object of this coupling (Fig. 27) was to transmit the power developed by the

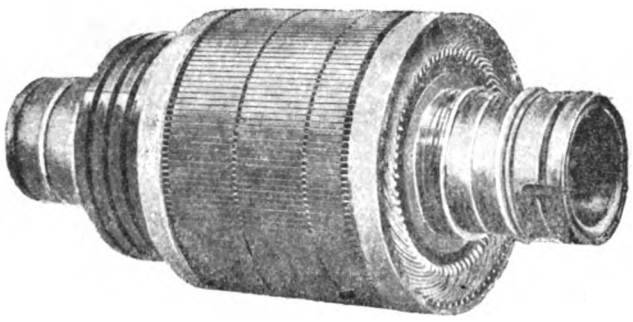

FIG. 24.

motor—750 h.p. maximum at 960 revolutions—from the hollow shaft to the wheels, thereby allowing the wheels a displacement of 10mm. relatively to the coupling arms; hence the arms had to be elastic, and, moreover, the head must be able to slide against the guides mounted on the wheel. The construction of the whole required a division of the coupling into three parts, corresponding to the three double arms that were adopted. The springs are secured in the annular pieces by wedges in such a manner that the tension of the wedges is further increased by the centrifugal force applied. Furthermore, the plates are extended laterally within the hub, and are thus prevented from flying out. The hub portions are of forged steel of ample cross-section.

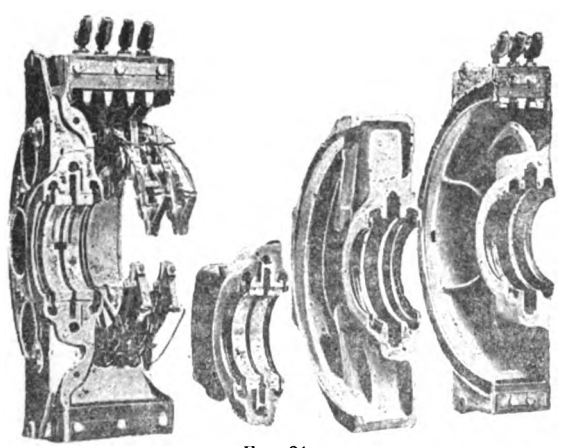

FIG. 26.

The power is transmitted by means of keys from the hollow shaft to the three-part hub of the coupling.

9. *Transformers.*—The three cores of the transformers (Fig. 28) are arranged side by side in accordance with the patents of the Allegemine Electricitäts-Gesellschaft. The axes of the cores run longitudinally in the car. The current transformation being from 12,000 volts to 435 volts, a massive copper spiral is used for the low-voltage winding, and the outer, or high-voltage winding, is separated from it by a micanite cylinder. A strong current of air passes through a longitudinal channel provided in each of the iron cores, and also through the space between the square cores and the round inner coil. As already mentioned, the air for this purpose is received through large air-holes in the roof and is delivered through air-ducts to the transformers. A protecting angle iron is provided on the roof for the removal of rain-water, and before the air enters the shaft and the channels it passes several times through wire netting with wide meshes; the air is then conducted over the transformer and filtered again before entering the cores. In spite of these precautions the air is only brought in direct contact with the interior of the cores of the transformer, and not with the parts carrying current. The cores are supported in the middle of their length to obviate any deformation due to the vibrations of the car. The transformer is suspended to the body of the car by draw bolts, so that the lateral sheets are only used for lining purposes, and are not called upon to carry any load. A further addition of springs connecting to the body of the car did not appear to be necessary, because the present arrangement is similar to that adopted for the International sleeping-cars, and should suffice to ensure a long life for the insulating materials.

10. *Cables.*—The current is taken from each of the three feeding wires by two trolley bows in parallel. The upper part of each of these arms carries a number of aluminium rods, attached by means of narrow plate springs. The masses of the individual rods must be sufficiently small to ensure that they bear constantly against the wire. The head of the arm carrying the bow is pressed out of aluminium sheet, and is connected to the vertical base by rods, the base being mounted on ball bearings in the socket on the car. The bow is pressed against the wire by springs, the tension of which is regulated by means of cams. The current is carried by insulated leads from the head of the bracket to the foot of the arms that take the current, and is thence transmitted to the cables affixed to the roof of the car. The making or breaking of contact between the bows and the wires is

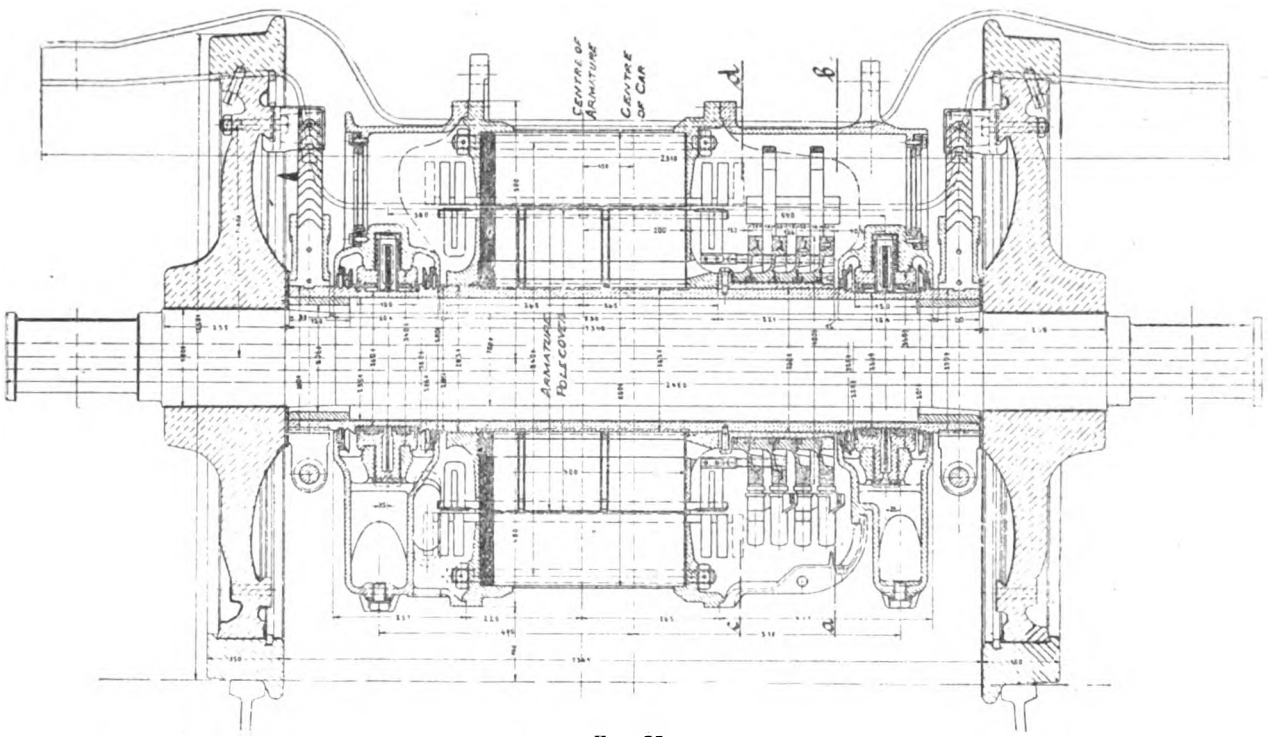

FIG. 25.

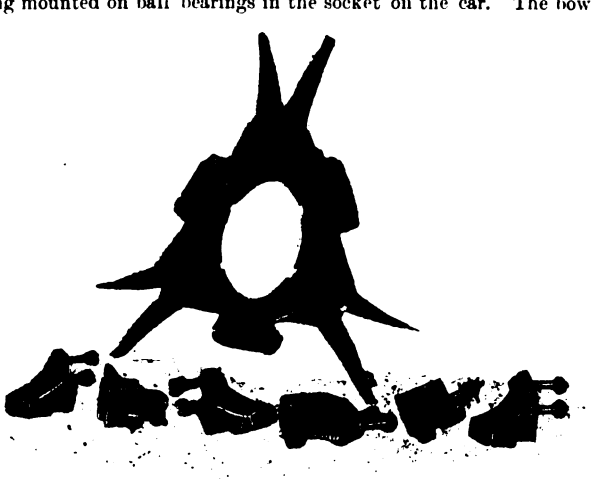

FIG. 27.

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effected from the interior of the car, so that the bows can be made dead before any person mounts to the roof. All high-tension conductors (Fig. 29) must have been subjected to an insulation test of 20,000 volts; but notwithstanding this, they are placed on high-tension insulators, and are thus treated as if they were bare wires. Safety fuses are fixed close to the single bow; these operate as soon as contact is made from any cause between any phase and the earthed car, and the car is thus freed from current by the melting of the fuse. The wires of both collector systems lead from the safety fuses to the high-tension cut-out. This cut-out is not requisite for controlling purposes, and serves merely to cut out the tension at the end of the run. The switch may be operated from the apparatus compartment, or from either of the driver's platforms, so that it serves also as a safety switch in the event of the proper switch failing to act as the result of an accident. The two branches of the current pass separately from this main switch to the

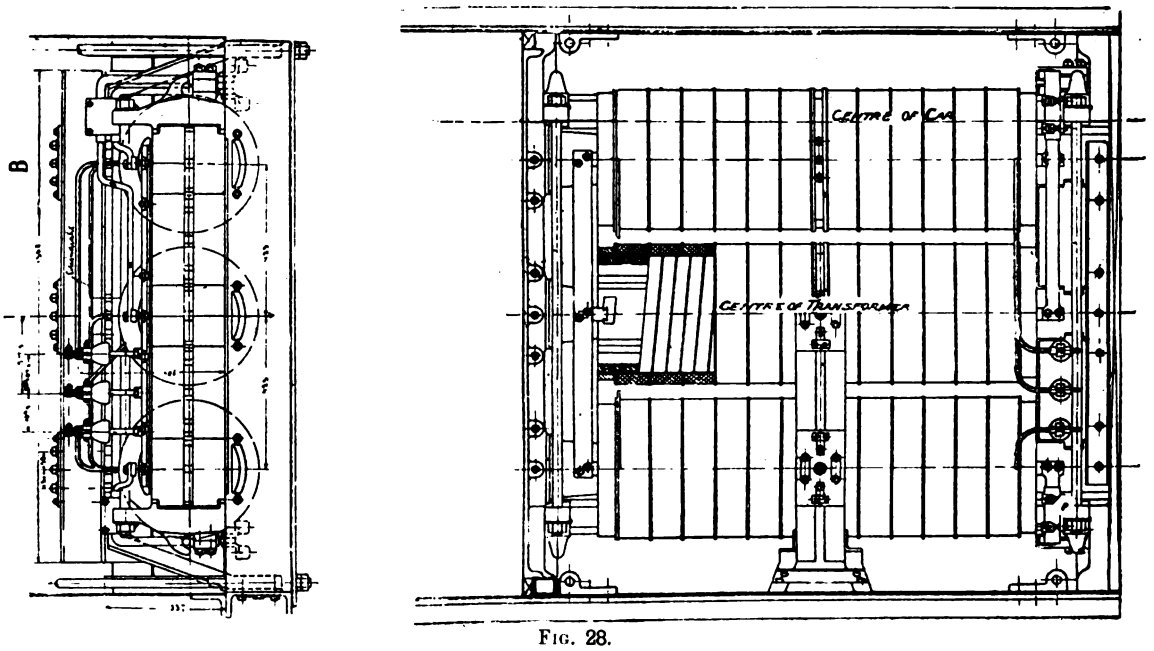

FIG. 28.

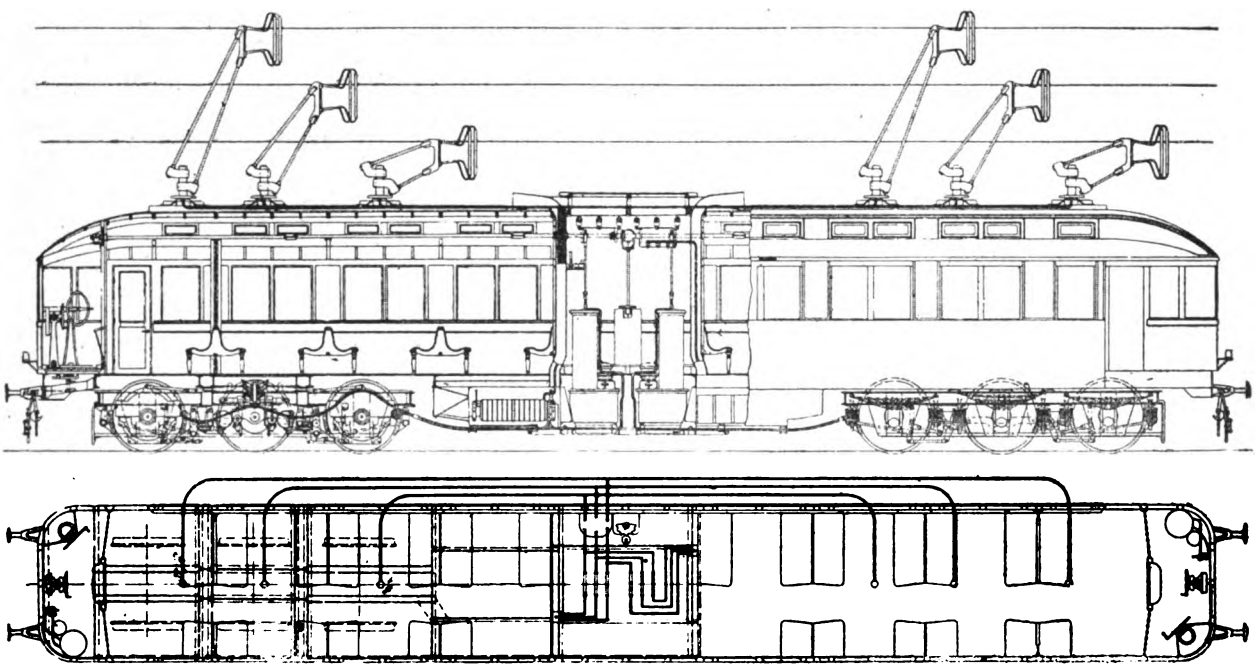

FIG. 29.

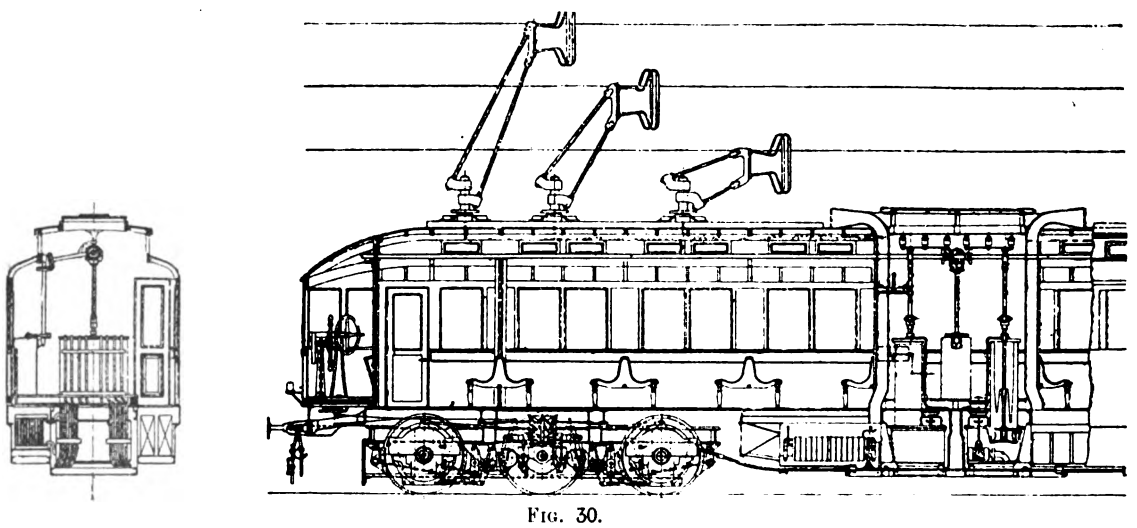

FIG. 30.

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transformers of the bogie. Each of these circuits and transformers is protected by fuses. The low-tension conductors lead from the transformers through a switching device to the motors. On account of the play to be allowed between the bogie and the car, in regard to both the lateral oscillation when running round curves and the vertical deflection due to the action of the springs, the cables had to be suspended from flexible supports; this was effected by hanging them from a strong girth or belt. The cables leading from the motors back to the starting device are secured in a similar way. The switch above referred to effects the admission of the current to the motor casings from the transformers, and it also allows of the adjustment for either direction of the driving or the delivery of counter current. Again, the storage battery is connected from this point to the stator circuit of the motors when braking the car as an automobile—*i.e.*, when braking independently of the overhead wire.

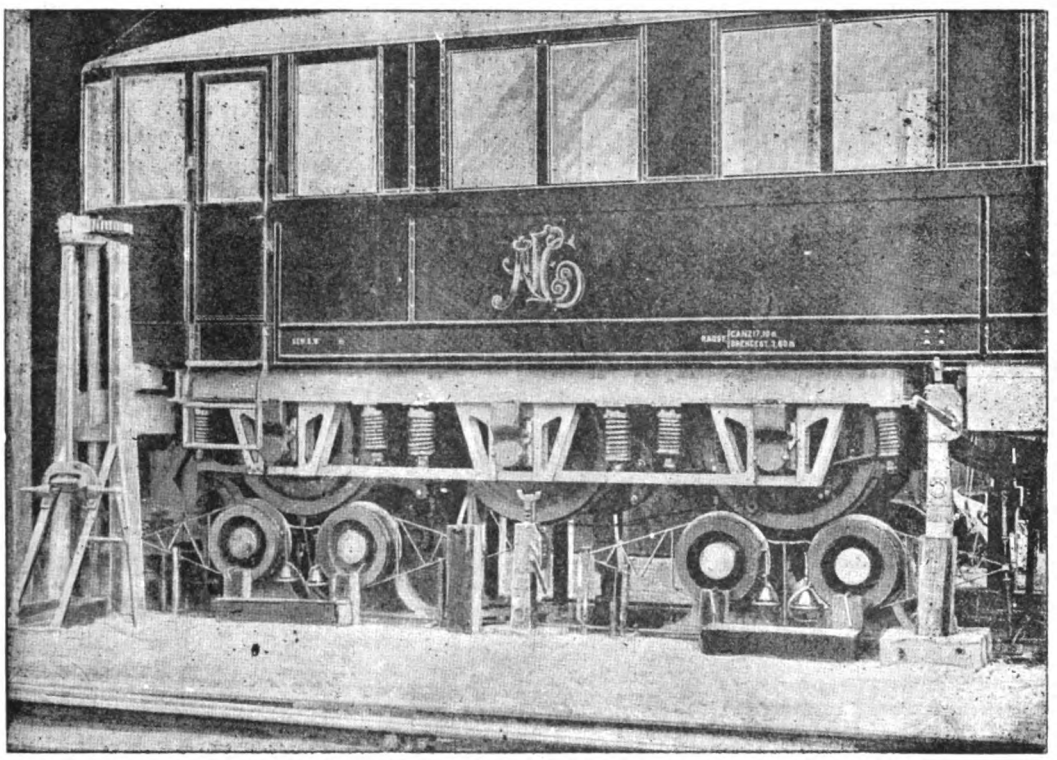

FIG. 31.

11. *Driving the Car.*—The car driver has only to operate one single handwheel (Fig. 30) in order to carry out all the manipulations. By means of an indicator he can at any time ascertain the position of the apparatus, and by an ampere-meter he ascertains the load on the motors. Another apparatus continually indicates the speed of the car. By the handwheel the driver operates a shaft extending through the entire length of the car. The switch is operated from this shaft by means of a pair of bevel wheels and cam wheels. The movement of this cam gearing to the extent of one tooth effects the switching of the controlling cylinder to forward current, reverse current, or braking action. The intermediate path which the cam or gearing has to traverse is used to operate the valve of the liquid starting device, to which reference has been made in Part I. It may be repeated that the driver is in a position to regulate the speed of the car from rest to the full speed of the motors within suitable limits, and that he can also start or stop as quickly and as gently as may be desired. The liquid of the starting device is fed continuously by means of a centrifugal pump through a cooling-coil system (Fig. 4), through which a current of air continuously passes, and is thereby constantly mixed and cooled. On the left of the driver is the handle for the operation of the compressed-air brake, and on his right there is another—a handwheel—for the hand-brake to be used in shunting. It is proposed to employ a number of different

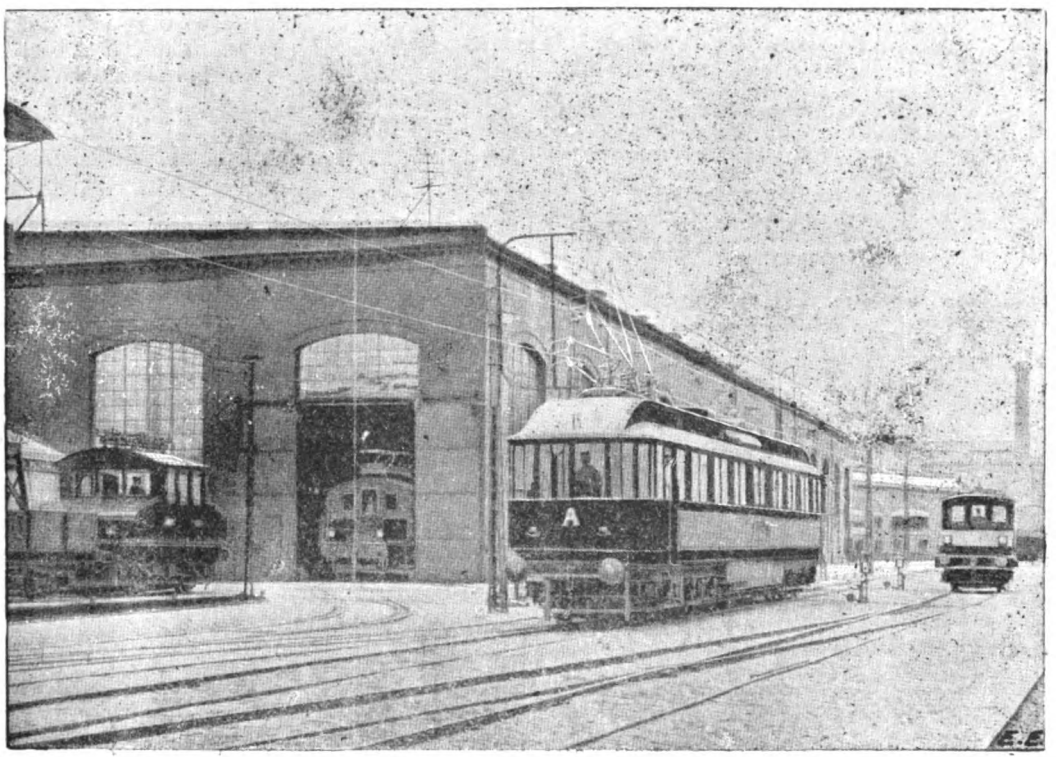

FIG. 32.

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kinds of measuring apparatus on the trial trips, especially with the object of indicating the acceleration of the speed, of measuring the air resistance met with in head and cross winds, and of measuring and registering the consumption of current.

12. *The Working Tests on the Trial Platform.*—In view of the novelty of the entire construction, and of almost every single part of the electrical equipment, and also of the great responsibility which the constructor had undertaken, it was deemed advisable to make the trial with the car at rest. The driving wheels of one bogie were supported on rollers mounted on heavy cast-iron plates. In view of the maximum peripheral speed of 56m. per second the rollers were made of cast steel, and the bearing rims were shaped to the profile of a rail-head. Wide plain rims were provided laterally to allow of a brake strap being applied, which, of course, like the rollers, had to be specially designed for the case in question. The latter were carried by means of strong axles in plummer blocks provided with white-metal brasses. The speed of the rollers is 1,800 revolutions per minute. By this experimental arrangement it was possible to run the motors of each single bogie up to full speed. The momentum required for testing the brake action of the motors and batteries was unfortunately wanting; and the small momentum of the motors and wheel sets could not furnish sufficient proof of efficiency; but, on the other hand, the results of the brake action described in Section 4 were so highly satisfactory that there seemed to be no grounds for supposing that the system would prove to be otherwise than satisfactory.

The above statements give an outline of the method by which the designer solved the problem, and it may be added that the practical experiments on the trial platform gave very favourable results. The great interest which experts throughout the world take in the development of the express railway has led to the publication of the above particulars. The question whether the speed aimed at will be fully attained depends only partly on the car itself and partly on the nature of the permanent way. A good deal of time is still required in order to gain sufficient experience on this point, and also in regard to the consumption of power under varying conditions of work, and this brings us in the presence of a second problem to be solved. There is already sufficient experience available as to many of the requirements and conditions of electrical traction as applied to long-distance working, and many a task, independently of whether lower or higher speeds are concerned, can now be carried out without any difficulty.

NEW COMPANIES REGISTERED.

The following new companies have been registered since our last issue:

Pollard Electrical Engineering Company, Limited.—Capital, £5,000. Object: to take over the business of electrical and mechanical engineers now carried on at Hyde, Cheshire, as Stanley, Davies, and Pollard; to carry on the business of an electric light, heat, and power company; and to manufacture and deal in cables, wires, lines, accumulators, lamps, electrical apparatus and machinery, etc.

Motor Haulage Company, Limited.—Capital, £15,000. Object: to carry on the business of engineers, makers of motors, motor lorries and cycles, engines, traction engines, locomotives, road-rollers, automobiles, trucks and self-propelled vehicles, whether worked by gas, oil, steam, electricity, etc.

Pioneer Gas, Electric Light, and Power Company of South Africa, Limited.—Capital, £2,000. Object: to acquire and deal with any rights, concessions, or contracts for generating, supplying, distributing, and employing electricity, steam, and other power in the Cape of Good Hope, the Orange River Colony, the Transvaal, and elsewhere in South Africa or otherwise, and to carry on the business of gas, light, and power suppliers, electricians, electrical and general engineers, suppliers of electricity, manufacturers of electric apparatus, etc.

Wilson Hartnell and Co., Limited.—Capital, £20,000. Object: to adopt an agreement with Wilson Hartnell for the acquisition of the business carried on by him at Volt Works, Kirkstall-road, Leeds, and to carry on the business of engineers, iron, steel, and brass founders, boilermakers, makers of dynamos and electrical plant, builders of locomotives and rolling-stock of all kinds, etc.

Penclawdd Colliery, Limited.—Capital, £10,000. Object: to establish and carry on the business of colliery proprietors, miners, manufacturers of patent fuel, bricks, gas, coke, coal, tar, and the products thereof (by distillation or otherwise), smelters, founders, converters of iron and steel, electricians, mechanical engineers, suppliers of electricity for the purposes of light, heat, motive power, etc.

Leeds, Wakefield, Dewsbury, and District Electric Tramways, Limited.—Capital, £100. Object: to undertake the construction, maintenance, and working of tramways, light railways, electrical and other railways, and motors, etc.

New Imperial Electric Lamp, Limited. — Capital, £3,000. Object: to carry on the business of manufacturers and importers of and dealers in electric and other lamps and apparatus connected therewith, and accessories, manufacturers of and dealers in dynamos, engines, motorcars, etc.

General Automobile Company, Limited. — Capital, £100. Object: to acquire the goodwill, assets, and contracts obtained by W. C. Bersey on behalf of the company, and to carry on the business of dealers in, factors of, and letters on hire of motor vehicles, mechanical, electrical, and general engineers, financiers, etc.

Portsmouth and Gosport Motors, Limited.—Capital, £5,000. Object: to establish and maintain services of and generally to trade with motor omnibuses, cars, wagons, cycles, and similar conveyances for locomotion, haulage, and the like, and to carry on the business of electrical and general engineers, etc.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

413. How is regulation best effected in a three-wire alternating-current system of distribution fed by high-tension mains from a distant power station?—Z.

414. Explain how the winding speed is varied, and starting and stopping arranged, on a mine shaft winding engine driven by a polyphase motor.—F. H. P.

ANSWERS.

Question No. 407.—How would you find out the current that is required for a 5-h.p. alternate-current motor at 100 volts 50 $\sim$? Can the formula be applied to polyphase motors? Give example.

Best Answer to No 407 (*awarded* 10*s.*).—The efficiency of a 5-h.p. alternate-current motor at a usual speed would be about 82 per cent.—*i.e.*, the ratio of the output watts to the true input watts (as measured on a wattmeter) would be ·82. The power factor of such a motor—*i.e.*, the ratio of the true watts (wattmeter measurement) to the apparent watts (as measured by an ammeter and voltmeter) put into the motor may be taken as about ·8. The true watts, therefore, put into the motor $= \frac{5 \times 746}{\cdot 82} = 4{,}550$, whilst the apparent watts put in $= \frac{4{,}550}{\cdot 8} = 5{,}650$. These figures are practically the same whether the motor be single or polyphase, but the corresponding input currents depend on the number of phases. Thus, if it be a single-phase 100-volt motor, the current in each of the two supply lines will be $\frac{5{,}650}{100} = 56{\cdot}5$ amperes. If two-phase supplied by four lines, the current in each of these lines will be $\frac{5{,}650}{2 \times 100} = 28{\cdot}25$ amperes. If two-phase supplied by three lines, with 100 volts between either outer and the central wire, the current in each of the outers will be again 28·25 amperes, but in the centre wire it will be the vectorial sum of two currents of 28·25 amperes each, with a 90deg. phase difference — *i.e.*, it will be $28{\cdot}25 \times \sqrt{2} = 40$ amperes. If the motor be three-phase, with 100 volts between any two lines, the current in each of the three lines will be $\frac{5{,}650}{\sqrt{3} \times 100} = 32{\cdot}6$ amperes, for the actual "phase current" is $\frac{5{,}650}{3 \times 100} = 18{\cdot}8$ amperes, and the current in any one line is the vectorial sum of two currents of this value with a phase difference of 120deg. between them—*i.e.*, it is $\sqrt{3}$ times the phase current, or $18{\cdot}8 \times \sqrt{3} = 32{\cdot}6$ amperes.

Stated as a general rule, the above figures could be got from the following formula—

$$\text{"Phase current"} = \frac{\text{Horse-power of motor} \times 746}{\text{Efficiency of motor (as a fraction)} \times \text{Power factor of motor (as a fraction)} \times \text{Number of volts between lines} \times \text{Number of phases}}$$

In the case of single-phase motors and two-phase motors with four lines, the current in each line is equal to the "phase current." In the case of two-phase motors with three lines, the current in each of the two outer lines is

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equal to the "phase current"; but the current in the centre line is $\sqrt{2}$ times the "phase current." In the case of three-phase motors the current in each line is $\sqrt{3}$ times the "phase current."—Q.

Answer to No. 407 (*awarded* 5*s.*).—The amount of current required to drive an alternate-current motor will be dependent upon (1) the load upon the motor; (2) the voltage of supply; (3) the efficiency of the motor at that load; (4) the power factor of the motor at that load.

Then if H = load in horse-power;
V = supply voltage;
E = efficiency;
p = power factor;
A = amperes input;

we have output = input × E, or $H \times 746 = V \times A \times p \times E$.

$$\therefore A = \frac{H}{V\,p\,E} \times 746 \text{ amperes (for single phase).}$$

Taking a 5-h.p., 100-volt, single-phase synchronous motor at full load we might have an efficiency of, say, 80 per cent. and a power factor of 1. (This latter condition may be obtained by suitable adjustment of field excitation.) The current would then be

$$= \frac{5 \times 746}{100 \times 1 \times \cdot 8} = 46 \cdot 6 \text{ amperes.}$$

Taking the case of an *asynchronous* or induction motor of 5 h.p. (still single-phase) the power factor would be much lower, say 0·6. We should then have

$$A = \frac{5 \times 746}{100 \times \cdot 6 \times \cdot 8} = 77 \cdot 8 \text{ amperes.}$$

For application to polyphase motors this formula must be modified.

In the case of a two-phase motor with a four-wire connection to the mains, the current as obtained above must be divided by 2 to obtain the current per wire. Thus we have

$$A = \frac{H}{V\,p\,E} \times 373 \text{ amperes (for two-phase, four wires).}$$

This is owing to the fact that each phase carries half the total power.

If there are but three wires leading to the motor, the above formula holds good for the current in the two small wires, whilst that in the middle or larger wire will be $\sqrt{2}$ (or 1·41) times this value. For a three-phase motor also the formula must be modified by dividing by $\sqrt{3}$ or 1·732. Since the power carried by a three-phase circuit is equal to $\sqrt{3}\ V\ A\ p$ watts (where V = volts between lines and A = current in each line), this will be the input to the motor. Hence the formula becomes

$$A = \frac{H \times 746}{V \times p \times E \times \sqrt{3}} = \frac{H}{V\,p\,E} \times 430 \text{ amperes.}$$

—R. C. C.

Question No. 408.—How would you ascertain the efficiency of a single-phase alternator separately excited? Should the exciting current be taken into account? Give a practical example of the losses likely to be found.

Best Answer to No. 408 (*awarded* 10*s.*).—To ascertain the efficiency of an alternator, the most direct method is to load the machine on a water rheostat or other non-inductive load, measure the mechanical input by means of a dynamometer and the electrical output with a wattmeter, the ratio of the latter to the former giving the efficiency. If the machine is driven by an engine, and the engine efficiency is known, the input to the generator may be obtained by taking indicator diagrams on the engine. The indicated horse-power so found, when multiplied by the engine efficiency, will give the input to the alternator. This method of direct measurement, however, is inaccurate at the best, as an error of 1 or 2 per cent. is important, especially in the case of large machines whose efficiencies run well up into the nineties.

It is therefore best to measure the losses separately, and from the results of these measurements compute the efficiency at various loads, for if we consider a machine with a full-load efficiency of 95 per cent., even if our measurements of the total losses are inaccurate to the extent of 10 per cent., this will only produce an error of about ½ per cent. in the efficiency.

The best way to measure the losses is to provide a direct-current motor to drive the alternator whose horse-power is about equal to the core and friction losses in the alternator. An ammeter and voltmeter should be provided to measure the motor input. Readings of the two instruments should be taken under the following conditions: (1) motor running alone at the required speed for driving alternator; (2) motor driving alternator at normal speed for latter (no excitation on alternator); (3) ditto, with alternator field excited to give normal voltage at normal speed.

The resistance of the alternator armature should then be measured by the "drop" method—*i.e.*, by sending a known direct current through it, and measuring the volts across the armature terminals. A similar test should be made upon the motor armature. We have then all the data required for deducing the alternator efficiency exclusive of excitation. The following figures are taken from an actual test of a 385-kw. machine:

Test 1	109·2 volts,	12	amperes	=	1,310 watts.
„ 2.....	110 „	42·6	„	=	4,690 „
„ 3.....	112 „	155	„	=	17,360 „

Resistance of alternator armature = 0·11 ohm.
„ motor „ = 0·035 „

From these figures we obtain the efficiency as follows:

Motor losses = 1,310 watts. Therefore friction and windage losses of alternator

= 4,690 − 1,310 − (C^2 R loss in motor armature)

(C^2 R loss in motor = $(43)^2 \times \cdot 035$ = 65 watts)

= 3,315 watts.

Core loss of alternator = 17,360 − (4,690 + motor C^2 R)

(Motor C^2 R = $(155)^2 \times \cdot 035$ = 840 watts)

= 11,830 watts.

Hence the friction, windage, and core losses of the alternator amount to 11,830 + 3,315 = 15,145 watts.

Now, the full-load current (at 2,000 volts) is 192 amperes, and the armature resistance is 0·11 ohm. So that the full load C^2 R loss is equal to

$$(192)^2 \times \cdot 11$$
= 4,050 watts.

(This would be greater when the armature is warm, increasing about 0·4 per cent. per degree Centigrade.) The total losses at full load are therefore equal to

$$15 \cdot 1 + 4 \cdot 1 = 19 \cdot 2 \text{ kw.}$$

This is 5 per cent. of the output, so the efficiency is $\frac{100}{105}$ = 95·2 per cent.

Efficiencies for lower loads may be similarly obtained, but the core loss will be somewhat less owing to there being less armature drop at smaller loads, and therefore less excitation required. The exciting energy is usually taken into account, and the efficiency is stated thus: "efficiency including excitation." The exciting energy at full load of the above machine is 5·8 kw. = 1·5 per cent. of the output. Hence the total losses are now 6·5 per cent., and the efficiency, including excitation, is 94 per cent.—R. C.

Answer to No. 408 (*awarded* 5*s.*).—The commercial efficiency of an alternator is given by the expression—

$$\frac{\text{Output of alternator}}{\text{Output} + \underset{\text{in armature winding}}{C^2\text{R loss}} + \underset{\text{in field winding}}{C^2\text{R loss}} + \underset{\text{bearing friction, in windage, in eddy currents, and hysteresis}}{\text{Losses in brush and}}}$$

The C^2 R losses in armature and field winding are readily ascertained from the currents and the measured resistances, but the other losses present a difficulty. If the alternator is driven at the correct speed by means of a light belt by a small continuous-current motor, and is fully excited, it is possible to obtain the value of these other losses at no load with exactness. The difficulty lies, however, in the fact that the other losses are in many types of alternator by no

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means independent of the load—in fact, they usually increase considerably as the load increases from nothing up to full load. The efficiency, therefore, worked out as above, using the other losses as measured at no load, is generally 1 or 2 per cent. too low.

If a large enough continuous-current motor is obtainable capable of driving the alternator under full load or nearly full load, a proper through efficiency test can be taken with fairly accurate results. The alternator should preferably be direct coupled to the motor, though a belt will do if necessary. It is then loaded to the required extent on a non-inductive (water) resistance, and the output is measured on a wattmeter at the same time that the continuous-current input is measured. By subtracting the C^2R loss in the continuous-current motor, armature, and field, as well as the friction and core loss and loss in belt (if any) in the motor from the total input, we get the input at the alternator splindle, and the ratio of the alternator output to this input + the loss in the alternator field is the commercial efficiency of the alternator. This method is quite accurate, as the losses in the continuous-current motor can be obtained with fair accuracy by a no-load measurement of the input required to run the motor round at full speed, and fully excited, as these losses are practically constant from no load to full load in the case of moderate-sized continuous-current machines.

In considering the commercial efficiency of an alternator, it is always necessary to take the exciting watts into account, and if the machine has its own exciter, either direct coupled or driven by belt, it is further necessary to include all the losses in the exciter itself as part of the alternator losses. A rough idea of the actual losses to be expected in alternators of different sizes running at usual speeds may be obtained from the following table:

Output in kilowatts.	Approximate speed.	Per cent. of full load lost in—			Commercial efficiency at full load.
		Armature winding.	Field winding.	Bearings, brushes, and iron core.	
5	1,200	4	6	10	80 %
20	600	3	3	7	87 %
100	500	2	2	6	90 %
500	300	1	1½	4½	93 %

—Q.

COMPANIES' MEETINGS AND REPORTS.

ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS.

Report of the directors to be submitted to the third ordinary general meeting of the shareholders, to be held at the offices of the Company, Strand-road, Preston, on Sept. 26, 1901, at 12.30 p.m.:

The directors in their report for the year ending June 30, 1901, state that the output of cars mentioned in the prospectus has been greatly exceeded, the works are fully employed, and the prospects of new work are satisfactory. The works have been fully maintained as regards buildings and machinery, the cost of which has been charged against revenue. After placing £4,000 to a depreciation fund, the profit for the year is £21,206. 8s. 7d., to which must be added £3,914. 4s. 11d. brought from last year, making a total of £25,120. 13s. 6d. The directors recommend that this amount be dealt with as follows: to write off expenses incurred to June 20, 1899, £7,342. 10s. 11d.; to carry to a general reserve fund, £2,000; to pay a dividend of 8 per cent. less income tax for the year ending June 30, 1901, £12,000; to carry forward to next year, £3,778. 2s. 7d Extra capital is required for the increased business of the company, and the directors therefore intend issuing debentures to the amount of £50,000, for which the shareholders will have the preference in subscribing. In accordance with the articles of association, two directors retire—viz., Mr. Fry and Mr. Kerr—and being eligible offer themselves for re-election.

LEGAL INTELLIGENCE.

ELECTRIC LIGHT STANDARDS AND STREET TRAFFIC.

A Question of Negligence.

At Brompton County Court on Monday, before Judge Stonor and a jury, Mr. William East, a newsagent, of Knightsbridge, sued the Westminster Electric Supply Corporation, Limited, to recover damages in respect of personal injuries alleged to be due to negligence on the part of the defendants' servants.

Mr. C. W. Overend (counsel) appeared for the plaintiff, and Mr. J. Stephenson (counsel) defended.

The Plaintiff stated that on May 1 last he was being driven by a friend in a van along Knightsbridge in the direction of Kensington. When opposite the Alexandra Hotel he saw some men hoisting a long pole by the side of an electric light standard. As the van was about to pass the pole, the top end, which had been pulled up about 8ft. from the ground, dropped a little, falling upon his (plaintiff's) right shoulder and arm. Owing to the accident, he had not since been able to properly use his arm, and he estimated his loss on that account at 15s. a week until the present time.

Under cross-examination witness denied that he agreed with Captain Webb, of the defendant corporation, to accept 30s. in settlement of all claim to compensation.

The Judge: Tell me exactly what caused the accident?—It was owing to the men having nothing to guide the pole as they raised it. The pole was swaying about.

Mr. Stephenson: I put it to you that you drove into the pole.

Plaintiff: No, it fell upon me.

Evidence given for the defendant corporation showed that the pole slipped from the base of the iron column, and the head, which was about 8ft. from the ground veered round. While the men were trying so get the pole in its proper position, the van ran into it.

The jury ultimately found in the plaintiff's favour, and assessed the damages at £20.

His Honor gave judgment accordingly, and allowed costs.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

East London.—Tenders are invited for the supply of a 50-kw. alternator and engine. Tenders by Nov. 26. Details in our advertisement columns.

Poplar.—The Libraries Committee invite tenders for the installation of electric light in four public libraries. Tenders by Oct. 1. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of main switchboard. Tenders by Oct. 14. Details in our advertisement columns.

Manchester.—The Electricity Committee invite tenders for the supply and delivery of ampere-hour and watt-hour meters. Tenders by Oct. 2. Details in our advertisement columns.

Huddersfield.—The Corporation invite tenders for the supply and erection of one 600-kw. alternating-current generating plant. Tenders by Sept. 30. Details in our advertisement columns.

Listowel.—The Urban District Council are desirous of treating with a responsible firm for the supply of electricity for street-lighting. Tenders by Sept. 30. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply and laying of cables. Specification, etc., can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by Sept. 25.

Winchester.—The Town Council invite tenders for lighting the streets of the city for three or five years from Nov. 1. Specification and particulars can be seen at the Surveyor's Office, Guildhall. Tenders by 24th inst.

Greenwich.—The Guardians invite tenders for proposed electric lighting installation at the new children's homes now building at Halfway Street, near Sidcup, Kent. Tenders by Oct. 10. Details in our advertisement columns.

Rochdale.—The Electricity Committee invite tenders for supply of feeder and distributor cables. Specifications, &c., may be obtained from Mr. C. C. Atchison, borough electrical engineer, Electricity Works, Dane-street. Tenders by Oct. 2.

Bristol.—The Electrical Committee invite tenders for the wiring of the Avonbank electric lighting station. Specification, etc., can be obtained from Mr. H. Faraday Proctor, city electrical engineer, Temple Back, Bristol. Tenders by 25th inst.

Doncaster.—The Corporation invite tenders for the supply, delivery, and erection of one high speed 220-kw. steam dynamo for traction and lighting purposes, together with steam pipes, steam valves, etc. Tenders by Sept. 27. Details in our advertisement columns.

Paris.—The Department of Postal Telegraphs invite tenders for 145 km. submarine cable, in three lots; 35,000 kilos 2½mm. iron wire; 295,000 kilos ·5mm. to 8mm. iron wire, in five lots; 4,500 kilos 3mm. jute thread, etc. Tenders to be addressed Rue de Grenelle, 103, by Sept. 24.

Rathmines (Ireland).—The Urban District Council invite tenders for the supply of meters and arc lamp carbons for 12 months from Oct. 1, 1901. Specification, etc., may be obtained on application to Mr. E. P. Fawcett, clerk, Town Hall, Rathmines, co. Dublin. Tenders by 23rd inst.

Kingston-upon-Hull.—The Electric Lighting Committee invite tenders for two high-speed three-crank compound steam-engines, 800 i.h.p. each, and four steel Lancashire boilers, 30ft. by 8ft., for 150lb. steam pressure. Tenders by Sept. 26. Details in our advertisement columns.

Hull.—The Corporation invite tenders for two steam dynamos; output of each, 90 amperes at 220 volts, and wiring, etc., the premises for about 24 arc lamps and 120 incandescent lamps. Full particulars may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull. Tenders by Sept. 27.

Madrid.—The Department of Agriculture invite tenders for the installation and working of an electric tramway for not more than 60 years. The route is from Linares to the mines of San Rogue and Tortilla. The deposit is 11,105 pesetas provisional, and 55,526 pesetas finally. Tenders by Oct. 17.

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Sheffield.—The Corporation invite tenders for boilers (type left open), induced draught, air heating tubes or economisers, motors, fans, iron chimneys, brickwork or iron flues, and all other accessories for evaporating 120,000lb. of water per hour. Tenders by Sept. 30 Details in our advertisement columns.

Leeds.—The Lighting Committee invite tenders for the supply of a main switchboard to deal with the output of three 1,500-kw. 50-period two-phase alternators, and comprising dynamo panels, feeder panels, synchronising apparatus, etc. Tenders by Oct. 8. Details in our advertisement columns.

Newport (Mon.).—The Corporation invite tenders for the supply and erection of winches, cables, overhead construction, complete electric motorcar, and repair shop equipment. Specifications, etc., can be had on application to Mr. H. F. Parshall, consulting engineer, 8 Princes-street, Bank, London, E.C. Tenders by Oct. 21.

Reading.—The Corporation invite tenders for the construction of new tramways and the reconstruction of the existing tramways, including the electrical bonding of the rails, the provision and laying of conduits and drawing-in boxes for the underground work, etc. Specification, etc., may be obtained on application to Mr. John Bowen, A.M.I.C.E., borough engineer and surveyor, Town Hall, Reading. Tenders by Sept. 28.

Maidenhead.—The Corporation invite tenders for supply and erection of three 60-kw. steam dynamos (vertical enclosed high-speed engines); two boilers of the Lancashire type, with fittings; and economiser, with dampers, etc. Specifications, etc., can be inspected and all information obtained at the office of Messrs. Burstall and Monkhouse, consulting engineers to the Corporation, 14, Old Queen-street, Westminster, S.W. Tenders by Sept. 23.

London, S.W.—The London County Council invite tenders for track rails and fastenings, slot rails and fastenings, tiebars and conductor tees, and roadwork and platelaying required for the construction on the conduit system of the tramway routes between Westminster Bridge, Blackfriars Bridge, and Waterloo Station respectively, and Tooting. Specifications and other particulars may be obtained from the Engineer's Department, County Hall, Spring-gardens, S.W Tenders by Oct. 8.

London County Council.—The County Council invite tenders for work to be done in supplying, fitting, and fixing lifts, motors, pumps, ventilating fans, lamps, cables, wires, conductors, switchboards, and columns, together with all supports, apparatus, fittings, and accessories which may be necessary or required for the electrical equipment of the Greenwich footway tunnel and its approaches. Specifications, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

Willesden, N.W.—The District Council invite tenders for the erection of main generating station and sub-station and offices in connection with proposed electric lighting scheme for their district. The works will consist of the following—viz.: (1) main generating station, Taylor's-lane, Willesden (a) engine-house, boiler-house, battery rooms and offices, etc., (b) chimney shaft; (2) sub-station, Salusbury-road, Kilburn, consisting of transformer and converter house, administrative offices, workshops, etc. Specifications and all further particulars may be obtained upon application to Mr. O. Claude Robson, M.I.C.E., engineer to the Council, Public Offices, Dyne-road, Kilburn, N.W. Tenders by Sept. 24.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a continuous-current 1,500-kw. dynamo working at from 550 to 625 volts, and the erection of these sets in the generating station of the South London Electric Supply Corporation, near Loughborough Junction. Also for three auxiliary 250-i.h.p. vertical high-speed enclosed steam-engines, each coupled direct to a continuous-current dynamo working at from 200 to 225 volts, and for the erection of these sets in the Council's generating station at Greenwich. Specifications and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a three-phase 1,500-kw. generator working at from 6,500 volts between conductors, each with an exciter, and for one 750-kw. reversible synchronous motor-generator, with exciter, designed so that either the low-tension or the high-tension side of the set will act as generator, and for the erection of these sets in the Council's generating station at Greenwich; also for nine 300-kw. synchronous motor-generators, working at from 550 to 600 volts on the low-tension side, each with an exciter, and for three 50-kw. induction motor-generators, working at from 200 to 225 volts on the low-tension side, and the erection of these sets in sub-stations provided by the Council. Full particulars may be had at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

RESULTS OF TENDERS.

Fulham.—A reference to the tenders submitted to the Borough Council will be found in another column.

Hastings.—The Town Council have accepted the tender of Geipel and Lange, London, at £125, for 11 three-way wattmeters.

Torquay.—The Corporation have accepted the tender of T. L. Harding, at £49. 15s., for an electric light installation at their buildings in Market-street.

Dudley.—The Town Council have accepted the following tenders: Ferranti and Co., Limited, Manchester, engine, £3,145; Electric Construction Company, Limited, Wolverhampton, dynamo, £1,969.

Halifax.—The Electricity Committee have accepted the tender of H. Jenkinson and Sons, 360, Queen's-road, Halifax, at £1,901. 11s. 3d., for erection of chimney shaft, 60 yards high, at the electricity works, Foundry-street.

Gravesend.—The Town Council have accepted the tender of F. and E. Davey, Southend-on-Sea, at £7,094, for the erection and completion of the proposed electric lighting and destructor buildings, and chimney shaft near the canal basin, Gravesend.

Birkenhead.—The Corporation have accepted the tender of Dick, Kerr, and Co., Limited, 110, Cannon-street, London, E.C., for the supply, delivery, and erection at their generating station, Craven-street, Birkenhead, of a steam engine and dynamo.

Morriston (near Swansea)—The tender of Handley and Shanks, Birmingham, has been accepted for arc and incandescent lighting plant, including 150-h.p. engine, dynamo, switchboard, and wiring for 60 Jandus and 500 incandescent lamps, at the Upper Forest Tinplate and Steelworks.

Ashton.—The following tenders have been accepted: Lancashire Electrical Engineering Company, arc lamps, subject to the tests of the lamps being satisfactory; Brockie, Pell, and Co., arc lamp resistances; E. Marshall, engine foundations, etc., in accordance with the plans, specifications, etc., of J. Eaton, Sons, and Cantrell.

Nelson.—The Electricity and Tramways Committee have accepted the following tenders in connection with the new works: Dorman and Smith, Manchester, switchboard; Greenwood and Batley, Limited, Leeds, balancer and booster (subject to slight constructural modifications as recommended by the engineer); E. Wood and Co., Limited, Manchester, iron and steel work; W. Macfarlane and Co., Kilmarnock, iron staircase to switchboard platform.

Hackney.—The following tenders have been received for the wiring of the works:

Waring and Withers (withdrawn)	833	0	6
Marryatt and Place (accepted)	866	7	2
J. C. Christie	1,036	15	0
J. E. Spagnoletti and Co.	1,075	5	6
D. Hulett and Co., Limited	1,121	11	6
Strode and Co.	1.245	9	9
Tamplin and Makovski, Limited	1,397	11	7
National Electric Wiring Company, Limited	1,438	0	0
Moody Bros.	1,461	1	0

The tenders of Johnson and Phillips for arc lamp pillars, and of J. Greenwood, of 10, Arthur-street, London Bridge, E.C., at £775. 17s. 9d., for the necessary equipment of the stores and test-room at the works have also been accepted.

BUSINESS NOTES.

TRACTION.

Indian Tramways.—Sir Allan Arthur has been granted concessions for tramways in Sarun.

Mount Vesuvius.—A few months will see the opening of an electric tramway from Naples to the Cook railway station below the summit of Vesuvius.

Sydney (Australia).—The electric power-house at Sydney has been severely damaged by fire, and the tram service is in consequence suspended for several days.

West London Tramways.—Considerable local opposition and obstruction is still being offered to the West London tramways on the grounds of speed and noise.

Salford.—Oct. 1 is named for the inauguration of the Higher Broughton tramway route. An experimental trial of a car will shortly be made over the Seaford-road route.

Kingswinford.—The Rural District Council have approved the scheme of the tramways company to run a double line of tramways through the Market-place at Dudley.

South London Tramways.—The London County Council have served notice on the South London Tramways Company for the acquisition of the whole undertaking.

Mexico.—Report states that the electric traction system of the city of Mexico, at present controlled by British capital, may shortly pass into the hands of American capitalists.

Shepherd's Bush Trams Delayed.—A delay of some 20 minutes' duration occurred on the Shepherd's Bush and Acton tramway route on Tuesday evening, owing to the failure of the current.

Electric Traction in Australia.—Mr. J. Roberts, of the South Australian railways, who has been making enquiries about electric traction in England and America, has returned to Adelaide.

Dundee.—The Town Council have approved a suggestion that stopping places on the various tramway routes, especially in the north-east of the town, should be fixed for the convenience of the public.

An American Scheme.—It is stated that the longest electric railroad in the world will be built from Cincinnati, Ohio, to Pontiac, Michigan, a distance of about 305 miles, if present plans are carried out.

Bath.—At a special meeting on Tuesday the Town Council, sitting as the urban sanitary authority, decided to take the necessary steps under the Tramways Acts to purchase the existing tramway system in the town.

Walthamstow.—A stormy discussion took place at the Urban District Council meeting last week on an outside proposal to construct tramways in the district. Consideration of the question was ultimately postponed.

Hucknall.—A notice of motion has been placed on the agenda paper of the District Council to appoint a deputation to confer with the Nottingham Corporation with a view to extending their electric tramway system to Hucknall.

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Ringsend (Dublin).—An electric tramcar passing over the Victoria Swivel Bridge, Ringsend, on the night of the 12th inst., came into contact with the bridge, the handrails of which and the front of the car were slightly damaged.

Southampton.—The Town Council have formally approved the intention to apply to the Board of Trade for a provisional order authorising the construction by the Corporation of additional tramways within the county borough.

Luton.—The Corporation have decided that the question of applying for a provisional order for the provision of tramways in the borough stand over for the present. The scheme submitted by Messrs. Beer and Reynolds has been rejected.

Newcastle-on-Tyne.—The Tramways Committee have decided to engage a manager at a salary of £750 a year to take sole charge of the electric tramways. It is probable that a public service of cars will be available on some of the routes by the beginning of November.

Scarborough.—A memorial has been received from ratepayers in St. Nicholas-street protesting against the proposal to lay down tramway lines along St. Nicholas-street, and drawing attention to the fact that that street is already too narrow for the ordinary traffic.

Dudley.—Negotiations are pending between the Corporation and the Electric Traction Company with reference to a through service of trams between Wordsley and Dudley Station. It is proposed to bring the Netherton and Kingswinford cars into the Market-place by a double line.

Proposed French-Belgian Electric Railway.—We notice that a French-Belgian syndicate is planning an electric express line from Paris to Brussels and Brussels to Antwerp. The trip from Paris to Brussels would occupy 1½ hours, and that from Brussels to Antwerp only 10 minutes.

Thames Ditton.—The surveyor will report at the next District Council meeting on the London United Tramway Company's plans for extending their system of tramways from the Orleans Arms to Esher. The company's proposals are for traversing about four miles of roads in the Council's district.

Wakefield.—A proposal to establish a line of tramways between Leeds and Wakefield is being considered. It is pointed out in the local Press that in this district there is need of a tramline from Sunderland to South Shields and another from South Shields to Hebburn or Heworth.

Canada.—Plans of the proposed Fort Erie Ferry electric railway, to run from Chippewa to Fort Erie, 20 miles, have been submitted to Government. During the 21 years' franchise the company is to pay the Government a ground rental starting at £200 the first year, and rising to £400 a year in the later years.

Heckmondwike.—It was explained at the last District Council meeting that the reason an additional boiler had been put in at the electric lighting works was to meet the need of the British Electric Traction Company, who would require a supply of electric energy for their tram system through the district when completed.

Epsom.—Mr. Clifton Robinson attended at the last meeting of the Rural District Council and explained his company's scheme of tramway extensions in Surrey so far as it affects the Epsom district. The Council agreed to consider the explanations given by Mr. Robinson, and the whole question was referred to the Highways Committee.

Hanley.—The Town Council have taken exception on the question of the adoption of the by-laws of the Potteries Electric Traction Company to the provision of smokers and the want for upper decks on the cars. A special committee has been appointed to confer with the company on the points in difference and make representations to the Board of Trade if necessary.

Tramways in Japan.—American consular reports from Japan state that the electric tramcars which are in use in Kyoto are constantly filled and are so well patronised by the working classes that the wealthier people still employ the jinrikisha to avoid the crowding. Electric lines have been projected at Tokyo and at Yokohama, but work has not been begun.

Stoke.—A potter has recovered £40 damages from the Potteries Electric Traction Company in respect of an accident he sustained while alighting from a car at Stoke. The claimant established his case that the place where the accident happened was a regular stopping place for cars, and that the car went on as he was alighting, with the result that he fell and fractured his thigh.

Hindley.—Negotiations have been proceeding between the Hindley and the Ince Councils with reference to the purchase of the tramways, and terms have been discussed. The Hindley Council have, however, informed the Ince Council that they are not prepared to accept 8 per cent. upon the purchase and cost to put the tramway into a good state of repair, as this has been found to be inadequate to cover the Council from loss.

Swinton and Pendlebury.—The District Council have decided to communicate with the tramway authorities of Salford with a view to ascertaining how it is proposed to work the Swinton and Pendlebury tramcar service during the interval between the completion of the electric service to the Height, and its extension to Swinton and Pendlebury, and as to the probable date of the completion of the electric service in the district.

Inquest.—An inquest was held on Wednesday at Walton-on-Naze on the body of a tutor named Chas. Symonds Faulke Watling, who, in endeavouring to cross the electric tramway on the pier at Walton, slipped and fell across the live wires. He eventually fell into the sea, after striking his head in the descent on a beam 20ft. below the pier. He sank immediately, and was drowned. "Accidental death" was the verdict on Wednesday.

Hyde.—In answer to a question at the last Town Council meeting as to whether the Electricity Committee were doing anything to put down a length of tramline between the Big Tree and the borough boundary, the Chairman said the committee had the matter under consideration, and were endeavouring to get a through service from Hyde market ground to the Bredbury Church so as to prevent a junction at the Big Tree, Gee Cross.

Glasgow.—A regular campaign has been made of late against the drivers on the Corporation electric tramways for alleged reckless driving, and more than one case has been recorded in these columns where the driver has been heavily fined. Yet another is reported this week, in which a driver was fined £1. 1s. or seven day's imprisonment for "having recklessly driven an electric car in Pollokshaws-road on the 11th inst., causing a collision with a cart."

Gosport.—The Board of Trade having refused to approve to service the notice by the Urban District Council on the Gosport Street Tramways Company for the purchase of the undertaking, the Council have obtained the opinion of the British Electric Traction Company on the subject, who advise that the only alternative is for the Council to negotiate with the tramways company with a view to arriving if possible at an amicable agreement as to the purchase price of the undertaking.

Ashton.—In a letter to the Town Council the secretary of the Oldham, Ashton, and Hyde Electric Tramway Company states that steps are now being taken to equip six of the existing cars to the double-deck type in such a way as will admit of their safely passing underneath the two bridges which cross the route. A sub-committee has been appointed to meet the tramways company relative to the working of a through service from Oldham to Denton *viâ* Oldham-road and Katherine-street.

Merthyr.—The County Council's scheme for a system of electric tramways in Glamorganshire, at an estimated cost of £600,000, has not met with approval in Merthyr. The Guardians at their last meeting were strong in denouncing the action of the County Council, which "would plunge the county into a great expenditure, a portion of which would have to be borne by a section of the community who would derive no benefit." Merthyr, it may be stated, already has its service of electric cars.

Aberdeen.—The burgh surveyor and electrical engineer has been asked for a report as to the construction of an electric tramway in Union-street with the overhead wires supported from rosettes attached to the houses. It is proposed to adopt this as a temporary expedient to connect the newly-equipped electric route in Great Western-road with the centre of the city. Meantime that new electric section terminates at the junction of the thoroughfare with Holburn-street, where there is only a service of horse cars.

Leeds.—The Whitehall-road section of the municipal tramways is now nearly equipped for an electric car service. As this is the only route on which horse cars are still running, next month will probably see the last of horse traction in Leeds. The steam-cars on the Wortley and Armley routes will also soon disappear. Satisfactory progress is being made with the electrical equipment of the New Wortley section, but before the scheme can be carried out in its entirety, the roadway beneath the railway bridge in Wellington-road must be lowered.

Wandsworth.—A communication was received at Wednesday's meeting of the Borough Council from the clerk to the London County Council stating that the Highways Committee of the County Council is very anxious that electric traction should be applied to the tramcars running between Clapham Common and Tooting at the earliest possible moment, and that the work will be commenced immediately after the reassembling of the Council. It further stated that once the work is commenced it will be pushed forward as rapidly as possible until completed.

Liverpool.—A remarkable accident to a tramway passenger is reported. Jumping on to an electric car going from the city to Walton, a passenger caught hold of the brass handrail fixed to the car. He immediately received a severe shock, which sent him headlong on the floor of the car, and he had to be removed to the Northern Hospital in the horse ambulance. According to the local newspaper reports of the incident, there was "a leakage in the electric appliances of the car, with the result that the brass rod became heavily charged with electric fluid."

Brierfield.—A conference is to be held between representatives of the Urban District Council and the Burnley Reconstruction Committee as to the reconstruction of the tramways for electric traction. The Nelson Corporation have agreed to the proposal of the Brierfield Council that Mr. Fraser, the Nelson electrical engineer, should superintend the laying of the electricity cables for lighting and tramways in the district, terms being arranged as to price of current. Current for the tramways, when completed, will probably be supplied by the Nelson Corporation.

Manchester.—A meeting of the Negotiations Sub-Committee will shortly be held to consider the reply of the Salford Corporation to the Manchester proposals in regard to the tramway service. The Salford Committee consider that "the only fair principle to be adopted is that neither Corporation should be hampered in the development and working of its own tramways, and that this principle must be the basis of any agreement between the two Corporations." It has been practically decided by the Tramways Committee to erect a second tram shed in Hyde-road.

Swadlincote.—A letter has been received by the Urban District Council from Mr. C. H. Gadsby, of London, stating that a syndicate is in course of formation which proposes to make application to the Light Railway Commission for an order to authorise the construction of overhead electric tramways extending from Burton to Newhall, Swadlincote and Woodville to Ashby, with a branch line through Gresley, and asking whether the Council would approve and support such an application. This the Council have agreed to do subject to the details of the scheme being afterwards approved.

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Brighton.—Some of the cars for the new municipal electric tramways have already been delivered, and trial trips will shortly take place. Each car provides accommodation for 50 people, and is handsomely appointed. It is electrically lighted at dusk, other appurtenances including electric bells, etc. The general appearance of the interior is roomy and lofty, and a broad stairway leads to the roof, which is fitted with reversible garden seats, supplemented by a patent by which when passengers leave the seats automatically turn over, so that in wet weather they can always be kept dry without a covering.

Devonport.—In consequence of an accident to the machinery at the Corporation electricity works, the tramway service was seriously dislocated a few days ago. A tube in one of the boilers broke, and rendered No. 2 engine (the most powerful of the three) useless throughout the day. The two other engines were only capable of providing enough power for seven trams. At the works other machinery is approaching completion for supplying the Plymouth, Stonehouse, and Devonport Company's trams, but this will not be in working order for a week or so. This is the first breakdown that has occurred at the works.

Tramways Orders.—A parliamentary paper has just been issued containing the report by the Board of Trade of the proceedings under the Tramways and Gas and Waterworks Acts of 1870 during the session of 1901. The number of applications made for provisional orders under the Tramways Act were 25, of which 20 were for powers to construct new or extension tramways; the remaining four were to authorise the use of mechanical power on existing lines, or to amend previous orders. The aggregate length of the proposed tramways was 24 miles of double line, and 47 of single line, and the estimated cost of production was £701,975.

Fenton.—The correspondence between the Urban District Council and the Potteries Electric Traction Company has been published with reference to the reconstruction of about 1,500 yards of tramline. The negotiations have not resulted in an amicable agreement, which is to be regretted. In forwarding the correspondence to the local Press, the secretary of the traction company says: "It was solely in the interests of the public that my directors entered upon these negotiations, and it is a matter of the greatest regret to them that they are debarred by the action of the Council from providing the increased services on the system so much desired by the public."

Greenwich.—At the half-yearly meeting of the London, Deptford, and Greenwich Tramways Company the chairman stated that with regard to the impending purchase of the undertaking by the London Council they were not much further forward. Shareholders were informed some 12 months ago that the Council had given the company notice, and over six months since the company had furnished its claim in due form. Negotiations were still pending in a friendly way, and every facility had been given the County Council in their transactions. As that body did not resume its session until Oct. 24 next, the company was not likely to hear anything further until November.

New Zealand Affairs.—According to the *New Zealand Mining Journal*, a second shipment of tramrails for the Auckland Electric Tramways Company has arrived in Auckland; also a quantity of machinery and appliances. The work of fitting the Westinghouse brakes to the rolling-stock of the Manawatu Railway Company is proceeding under the erection of an expert from America. The installation of the system will be completed about the end of the year. The electric tablet system, to ensure the safe running of trains between stations, has just been brought into operation on the section from Wellington to the Hutt, and will gradually be extended to other lines.

London Motor-Omnibus Service. — As foretold in these columns last week, a service of motor-omnibuses between Piccadilly-circus and Putney was put on the road for the first time on Wednesday. This is a new venture, undertaken by Mr. F. J. Bell, who has been carrying on a successful service of 10 motor-omnibuses at Bournemouth for the past year or two. The 'buses are of the Panhard-Daimler type, the carriage being an open car seating eight, which in cold or wet weather is covered in. In addition, new cars of larger size, to seat 10, are being built for the London service. The fare is 4d. all the way, or 2d. between South Kensington Station and either terminus.

Outing.—The employés of the British Thomson-Houston Company, Limited, now engaged on the construction of the municipal electric tramways at Croydon, had an outing to Boxhill and Dorking on Saturday last, after their recent heavy work in connection with the completion of the base line of this important undertaking. At a dinner which took place in the evening at the Old Wheatsheaf Hotel, Dorking, a suitable present was made to Mr. A. G. Livesay, who has left the company to take up a position as an additional engineer on the Corporation tramway system at Leeds. The presentation, which was made by Mr Frederick S. Grogan, who has succeeded Mr. Livesay as resident engineer of the company at Croydon, took the form of a handsome silver non-magnetic stop-watch, supplied by Messrs. Smith and Son, of the Strand, W.C.

The Inner Circle.—Notwithstanding the reports which have gained currency of late as to the electrical equipment of the Inner Circle Railway, we are officially informed that nothing has at present been settled in regard to the holding of a Board of Trade enquiry as to the system of electric traction to be adopted. In fact, it is not certain that an enquiry will be held at all, and it is quite possible that the question may yet be amicably decided by private conference between representatives of the two railway companies concerned and those gentlemen directly interested in the matter. However this may be, we are in a position to state that no steps have yet been taken to institute a Board of Trade enquiry into the relative merits of the systems of electric traction favoured by the Metropolitan and the Metropolitan District Railway Companies respectively.

Ryton.—The Electrical Power Company have asked the District Council if there is "any possibility of the Council supporting them in an application which they intend to make this autumn for power to run the tramways Ryton way and to supply electric light for the district." The Clerk stated at the last District Council meeting that about a year ago another company said that they were going to apply to the Board of Trade for a license, and the Council did consent to it, but they had not since heard anything as to whether they were really going to apply. The Newcastle company would only supply the power for lighting, but the Gateshead company would also bring the tramways; and the latter wished the Council to keep an open mind on the matter, and not to pledge themselves to any other company.

Cardiff.—A heated discussion took place at the last meeting of the Tramways Committee on the present position of the Cathedral-road and Docks route of the new electric tramways. It was agreed to ask the electrical engineer to report to the next meeting as to how much it would cost to run the traffic from Cathedral-road to the Docks at the earliest possible date, assuming that a special cable would be put down, also that the borough engineer and the electrical engineer be instructed to report to them when the Cathedral-road route will be equipped, and when the machinery and power station will be completed and ready for work. There is at present a dispute between the Corporation and the tramway company as to whether the £40,000 to be paid for the undertaking includes parliamentary expenses (£1,600) or not. The directors of the company have the matter under consideration.

Wolverhampton.—It was stated at the last meeting of the Corporation that the agreement with the Lorain Company had been signed on July 26 last, and as a corollary the company undertook to run a certain mileage of tramways within three months from that day, which practically meant at the end of October. A legal action is pending in regard to the dispute with the British Electric Traction Company concerning a through service of trams between Wolverhampton and the outlying districts of Bilston and Willenhall. The Council have decided to purchase Anfield, Waterloo-road South, for £1,300 for the purpose of widening New Hampton-road West, so as to permit the construction of a double tramway line. With the practical completion of the New Hampton-road line for electric traction, a start with the conversion of the Bilston-road section is now proceeding.

Crewe.—The British Electric Traction Company having applied for another order for the light railway scheme, the Light Railway Commissioners have arranged to hold another local enquiry this month. The Corporation have lodged notices of opposition, being unwilling that any outside body should have the power of running railways through their streets. They have decided to go in for another scheme themselves, less expensive than their previous one, and formal application is being made to the Board of Trade with a view to another local enquiry being held as to the feasibility of this. Their proposal now is for six railways, extending from the railway station and following the main street to the junction of West-street, Victoria-avenue, and in another direction from Earle-street through Hungerford-road to Haslington, and from Crewe Green to the railway station.

Croydon.—We understand that the Board of Trade inspection of the main base line of the new municipal electric tramways from Norbury to Purley will take place to-day (Friday), and that, subject to the sanction of the Board being received, the tramway will be formally opened for passenger traffic on the 26th inst. The Mayoress of Croydon, who will start the first car on this occasion, will be presented with a handsome gold bangle by the principal contractors, the British Thomson-Houston Company, Limited. The consulting engineer (Mr. Monkhouse) has visited Croydon, and made several journeys over the line in one of the new cars, accompanied by the construction engineers responsible for the work. He has expressed himself as being thoroughly satisfied with the manner in which the work has been executed. During the past week drivers have been receiving instruction in the handling of the electric cars, and a successful inauguration is anticipated. Work on the branch lines to Norwood and Addiscombe is now being proceeded with. The length of the completed section of the tramway is between five and six miles.

Bury, Rochdale, and Oldham Tramways.—The half-yearly meeting of the proprietors of this company was held in Manchester on the 13th inst. The directors' report for the half-year ended July 31 stated that the accounts for the half-year show a gross profit of £3,065. They recommended that this amount be applied as follows: £1,000 to reserve account against depreciation; £1,014 to debenture interest fund, which, with the sum of £9 brought forward, enables the payment of 2 per cent. per annum and leaves £10 to carry forward; £1,051 as dividend to shareholders, which, with the sum of £208 brought forward, enables the payment of 5 per cent. per annum and leaves £209 to carry forward. There is an increase of £460 in traffic receipts, making the largest total in the history of the company. The directors consider this fact a very gratifying one. Repairs to permanent way have cost £1,678; repairs to rolling-stock have cost £4,086. Both these sums have been charged to revenue account. The lease of the Oldham lines from the Corporation of Oldham, under whom the company works them at a rental of £1,249 per annum, will expire on the 31st prox.

South Shields.—A meeting of the Property Owners and Ratepayers' Association has been held to consider the desirability of supporting (or otherwise) the British Electric Traction Company's proposed scheme for a light railway from South Shields to Harton, Cleadon, etc. It was stated that the company intended to connect the whole of the south side of the Tyne by a light railway. The lines would extend from Gateshead through the Felling down to Jarrow and Tyne Dock, and this portion of the light railway would be taken in hand almost immediately, as they had already obtained the order. The railway would be continued by horse traction under lease to the South Shields Corporation from Tyne Dock to the pier. It was also proposed to have a light railway from South Shields to Sunderland with a spur to Whit-

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burn joining the Sunderland tramways at Roker; and later on through Jarrow, Whitburn, and across through Bolden. A motion was eventually adopted to the effect that the scheme of the company should have the best consideration of the association, but that in the opinion of the meeting it was desirable that the tramlines within the borough should be in the hands of the Corporation.

Plymouth.—The latest tramway accounts show that there was down to March last a loss incurred on the revenue account of £8,218. The amount lost each year has been held in suspense and the interest paid to the bankers in respect thereof charged to the suspense account. The undertaking has thus been saddled with compound interest upon its annual losses, such interest amounting to over £1,200. It is expected now that the Compton section has been electrically equipped that the deficiency will be paid off in a year or two. If, however, a deficiency remains at the end of two years, the Council should transfer the necessary balance from the borough fund to put the account straight. After the deficiency has been wiped out, a reserve or depreciation fund should be commenced, and the Council is advised not to carry any future profits in aid of rates until a substantial fund has been accumulated. The total amount borrowed for tramways purposes is £83,865, and the total sum spent £87,782. The capital account is therefore overdrawn £3,917, none of which expenditure has been sanctioned by the Board of Trade or Parliament. Application for a sanction to borrow the amount of this excess it is recommended should forthwith be made, or the Council should order it to be defrayed out of revenue.

Felling.—Letters were read at a special meeting of the Urban District Council last week offering terms for electric lighting and additional tramways for the district from the following companies—viz., Electric Power Distribution Company, Limited; Northern Counties Electricity Supply Company, Limited; United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited. With respect to where the power station would be, one company said the position would depend on arrangements with Hebburn, while another stated it would either be in Hebburn or Felling, as may be decided by the joint councils, provided that coal can be easily brought to the site and condensing water obtained at a moderate rate. Regarding the running of the trams, one company stated that the line will be promoted to afford general and through communication, with a normal fare of 1d. per mile, special facilities being given to working classes before 8 a.m. and after 5 p.m., the fares being then ½d. per mile. One company, quoting length of time before supply could be given, said if the matter was settled during August they could give supply before Christmas; another judged eight months after the transfer had been completed, and another bargained for 15 months. The Council eventually referred the matter back to committee.

Bradford.—Major Pringle, R.E., in his report on his inspection of the Queensbury tramways, recommends that the speed shall not exceed eight miles an hour at any point. The Tramway Committee have asked the Board of Trade to reconsider the question, and to authorise a higher maximum than eight miles an hour. A resolution was passsd by the committee sanctioning the expenditure by the Electricity Committee of the following sums for the purchase and laying of electric feeder cables: Manchester-road, £10,522; Leeds-road, £3,079; Wakefield-road, £7,877; Sunbridge-road, £871; and Manningham-lane, £4,663—total, £27,012. On the question of tramway contracts, the Council have adopted the following resolution: "That it be an instruction to the Finance and General Purposes Committee to appoint a small sub-committee to consider and report upon the proper clauses to be inserted in future Corporation contracts, to secure that all Corporation contractors shall be bound to observe fair conditions of labour and pay standard rates of wages, and to define the term 'standard rate of wages.'" The tramways revenue account for the year ending March 31 shows that the number of car miles run was 714,150; the total earnings were £33,123, being at the rate of 11·131 per car mile. The expenditure, including £5,955 for interest and sinking funds, and £8,451 for depreciation, was £32,585, and the net profit for the year was £537. 12s. 5d.

LIGHTING AND GENERAL.

Walthamstow.—The electric light works will be opened to-day at 6.30 p.m.

Alloa.—The electric wiring of the town hall is before a small committee.

Lowestoft.—The engineer is about to lay a sixteenth network in Tonning-street.

Battersea.—The electric light works will be opened on the afternoon of the 28th inst.

Longton.—The Council's electric lighting undertaking is to be opened next Wednesday.

Chipping Norton.—The Council are going to take steps to obtain an electric lighting provisional order.

Kinning Park.—Details of the lighting of the halls and baths with electricity are under consideration by the Town Council.

Southampton.—The Corporation are advertising for applications for the appointment of electrical engineer, at a salary of £500 per annum.

Brierfield Telephones.—The Council have decided to appoint a deputation to attend a meeting at Burnley to consider the above subject.

Cottingham.—The Urban District Council are making enquiries from the Hull Corporation with regard to the installation of municipal telephones.

Nelson.—The enquiry referred to in our last issue with respect to the borrowing of £25,000 for the electric lighting works was held on Wednesday.

Rome.—Electric power derived from the waterfalls of Tivoli is now transmitted about 15 miles across the Campagna to illuminate Rome and to drive the tramcars.

Colwyn Bay.—Ninety-nine applications were received by the Urban District Council for the post of electrician, and Mr. H. D. Carter, of Leicester, has been appointed.

South Africa.—The Rand Central Electric Works have received cable advice from Johannesburg that their works at Brakpan are expected to restart on the 23rd inst.

Llandudno.—The Electric Lighting Committee's report recommending the immediate carrying out of extensions has been referred back for further consideration and report.

Epping.—The Urban District Council will on Oct. 15 consider the following resolution: "That the Council do apply for powers enabling them to provide electric lighting for the district."

Norfolk.—The County Council have granted an application of the Norwich Electricity Company for leave to break up a path for a main in Thorpe St. Andrew, near Whitlingham Station.

North Berwick.—Another *plébiscite* of the ratepayers is to be taken as to whether or not the proposed electric lighting agreement between the Council and Crompton and Co. be entered into.

Bury.—The electrical engineer's estimate for an extension of the mains in Bolton-street, from Castlecroft to the Hope and Anchor Inn, has been accepted, and the work will be carried out.

Kilmarnock.—The Town Council, after discussing the proposed electric lighting scheme and tenders amounting to £29,000, have refused to accept the same, and thus the scheme is postponed indefinitely.

Londonderry.—The Town Council have decided to ascertain on what terms Sir Wm. Preece will examine and report on a plan for private electric lighting and power scheme based on his (Sir Wm. Preece's) report.

Ashton.—The engineer has been empowered to arrange for alterations to 240 volts of all motors now at work on the mains where necessary. Temporary pipes and switch gear are to be provided for the two new generators.

Maesteg.—The District Council have decided to engage an electrical expert to advise upon the question of lighting the town by electricity. It is also suggested that the Council should also seek powers to run electric cars in the town.

Hucknall Torkard.—The Urban District Council have notified the Derbyshire and Nottinghamshire Electric Power Company of their intention to apply for a provisional order. Mr. Warden-Stevens has been appointed as consulting engineer.

Stock Exchange.—The Stock Exchange Committee have ordered to be quoted in the official list the British Electric Traction Company's further issue of 30,000 6 per cent. cumulative preference shares of £10 each, fully paid, Nos. 160,001 to 190,000.

Guildford.—The Guildford electricity lighting extension order, together with amended description of the system proposed to be adopted by the undertakers for the supply of energy under the order, is being considered by the Lighting Committee.

Fire.—A fire occurred on Monday at Enderby's Wharf, East Greenwich, S.E., on the premises of the Telegraph Construction and Maintenance Company, Limited. A building used as engineers' workshops, pattern-room, and stores was entirely destroyed.

London Gazette.—The partnership existing between H. Patterson and C. R. Whipple, electrical and mechanical engineers, 33, Moorfields, and 5, Edmund-street, Liverpool, trading as Patterson and Whipple, has been dissolved by mutual consent.

Balmoral Castle.—Messrs. Pratt and Keith, Perth and Aberdeen, have obtained an order from Balmoral Castle for the supply and wiring of several large electroliers, brackets, and standards for the dining and billiard saloons, library, and bedrooms at the castle.

Hawick.—The Urban Electric Supply Company, for the supply both of light and power, have commenced operations for the erection of works in Commercial-road. It is expected that the work will be so far advanced as to be partially in operation on Nov. 1 next.

New Branch.—Messrs. Handley and Shanks have appointed Mr J. W. Garsden as manager of their Manchester branch, and all enquiries sent to 46, Corn Exchange-buildings, Fennel-street, Manchester, will meet with immediate and prompt attention.

Heywood.—Estimates for electric lighting of the library are to be obtained. The electric light has been switched on at the technical school as a test. The Electric Lighting Committee expect to be able to supply customers with the current almost immediately.

Strabane.—Another committee has been appointed, consisting of the members of the Urban Council, the former committee, representatives from the House League, and a number of other ratepayers, to further consider the question of public and private lighting.

Middlesbrough.—Mr. W. O. E. Meade-King held an enquiry on the 17th inst. into the application of the Corporation to borrow £34,100 for electric lighting extensions in the borough, which sum includes £13,000 excess expenditure and £21,000 for additional plant and laying of mains.

Benwell and Fenham.—The Urban District Council are negotiating with the Newcastle and District Electric Lighting Company, Limited, for the taking over and working of the provisional order (Benwell and Fenham Lighting Order, 1901) for the supply of light and power in that urban district.

Richmond (Surrey).—The Highways Committee have appointed Mr. Dykes (Handcock and Dykes, Westminster) to inspect the cables to be laid and works executed by the Richmond Electric Light and Power Company, Limited, within the borough, and of which notices have already been given by the company.

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Rochester.—The Corporation are desirous of purchasing so much of the electric light company's undertaking as affects the city, and they have increased their offer from £3,800 to £5,000, the terms in other respects to be the same as those embodied in a former resolution of the Estates and General Purposes Committee.

Oban.—The committee appointed to promote a provisional order under the Electric Lighting Acts to supply electrical energy within the burgh has been reappointed with instruction to take the necessary steps for the carrying out of a scheme, under which it is stated that they might possibly have the light for next July or August.

Tiverton.—The Lighting Committee have under consideration the question of the electric lighting of the town, but up to the present they are unable to report in such a way as to give the Council an opportunity of discussing proposals satisfactorily. Two special engineers have been consulted in addition to the borough engineer.

Personal.—Mr. W. J. Poole, station superintendent, Glasgow Corporation electricity department, left for the United States last week for the purpose of studying the American practice in electrical undertakings. He will be absent for a month, and will visit New York, Pittsburg, and many other important centres of electrical industry.

Leeds Telephones.—The Parliamentary Committee of the Corporation have appointed a sub-committee, consisting of Aldermen Tetley and Gordon, Councillors Wilson, Clarke, M'Candlish, Henry, Kinder, Wormald, and Hawkyard, to enquire into the whole question of municipal telephones, with power to visit other towns and obtain expert advice on the question.

Blaydon.—The Urban District Council have decided to reply, in answer to a communication from the Blaydon Manure and Alkali Company, asking what steps, if any, had been taken by the Council to encourage electrical power in the district, that the matter had been before the Council, who were equally anxious to have electricity introduced into the district.

Thames Ditton.—The Works Committee have received a notice from the Provincial Electric Supply and Traction Company that the latter intended to apply to the Board of Trade, on or before December next, for a provisional order to supply electricity for public and private purposes in the district. The committee recommend the Council not to consent to the application.

Heytesbury.—The work of fixing the cable for supplying the village with electric light is being rapidly proceeded with under the direction of Mr. Smith, of Messrs. Christie's, Redhill. The main cable will be carried overhead. At present the installation will be only laid on to private houses and the church, no arrangements having as yet been made for street-lighting.

Linthwaite (Yorks).—The Urban District Council last week considered whether they should obtain an electric provisional order, or whether they should purchase in bulk from the electric light company and then retail out to consumers. Eventually it was decided to arrange for a meeting with the Slaithwaite, Marsden, and Golcar Councils to consider the point.

South-Western Polytechnic.—The next session of day and evening courses in elementary, intermediate, and advanced electrical engineering, wiring, and technical mathematics commences for evening classes Sept. 23; the day classes begin Sept. 30. The secretary of this excellent institution is always ready to supply intending students with all the information they require.

Swansea Telephones.—At a meeting of the Municipal Telephones Committee on Monday, it was reported that 159 local telephone subscribers had replied assenting to transfer their business to a municipal exchange. It was thereupon decided, as this number exceeded the limit, to recommend to the Council the engagement of Mr. A. R. Bennett, engineer of the Glasgow Corporation, to report generally on the question.

Limerick.—On Tuesday last week a report was received by the Electric Lighting Committee from Mr. Enright suggesting that in view of the reduction in the prices of material, the committee should request the firms who had already tendered for the erection of electric plant to revise their prices. He considered it inadvisable under the circumstances to readvertise for fresh tenders. After debate it was decided to advertise for fresh tenders.

Worksop.—With reference to the discussion which took place at the last meeting of the Urban District Council on the tenders for the lighting of the town hall, we are informed that the difference between the accepted tender and the lowest was only about £13. The tender was given to the local man because it was thought more advisable to have the work done by a man who, in the case of any hitch, could always be got upon the spot at a moment's notice.

Shipley (Yorkshire).—The Urban District Council are now installing on their street-lighting extensions a number of the Prism Globe Company's two-light swan-neck brackets and fittings, each adapted to carry two 40-watt Nernst lamps. This is probably the first instance in England where Nernst lamps will be employed for public street-lighting. The work is being carried out to the specification of Mr. Robert C. Quin, the consulting engineer.

East Greenwich.—A number of electric light consumers were summoned on Monday by the Blackheath and Greenwich District Electric Light Company, Limited (for whom Mr. C. E. S. Mason appeared), for failing to pay for electricity supplied and rent of meter. Since the summonses were issued two of them had paid. The magistrate ordered the others to pay £4. 17s. 2d., the amount claimed, with 3s. costs, and £4. 13s. 11d., and 3s. costs, respectively.

Dumbarton.—The Town Council have decided to apply to the Board of Trade for a provisional order under the Electric Lighting Acts on behalf of the town. This action has been taken on account of the recent decision on the Clyde Valley Electric Power Bill, as if the Town Council did not become authorised distributors within two years the company would be in a position to come into the burgh, lay down their mains, and provide a public supply of electricity.

Wireless Telegraphy.—The directors of the Cunard Company, having satisfied themselves of the utility of the Marconi system of wireless telegraphy by its trial on the "Lucania," have now decided to fit the system on the whole of their Saturday mail boats between Liverpool and New York. Experiments with a wireless telegraph are to be made between Danvers and Boston by means of a relay.

Arc Lamps.—The note which appeared in our last issue under this heading should have read as follows, substituting "other" in the last line for "their": "Arc Lamps.—We are informed by Mr. G. Braulik, of 217 and 218, Upper Thames-street, E.C., that the agency which he had held for the past 10 years for Messrs. Koerting and Mathiesen's arc lamps terminated on Sept. 4 last, but that he will still continue to supply arc lamps of other make, besides other electrical accessories."

Merthyr.—The Market-square Congregational Church, Merthyr, have entered into contract with Messrs. Edwards and Armstrong for electric lighting. The current will be supplied by the Merthyr Electric Traction and Lighting Company. This will be the first Noncomformist place of worship in the town at which the electric light will be employed. The parish church has already been so lighted under the superintendence of Mr. Clapp. The Market-square Schoolroom will also be lighted by electricity.

"Industrial Applications of Electricity."—This is the title of a well-illustrated pamphlet just issued by the British Thomson-Houston Company, wherein it is shown how the development of the application of electricity to industrial purposes has largely contributed to the reduction in the cost of manufacture and improvement in the quality of the product. We would recommend its perusal to all power users who have to consider the advisability of replacing by electric motors their present methods of driving.

Sheffield.—Mr. S. E. Fedden, the electrical engineer, is preparing an exhaustive report on a municipal telephone system for the city, which is to be carried out on a very extensive scale. The electricity department is now very busy with overhead transformer stations. Ten are being erected, at a cost of about £1,000 each; a number of short subways have been or are being made; and the Council will shortly make an application for sanction to a loan of half a million pounds to cover extensions in this department.

Hartley College, Southampton.—Important courses of instruction in mechanical, civil, and electrical engineering commence on Oct. 2, 1901. The full course of instruction in either of these subjects extends over three years. The college is furnished with well-equipped physical, electrical, mechanical, and chemical laboratories, drawing office, lecture theatres, smiths' shop, woodwork shop, plumbers' shop, museum, etc. Prospectuses and particulars of entrance scholarships may be obtained on application to the registrar.

Burton.—The return for August shows that the quantity of electric light sold was 8,520 units, showing an increase of 1,308 units over the corresponding month of last year. The sum of £1,020, part of the money which the Local Government Board disallowed from the electric light loan of £5,000 on account of that amount being still outstanding on the capital borrowed originally for the machinery removed to make room for the new set, is to be borrowed from the gasworks reserve fund and paid back by 18 equal annual instalments, or earlier if it is found convenient to do so.

Luton.—Electric light has been installed at the Congregational Chapel. The chapel is furnished altogether with 67 lights, which can be brightened and dimmed at will. From the ceiling, and suspended by a chain, are three five-light electroliers; there are three brackets attached to every pillar, and in the body of the chapel are single filigree pendants fitted with polophanes. This is the first place of worship in Luton to be provided with the electric light, and the result has given great satisfaction. The work has been carried out by Messrs. Shoolbred and Connell, George-street.

Coatbridge.—The Municipal Buildings Committee have adopted a report by Mr. W. A. Chamen upon the electricity company's proposed alterations in the method of lighting the buildings in view of the change of pressure to a higher voltage, and have agreed to accept of the electricity company's proposal as qualified by Mr. Chamen's report. Messrs. Anderson and Munro, the contractors, have been instructed to begin the job at once. Two applications for leave to lay electric wire over the roadway are being considered, although a former application for overhead wiring has been refused by the Council.

Belfast.—Mr. M'Cowen, engineer, has reported to the Town Council that a man named J. Forgion had been fined by the magistrates for abstracting electricity from the wires. This was the first case of tapping the wires, and the committee hoped it would be the last. It was announced with considerable satisfaction that the credit balance in the electrical department at present stood at £37,000. It was decided to request Mr. M'Cowen to proceed with the work in regard to the lighting of the lodging-houses and also the new art department of the technical institute in Merchant's-buildings, North-street.

Southwark.—At a special meeting of the Borough Council on the 18th inst. the following resolution was considered: "That the Council do make application by memorial to the Board of Trade, in pursuance of the provisions of the Electric Lighting Acts, 1882 and 1888, for a provisional order, to be confirmed by Parliament in the ensuing session, to authorise the mayor, aldermen, and councillors of the metropolitan borough of Southwark to supply electricity for public and private purposes within so much of the metropolitan borough of Southwark as is not comprised in the Council's area of supply under the Newington Electric Lighting Order, 1897."

Shrewsbury.—Mr. Boulnois has held an enquiry into the Council application for power to borrow £16,526 for the purpose of extending the electric light works. The Town Clerk said that in 1898 the

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Corporation purchased the electric works from the public company which established them, and to pay for them the Local Government Board authorised loans to the amount of £35,900. Since then the Corporation had made several important additions to the works; all the public buildings are lighted by electricity, the demand for the new light is continually increasing, and during last winter the resources of the works were very severely taxed. There was no opposition.

Catalogues.—We have received from the Electrical Trades Supply, Limited, manufacturers and merchants, Cornwall-buildings, Cornwall-street, Birmingham, advance sheets of an illustrated catalogue of electrical accessories, etc. Amongst the novelties mentioned are Treppmann's patent universal clawed dowels for electrical installation, etc., these being simple fasteners for porcelain insulators, cup insulators, circuit closers, feeding devices, etc.—The General Electric Company (1900), Limited, Queen Victoria-street, E.C., have just issued a leaflet dealing with their new "Angold" alternating enclosed arc lamp and certain accessories, as an advance sheet of their arc lamp catalogue.

Clydebank.—The clerk (Mr. John Hepburn), in a recent report on the effect on the burgh of the powers contained in the Clyde Valley Electric Power Bill, said the Bill gave powers to its promoters to lay pipes through their streets without their consent, but no authority to provide power. The local authority, by providing its own power, or purchasing a sufficient quantity from the company, could prevent the company from trading inside the burgh in opposition to them. The company could not place any overhead wires without the consent of the local authority, and was fully to idemnify the local authority for all damages caused from time to time. The Bill is now under the consideration of the Council.

Dundee.—The cleansing department have just received a combined electric sweeper and sprinkler, which is worked in the same manner as the ordinary trolley car. At each end is a platform for the men who work it, while immediately beneath are reversible rotary brushes, set at such an angle as to command a wide stretch of the roadway. The centre is fitted with a water-tank about 6ft. square and of similar height. The immediate effects of this innovation will be to dispense with a good deal of horse haulage, while it is also claimed for it that it will execute its work with greater expedition and less inconvenience than the older and more cumbrous method involves. The experiment will be watched with considerable interest.

Kingswinford.—The Council have written to the Midland Electric Corporation pressing for a fulfilment of their promises to the Council, and stating that the Council and the ratepayers were of opinion that the Corporation did not intend to carry out the undertaking they gave to light in September. The corporation replied that they had been doing their very best to fulfil their undertaking, and if they had not succeeded as they had wished it was the fault of the contractors. The Council now propose to enter into negotiations with the Brierley Hill and Stourbridge Gas Companies to supply them with lighting for the coming season. The matter will be considered at a meeting to-day, when probably the Midland Company will be able to satisfy the Council.

Darlington.—Mr. W. O. E. Meade-King has held an enquiry into the application of the Darlington Corporation for sanction to borrow £12,250 for electric lighting purposes and £14,000 for gasworks. Mr. H. G. Steavenson said the Council desired to meet the increasing demand for the light. Already they were providing power for 8,400 lamps of 8 c.p. to 106 consumers, and by the end of the year they estimated that power would be required for 18,000 lamps. The sum of £25,940 had been raised by loans, and the expenditure had exceeded that sum by £1,670. 15s. 3d. The liabilities incurred were £3,593. 2s. 2d. in excess of the powers. The money required on behalf of the gasworks was chiefly for automatic meters, mains, engine exhauster, extensions, lamps, etc.

Aberdeen.—The erection of the new electric station at Dee Village is proceeding apace. The chimney, which is to have a total height of 208ft., has been built to a height of 90ft. The economiser-house is now ready for the water-tank. One of the walls of the engine-room is at the required height, and two engine bed-plates are being put into position. The mason work of the boiler-house is practically completed. The boiler seats have been fitted in, and four of the boilers placed in position. The battery-room is in an advanced state, and the floor is being tiled. Altogether more than half of the mason work of the buildings has been completed, but it will be a month or two yet before it is entirely finished. A temporary engine-house has been erected to facilitate the work at present being carried on.

Boilermakers and Iron and Steel Shipbuilders.—The monthly report of the United Society of Boilermakers and Iron and Steel Shipbuilders, issued on Tuesday, states: "Judging from reports coming from various centres, we find that trade regarding shipbuilding and other branches connected with us, such as locomotive work, is in fairly good condition. But we are sorry to say that, while trade is in a healthy condition, many complaints reach us about men losing unnecessary time, much to their own discomfort and to the discredit of the society. Our boiler shops are fairly busy, and we would urge our young members of this branch to qualify and adapt themselves for all the higher skilled work connected with the water-tube boilers. It is most annoying to be told that skilled workers in this type of boilers are scarce."

Wednesbury.—An application has been made to the Electric Lighting Committee of the Walsall Town Council by Mr. J. Warden-Stevens, on behalf of the Wednesbury Corporation, for terms on which the former would supply current in bulk to Wednesbury at a convenient point on the boundary, the latter undertaking to distribute it in their borough. We learn, however, that having regard to the fact that a capital outlay of £8,000 would have to be incurred in laying the necessary mains to the Wednesbury boundary, and erecting a transformer station, and that it would be necessary for Wednesbury Corporation to enter into a contract to take for a period of 25 years a minimum quantity sufficient to justify such outlay, the Walsall Committee feel that they could not offer any terms which would be advantageous to the Wednesbury Corporation.

St. Marylebone.—The Lighting Committee last night recommended that no further objection be raised to the Metropolitan Electric Supply Company's notice as regards the laying of a 5in. pipe in Chapel-street and Crawford-street, stating the pipe in question is for the purpose of supplying energy from Manchester-square station, and not from a Paddington station, and that the Board of Trade be informed accordingly. A similar recommendation was submitted referring to the Metropolitan Supply Company's amended notice as to the laying of a second 5in. pipe (as there is no further room in the present pipe for cables) across South-street at the Manchester-square station, and along the south side of South-street to the east side of Manchester-street. Messrs. Greenwell and Co., solicitors, have reported that the Bill for the confirmation of the Council's electric lighting provisional order had received the Royal assent.

Ayling Challenge Cup.—The annual race for the above trophy was rowed on the Thames at Putney on Wednesday, Sept. 11, under the auspices of the Cygnet Rowing Club. The competition is open to crews from any department of the postal and telegraph service, the winning crew becoming the holders of the cup for the ensuing 12 months, each individual member receiving in addition a gold medal in commemoration of the win. There were nine entries, the race being rowed in three heats as follows: Heat 1—Inland Section G.P.O. Juniors (winners), Eastern District Office, Eastern Central District Office. Heat 2—Dover Post Office (winners), South-Western District Office, Northern District Office. Heat 3—Inland Section G.P.O. Seniors (winners), Portsmouth Post Office, Richmond Post Office. The final, which proved an exciting race, was won by Dover, who led at the finish by only half a length. The names of the winners are Messrs. G. Sanders (stroke), F. Sanders, A. Edwards, G. Cole, and E. Chettle (cox.). This is the first year the cup has been won by a provincial crew. The visitors were entertained by the Cygnet Rowing Club after the race, and a very enjoyable concert, at which the cup was presented to the winners, brought the day to a close.

Willesden.—Mr. H H. Law has held an enquiry into the application of the District Council for sanction to borrow £143,094 for purposes of electric lighting, and probably the supply of electrical power for factories, etc. Mr. R. Murray, the electrical engineer, said in preparing his scheme he kept prominently before him designing which would allow of enlargement and the supply of continuous current. The district was a triangular one, and the scheme would enable an economical supply to the whole. The voltage would be 240 on the three-wire system, and the electrical energy would be generated at one works, which would be near the Midland and S.W. Railway, and would directly supply a square mile and a half. Three miles distant there would be a sub-station, to which the current would be supplied by the alternating high-tension system. There would be 15 miles of streets in which distributing mains would be laid and a supply given at the outset. Ninety-four arc lamps would be provided for street-lighting, and the total cost would be £139,648. At the generating station the dynamos could supply 1,000 kw., and the sub-station 550, and the total cost would be £143 per kilowatt. He thought there was every possibility of having 18,000 lamps connected up in the first year. On the frontage of the Hampstead borough they had a demand of 350 kw. He anticipated a large demand from small property owners and tenants in the district. He had no doubt free wiring would be arranged.

Accidents.—Unfortunately we have quite a number of accidents to chronicle. Two labourers were killed at Jarrow, and we need not further comment on the accident than state that at the inquest the coroner, in summing up, said that the case was a sad one, and at the same time interesting, as showing the great danger there was with all matters of electricity. So far as the facts went, they seemed to show that no blame could be attributed to anyone connected with the works. The motor-house was in course of erection, but there was a barricade or obstruction at the entrance, and no one going casually about the place could come to any harm. It was evident that the men went where they had no business, and had been what was popularly known as electrocuted. The jury accordingly found that the men had been accidentally electrocuted in the motor-house at Palmer's new forge.—Some Electrical Volunteers proceeding to Galleywood last week to practice with a large searchlight which Messrs. Crompton and Co., Limited, have just finished for the War Department, had a costly mishap. On leaving the gates of the Arc Works, the two-wheeled carriage on which the apparatus is conveyed tipped up, and the mirror was badly dented. The damage is stated to be about £60, the mirrors being very expensive.—At the Urban Council's works at Worksop one of the engine cylinders burst. The damage will take some time to repair, but as duplicate engines have been provided, the successful opening of the works was in no way interfered with.

Walsall.—The Electric Lighting Committee's last report recommends: "That the scale of charges for electric current for lighting purposes be amended by reducing the number of hours the maximum load shall be charged for at 6d. per unit from 273 to 230 in each half-year, which will represent striking off one hour and a half for each Sunday, Bank Holiday, Christmas Day, and Good Friday, from the number of hours in respect of which the maximum charge of 6d. per per unit has hitherto been made, which it is estimated will involve a loss of revenue of about £300 a year. That the scale of charges for electric current for motive power be amended by reducing the number of hours at which the charge of 2½d. per unit shall be made from 300 to 200 per quarter, so that all units above the last-mentioned quantity will in future be charged at 1d. per unit. That the alterations in the scale of charges for electric current for lighting purposes and for motive power mentioned in the two last preceding resolutions, take effect as from July 1 last. That the electric mains be extended from the Freer-street transformer station, along Freer-street, Goodall-street,

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High-street, Temple-street, and Sandwell-street, to Highgate-road, at an estimated cost of £1,700; that application be made to the Local Government Board for a loan to defray the cost; and that the committee be authorised to proceed to carry out the necessary work." The following notice of motion has been given: "That after Sept. 29 next the price of the electric light now supplied by the Walsall Town Council be charged to consumers at the same price and upon the same basis as is now charged by the West Bromwich Town Council to their customers—viz., for the first hour, 4½d.; for two hours, 3d.; for three hours, 2½d.; for four hours, 2¼d.; for five hours, 2d.; and for power purposes, 1d. per unit."

Manchester.—In view of the approach of the dark days, says the *Manchester Guardian*, some curiosity is naturally felt with regard to the supply of electric light and power in the city. The only generating station at present in use is that in Dickinson-street, which has been working at full pressure for some considerable time. The new works in Bloom-street, which when completed will produce electricity equal to 14,000 h.p., are still far from finished. It is only within the last few weeks that the authorities themselves have felt free from anxiety as to the rate of progress at this station. It is now stated, however, that the boiler-house, which with the chimney flues is the most pressing work at present, will soon be completed. It is therefore hoped that by the end of October the Bloom-street works will contribute as a first instalment an additional horse-power of 3,500, which will considerably relieve the Dickinson-street plant, and enable an adequate supply of power to be maintained throughout the winter. The work at Stuart-street is also being pushed forward. The voltage of the current contributed from the works at Dickinson-street only amounts to 400, but when the new works in Stuart-street are completed the sub-stations will be fed with current at 5,000 volts, generated by six three-phase alternators. The total output of these works is estimated at 15,000 h.p. Already the footings are in position, and the workmen have commenced upon the engine-bed, and the foundations for the chimney are now in place. Should all go well, the first two Stuart-street sets may be at work by next May. With regard to the failure to supply electric light at a distance from the works, the explanation is that no superfluous power is available, and the officials cannot as yet connect the supply. As soon as the first instalment is at work at Bloom-street, the authorities hope to be able to light up the more urgently required of the connections. With the completion of the Bloom-street works to supply 14,000 h.p., and Stuart-street with 15,000 h.p., there will be ample power for all purposes.

Cardiff.—In his report to the Electrical Committee on Tuesday, Mr. Ellis reported that the increase of current for the month of August in consumption was 45 per cent., compared with the previous August. There were now 439 consumers, taking current equivalent to 43,933 8-c.p. lamps, an increase of 48 per cent. on last year. The Board of Trade units were 72,497, an increase of 48 per cent. The greatest number generated in one day in the month was 3,909, and the maximum load reached on the machines was 714 kw. The calculated revenue from street-lighting was £163. 17s. 3d., and private supply £747. 11s. 4d.—an increase of 26 per cent., although the calculation is now made on 4d. per unit instead of 6d., as was the case last year. The total cost per unit was 3·39d., this including works and management costs and interest on loan charges. In July the cost was 4·4d. per unit. Messrs. Siemens Bros. have erected a new 300-kw. set, which should carry them over the winter load. Mr. A. Ellis said he intended to deal with the question of free wiring as soon as they received power to borrow money. He would not recommend the Corporation to actually do the wiring. They had in the town about a dozen contractors, and they made excellent canvassers. The Corporation would receive tenders and pay the price, and then charge the consumer the interest. This was practically the only way, as the Board of Trade would not grant corporations powers to do free wiring. In the annual report of the chief inspector of factories, Mr. T. O. Edwards, Cardiff, says: "The high-tension stations in this section of the district being the property of wealthy corporations, there has been no difficulty with regard to the recommendations of the Dangerous Trades Committee (1897). I was informed by the electrical engineer to the Cardiff Council that the local transformer stations complied with the recommendations, and I therefore did not inspect them; but as regards the sub-stations, I quote from the report of the electrical engineer to his committee: 'Many of the sub-stations are veritable death-traps. In many cases there are switches and fuses entirely unprotected with a potential of 2,000 volts across the terminals. In one sub-station there was a pair of high-pressure cables slung across the sub-station and tied up to the metal ladder by which access is gained.'"

The "Oxford."—The Oxford has just been redecorated generally, under the superintendence of Messrs. Wylson and Long, theatre architects. The whole of the seating has been changed, new carpets and upholstery have replaced the old, the stage has been considerably enlarged, and a most important extension in Hanway-street made to the building in the shape of an additional exit for the audience, and a fine stage entrance for the artistes and workers, whilst a new duplex electric lighting installation has been provided, the circuit being so distributed that should one source of supply break down the business can be carried on by the alternative supply without interruption. The internal appearance of the theatre is most striking; the tones of the wall and ceiling decoration are kept subdued, ivory and gold being the prevailing colours, whilst the draperies and upholstery, from Shoolbred's, are of a deep rich crimson. Art metal has been introduced from the celebrated ecclesiastical *ateliers* of Benham and Froud. The whole of the pillars are encased with hammered and repoussé copper, and the dados on the ground floor and balcony contain most artistically designed panels of rich gold metal. Altogether the effect of this new scheme of decoration is strikingly handsome and solid without seeming to be heavy. The existing saloons have been sumptuously redecorated, and a new *foyer* in the balcony level has been commenced. A most thorough system of ventilation has been established by means of a large number of partly concealed electric fans. A fireproof curtain and various other improvements have been added, making the whole a most comfortable and beautiful house. The fans were fixed by the electrical engineer in charge, Mr. T. Holman, who has also perfected certain arrangements in regard to a new stage arc lamp made by Messrs. Clement and Gilmer. This lamp, which can be focussed sharply at any distance, gives an absolutely pure white light without any prismatic interferences. Messrs. M. Leo. Sutherland, Victoria-street, S.W., who were the contractors for the electric lighting installation, are now erecting a new switchboard on the stage. Mr. G. W. Partridge is the consulting engineer to the Oxford Theatre Company. The magnificent new curtains and the decorating was in the hands of Messrs. Campbell and Smith, and the building contract, which included a new stage entrance, enabling carts and animals to come up to the stage direct from the street, has been executed by Mr. Ben Kirk, formerly Kirk and Co. All gas has now entirely been done away with, if we except the performers; every part of the house is alternatively connected with the St. Pancras and Metropolitan Companies. There are 16 arc lamps and an equivalent of over 2,500 8-c.p. lamps connected. The show itself is keeping up its old reputation for excellence and for novelties, and the house is as full as ever.

New Issue.—Accumulator Industries, Limited, who have a capital or £40,000, divided into 20,000 ordinary shares of £1 each, and 4,000 7 per cent. cumulative preference shares of £5 each, are issuing 2,000 7 per cent. cumulative preference shares of £5. The directors are Henry Leitner, engineer, Maybury, Woking, Surrey; Berthold Kuettner, engineer, Commercia-road, Woking, Surrey; and Alfred Thompson, M.I.E.E., 32, Craven-hill-gardens, W. This company was incorporated on Sept. 12, 1900, with a capital of £10,000, in 10,000 ordinary shares of £1 each, and by a resolution of the company dated Sept 10, 1901, was increased to £40,000, divided into 20,000 ordinary shares of £1 each, and 4,000 cumulative preference shares of £5 each, of which due notice has been given to the registrar of joint-stock companies; 2,000 only of the cumulative preference shares of £5 each are now offered for subscription, the balance being available for future issue. The company was formed to carry into effect certain agreements hereinafter mentioned and for the manufacture of electrical accumulators, controllers, motors, and electrical vehicles of every description. The company has secured agencies from manufacturers of electrical machinery and components connected with accumulators and electrical appliances and accessories. The specialities of the company are: (1) light automobile and launch traction accumulators; (2) intermediate traction accumulators for work where the greatest possible durability without excessive weight is required; (3) stationary accumulators for central stations and power-houses, as well as for private lighting installations. The company has established through its American representative, Mr. John A. Chrystie, an office in New York, and has made arrangements whereby the British and Foreign Electrical Vehicle Company, Limited, of 14, Devonshire-square, E.C., 4, Bloomsbury-place, Bloomsbury-square, W.C., 11, Johnson-street, Notting Hill-gate, W., 15, Bury-street, South Kensington, S.W., and 9, Juxon-street, Lambeth, S.E., will act as their London agents and carriage-builders. The latter company has great facilities for the sale, equipment, charging, storing, and hiring out of electrical vehicles, which are to be equipped with "Leitner" accumulators, and the estimated requirements for batteries through this agency are very considerable, and in themselves necessitate an immediate extension of the company's plant. The company has established in Scotland an agency with the firm of Messrs. Middleton and Townsend, of Edinburgh, who, judging from past experience, estimate their requirements for stationary and traction accumulators for the forthcoming year at £5,000, and they consider that probably this amount will be exceeded. The works now occupied by the company have been erected on an estate in Woking, where there is ample room for extension. The property is sufficiently large to allow for a trial track being laid down for automobiles. The works are within a few miles of the Thames, where launch equipment already forms a business for the company.

Colne.—Progress is being made with the construction of the new electrical works which are in course of erection at Phillips-lane. We understand that Mr. A. G. Cooper, the engineer, is quite ready to supply current to the new technical school, sufficient machinery having been installed, together with a switchboard, over which a temporary wooden roof has been erected to allow the current to be sent to the transformer station. The turbine will find its home in the engine apartment adjoining the dust destructor, and at the new works on the other side of the Calder Brook temporary accommodation has been made for the switchboard and the balancer boosters. When all is ready the dynamo—which is supplied by Messrs. Greenwood and Batley, who are engineers of the light railway scheme which will be worked in conjunction with the lighting and traction works—gives a total voltage of 480. Balancers fitted with boosters are to be used to equalise the two sides of the three-wire, continuous-current system, so that it will be practical to use the 240-volt lamps. The works will comprise a number of offices over the accumulator-room, an engine-room, a boiler-house, and coal bunkers. The switchboard is of Mr. Cooper's own design, and is made entirely of marble with iron supports, so as to be perfectly fireproof, and consists of numerous panels which can without difficulty be added to as the consumption of current extends. It is fitted throughout with interlocking switches. Like all the machines, it has been designed for both lighting and traction. The whole station has been designed with the idea of possible future extensions. The battery-room below the offices will accommodate 270 cells, which will have a capacity of 250 kilowatt-hours The engine is of the Belliss pattern, the switchboard is by Cowans, of Manchester, and the balancer booster is by Siemens Bros. There will be rooms for the chief engineer and his clerk, another for the assistant engineer, and a fourth for the testing of meters. A bridge will be thrown across the river to connect the

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destructor premises and those of the generating station, and the abutment on the lower side will form the pumping-room for lifting water for condensing purposes. In the boiler-room will be space for three Lancashire boilers. The chimney shaft has been placed in the centre, so that a similar boiler-house can be placed on the other side. Already 40ft. of its 170ft. height has been constructed. At the destructor works is the steam-turbine capable of supplying three or four thousand 8-c.p. lamps. The total estimate is £25,000, both for lighting and for supply of the power for the new Colne and Trawden light railway. Current will be supplied on the maximum-demand principle at 6d. and 2½d. per unit, and 2½d. per unit for power for the first four hours, and afterwards a sliding scale which will bring the price to 1½d. for a 10 hours' daily supply. Public street-lighting by electricity will probably be adopted when the tramways are ready, as the same posts as are used for the overhead trolley system can be brought into requisition for lamp-posts. At the present the current will be supplied to private consumers and to some of the institutions.

Bradford.—The foundation stones of the new generating station now in course of erection for the Corporation in Valley-road were formally laid on Tuesday by Mr. T. H. Shaw, the chairman, and Mr. J. Akam, the deputy-chairman of the Electricity Committee of the Corporation. The city electrical engineer (Mr. R. A. Chattock), the architects (Messrs. H. Mawson and R. Hudson), the contractors (Messrs. L. and F. Obank), and a number of visitors attended the ceremony. Mr. Shaw said in 1899 the capital expended was £18,456, while in 1900 it had increased to £280,649. The number of consumers had risen from 43 to 1,277. Following the ceremony, luncheon was taken at the Great Northern (Victoria) Hotel, at which Mr. Shaw presided. The new works will face the Midland Railway Station, and the buildings are so designed that they may be duplicated by building a second engine-house. The portion of the engine-room at present being built will accommodate three engines, having a total of 6,000 h.p. The electric generators each have a capacity of 1,000 kw. The engine-room will be capable of containing five units of plants, with a total capacity of 10,000 h.p., and it is proposed to instal six boilers with a capacity of 4,800 h.p. The coal-store will be capable of housing 2,000 tons. The completion of the buildings has been delayed owing to the dispute in the building, but everything is expected to be in working order by next summer. The interior of the engine-room will be built with glaze bricks of an ornamental design. The section which is now being erected will accommodate three engines having a total horse-power of 6,000. Two of these are now on order with Messrs. Cole, Marchent, and Morley, Limited, of Bradford, and are practically finished. The electric generators, each having a capacity of 1,000 kw., have been built by the British Westinghouse Electric and Manufacturing Company, Limited, and have already been delivered. Surface-condensing plant will be installed to be used in conjunction with these engines, and will be operated in connection with the cooling tower that is now being erected over the reservoir. An electrically-driven 30-ton overhead crane will be installed in the engine-room for the purpose of erecting or repairing any parts of the plant. The engine-room when finished will be capable of containing five units of plant, having a total capacity of 10,000 h.p., and the second engine-room at the back of the boiler-house will be of the same capacity, making the total output of this station when finally completed equal to 20,000 h.p. The boiler-house is arranged for two batteries of boilers, and it is proposed to adopt the watertube type of boiler, fitted with mechanical stokers and superheaters. It is proposed to instal six boilers, having a total capacity of 4,800 h.p. The gases from these will pass into a main flue, which will conduct them through an economiser and into the chimney. This has been arranged in as direct a way as possible, in order that full advantage may be taken of the chimney draught. A circular brick chimney will be built having an internal diameter of 13ft. It is to be 200ft. high, and capable of dealing with the furnace gases required by 10,000 h.p.

Glasgow.—The report of the Committee on Electricity (just issued) shows that the gross revenue amounts to £79,449. 14s. 11d., and the working expenditure to £46,647. 4s. 11d., leaving a balance of £32,802. 10s., out of which the committee had to meet the following requirements: (1) interest on loans, £24,547. 4s. 3d.; (2) sinking fund, £8,662. 19s. 4d.—together, £33,210. 3s. 7d., leaving a deficit on the year's ordinary working of £407. 13s. 7d., to which add proportions of cost of lamps and fittings supplied to consumers consequent on change of voltage, charged to this year's revenue account, £4,109. 13s. 4d., making the deficit for year £4,517. 6s. 11d., to meet which there has been applied the amount standing at the credit of the reserve fund, £4,517. 6s. 11d. From the capital account there has been transferred to revenue account a sum of £13,847. 9s. 3d., being the amount expended during the past three years for lamps and fittings supplied to consumers in consequence of the change of voltage. The proportion as above, borne by the current year's revenue, is £4,109. 13s. 4d., leaving a balance of £9,737. 15s. 11d., which has been placed to a suspense account to be written off in four years. The committee regret that the result of the year's operations has not been more favourable, which is due to the increased interest and sinking fund charges on the large amount borrowed for the new works and mains, which are not yet wholly productive, and also to the special charge on account of lamps and fittings. The quantity of electricity sold to private consumers during the past year was 6,290,819 units, as compared with 3,788,795 units during the previous year, being an increase of 66·04 per cent. The above 6,290,819 units were sold at the following prices: 1,249,352 at 6d. per unit, 151,684 at 4d., 550,630 at 3½d., 31,460 at 3d., 369,952 at 2½d., 963,130 at 2d., 2,509,906 at 1½d., and 464,695 at 1d. The number of consumers on May 31, 1901, was 4,031, as compared with 2,852 at May 31, 1900, being an increase of 1,179, or 41·34 per cent. during the year. There were 185 consumers who consumed the equivalent of five hours or over per day of their maximum demand throughout the year. The number of motors in use and supplied off the Corporation mains as at May 31, 1901, was 427, with a total horse-power of 1,894, as compared with 212, with a total horse-power of 754 as at May 31, 1900. The total number of arc lamps erected and in regular use in the streets as at May 31, 1901, was 348, as compared with 265 at the same date last year, and the quantity of electricity consumed for street and stair lighting was 523,172 units, as compared with 461,874 during the preceding year. The number of units consumed by private consumers, per lamp fixed, averaged out month by month, according to the date of connecting up, was 20·46, as compared with 17·42 last year, but this figure also cannot be taken as absolute for the reason above stated. The buildings at Port-Dundas having been completed so far as the first section was concerned, and the buildings at Pollokshaws-road being also practically completed, your committee thought it fitting to formally inaugurate both of these stations, which was done by the Lord Provost and the other members of the Corporation on Sept. 13 last. The department, the plant at Waterloo-street and at Kelvinside station, has a total engine power of 16,380 h.p. The Kelvinside works, purchased from the Kelvinside Electricity Company, have had a careful overhaul, an additional boiler of 1,200 h.p. and three 360-h.p. engines and dynamos having been laid down. The works have a capacity for about three times this plant. Meanwhile the extension already made is justified by the further increase during the year of the number of consumers in the Kelvinside area.

Fulham.—At the meeting of the Borough Council on Wednesday, the Establishment Committee reported that with a view of carrying out the resolution of the Council of July 24, 1901, authorising the laying of distributing mains in Wandsworth Bridge-road, at an estimated cost of £5,500, and the provision of additional boiler power at an estimated cost of £4,000, tenders have been invited from the following firms: mains, lamp-posts, and work generally in the streets—British Insulated Wire Company, Callender's Cable and Construction Company, Johnson and Phillips, Henley's Telegraph Works Company, and W. T. Glover; new panels to main and rectifier switchboards and new rectifier—Ferranti, Limited; arc lamps, switches, and cable connections in the lamp-posts—General Electric Company (Manchester); sub-station, and excavation and foundation work for new boilers—F. G. Minter and George Neal (Willesden-lane); new transformers—Johnson and Phillips and Electric Construction Company; boilers—Davey, Paxman, and Co. (Colchester), R. Taylor and Sons (Marsden), E. Danks and Co. (Oldbury), Lindsay, Burnett, and Co. (Govan), and Babcock, Wilcox, and Co.; pipework—contractor for the boilers, Mirrlees, Watson, and Co., Aiton and Co., and William Boby; new coal conveyor and coal store—Barry, Henry, and Co. and Mirrlees, Watson, and Co.; induced draught plant — Sturtevant Engineering Company and Erith Engineering Company. The Local Government Board having sanctioned the scheme for engineering works at the infirmary, and for lighting by electricity the offices, workhouse, and infirmary of the Board of Guardians, Mr. Medhurst has been instructed to prepare the necessary specification of works, plans, and forms of tender upon the following terms—viz., for making report, preparing specifications and plans, and, if approved, superintending the works to completion, 5 per cent. upon the cost of the work, exclusive of engineer's fees, quantity surveyor's charges, clerk of works' salary, etc. The estimate of £10,220 for such work is to be adhered to as closely as possible. The following resolutions were passed: "(1) To the provision of increased boiler accommodation and the erection of a chimney at the workhouse, and to the execution of works and the provision of machinery and apparatus for the purpose of lighting by electricity the workhouse, infirmary, and Board's offices of the parish, in accordance with plans to which the Local Government Board have affixed their seal, subject, nevertheless, to such modifications as the Local Government Board might direct; (2) to the expenditure for the above purposes of a sum not exceeding £11,111; (3) to the borrowing of such an amount or such part as might be necessary for the purposes in question." It was further decided that of the sum so borrowed £2,000 should be repaid within a period not exceeding 30 years, and £9,111 within a period not exceeding 15 years. The Consulting Engineer submitted a report to the Council on Wednesday with regard to proposed extensions in the electric lighting system. After dealing with a number of details, the engineer submitted estimates, as under, for various items in connection with the proposed extensions: boilers, flues, etc., £3,680; steam, exhaust, and other pipes, £900; condensing plant, £800; engine-room plant, £9,100; sub-station equipment, £1,400; arc lamp posts, etc., £5,723; mains, conduits, etc., £23,357; builder's work, £900; engineering expenses, etc., £3,680; other electrical work brought up the total estimated expenditure to £74,400. The Council decided, subject to the necessary estimates being submitted to the Finance Committee, to sanction the various extensions.

PROVISIONAL PATENTS, 1901.

SEPT. 9.

18023. Improvements in electric storage batteries. Lars Bristol, 70, Chancery-lane, London.

18027. Improvements in electrical machines and motors. Georges Guy, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18030. Improvements in electrical apparatus for transmitting the speed of a rotating body to an indicator at a distance. Alfred Upton Alcock, 46, Lincoln's-inn-fields, London.

SEPT. 10.

18079. Improvements in electric heating systems for cars. Frank Clarence Newell and Edwin Musser Herr, Westinghouse-building, Norfolk-street, Strand, London.

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18082. An improvement in direct-current generators or motors. Harold Edward Donnithorne, 12, Birdhurst-road, East-hill, Wandsworth, London.

18093. Improvements in or relating to electric gas lighters. Henri de Thiersant, 4, South-street, Finsbury, London. (La Société Radiguet et Massiot, France.)

18100. Apparatus for registering telephone calls. Harry Snowdon, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

18105. Improvements in coherers or detectors for electrical waves. Guglielmo Marconi, 24, Southampton-buidings, Chancery-lane, London.

18110. Improvements in connection with electrically-operated cranes and other electrically-operated machines or vehicles. John Brown and Co., Limited, Tolmie John Tresidder, and David George Jones, 47, Lincoln's-inn-field, London.

SEPT. 11.

18124. Improvements in electrical switches. Arthur Henry Hickley, 10, St. George's-crescent, Liverpool.

18125. Improvements in and connected with electrical controlling switches. Arthur Henry Hickley, 10, St. George's-crescent, Liverpool.

18155. Improvements in electric circuits and electromagnetic regulators. Otis Elevator Company, Limited, 55, Chancery-lane, London. (Otis Elevator Company (Incorporated), United States.) (Complete specification.)

18169. Improvements in searchlights or projectors for naval and military purposes. Crompton and Co., Limited, Rookes Evelyn Bell Crompton, Arthur John Hodgson, and John William Ewart, 55, Chancery-lane London.

18179. Improvements in electric cables. Julius Henrik West, 46, Lincoln's-inn-fields, London. (Complete specification.)

18180. Improvements in the manufacture of electric cables. Julius Henrik West, 46, Lincoln's-inn-field, London. (Complete specification.)

SEPT. 12.

18228. A method of testing the lines of electrical fire-alarm, burglar alarm, and call systems. August Eckstein and Francis George Bell, Peel Works, Adelphi, Salford, Manchester.

18246. Improvements in and connected with magnetic separators. Carl Scholl, 6, Lord-street, Liverpool. (Complete specification.)

18256. Improvements in electric accumulator batteries. Maxime Jean-Baptiste Alfred Colletas, 18, Buckingham-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Feb. 12, 1901, being date of application in France.) (Complete specification.)

18258. Combined electric logs and speed recorders. Francis Napier Dennison, 4, South-street, Finsbury, London.

18267. Improvements in or relating to detectors and so-called coherers for the detection of electrical disturbances, Hertzian waves, light waves, and other radiations. Jagadis Chunder Bose and Sara Chapman Bull, 70, Chancery-lane, London.

18268. Improvements in or connected with electrical resistances. Jagadis Chunder Bose and Sara Chapman Bull, 70, Chancery-lane, London.

SEPT. 13.

18273. Improvements in methods of electric haulage and locomotion. George Cawley, 29, Great George-street, Westminster, London.

18282. Improvements in and relating to fittings for electrical lamps or gas fittings and the like purposes. Herbert Cooke, 104, Colmore-row, Birmingham.

18288. Supporting and automatic disconnecting shackle for electric tramway cables and other electric traction work. William Henry Stewart, 15, St. James's-road, Liverpool.

18314. Improvements in means for measuring the energy of three-phase alternating-current circuits. Frank Conrad, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Feb. 14, 1901, being date of application in United States.)

18322. A bond for making an electrical connection between the hub and the felloe and tyre of railway and the like wheels having a wooden or other non-conducting body portion. Arthur Henry Johnson, The Avenue, Bickley, Kent.

18329. Improvements in electric circuit breakers. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

18330. Improvements in electric motor control systems. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

18331. Improvements in systems of electric motor control. Frank E. Case, Bush-lane House, Cannon-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Feb. 15, 1901, being date of application in United States.) (Complete specification.)

18332. Improvements in electric rheostats. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

18346. Improvements in recording apparatus for electrical currents. Rudolf Ziegenberg, 18, Buckingham-street, Strand, London.

18350. Improvements in or relating to arc lamps with contact weather-hoods, safety catch, and wire-rope attaching device. Charles Oliver, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

SEPT. 14.

18393. An improved electric furnace. James Farnsworth, 20, Washford-road, Attercliffe, Sheffield.

18395. Improved system of operating and controlling electrical lifts. Henry Cecil Walker, 60, Queen Victoria-street, London.

18460. New or improved controlling apparatus for electrically operated or driven ammunition rammers. August Reichwald, 33, Chancery-lane, London. (The firm of Fried. Krupp, Germany.)

18417. Improvements in the manufacture of electrically insulating acid-proof materials and objects made therefrom. Robert Abrey, 77, Chancery-lane, London. (Complete specification.)

18428. Improvements in systems of electric motor control. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Philip Farnsworth, United States.) Complete specification.)

18430. Improved means or apparatus for detecting or indicating light waves, Hertzian waves, and other radiations. Jagadis Chunder Bose and Sara Chapman Bull, 70, Chancery-lane, London.

18437. Improvements in incandescent electric lamps. James Wright Forster, 46, Lincoln's-inn-fields, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 5.

1900.

15864. Street lamp fittings for incandescence electric lamps. Hawtayne.

16164. Electrical measuring instruments. Heap.

16389. Apparatus for trimming commutators. Phillips.

16415. Means for supporting electric lamps. Inglefield.

17404. Globes or shades and holders for attaching the same to lamps, gasoliers, electroliers, brackets, and the like. Banks.

18283. Junction boxes suitable for connecting high-tension electric conductors. Hetherington and British Electric Transformer Manufacturing Company, Limited.

18284. Electric transformers. Berry and British Electric Transformer Manufacturing Company, Limited.

18855. Electrically driving machine tools or other mechanism. Humpage and Epicyclic Manufacturing Company, Limited.

18940. Means for the electrical illumination of the dials of ships' telegraphs and for similar purposes. Evershed and Vignoles, Limited, and Evershed.

19470. Electric switches. Crompton and Co., Limited, and Brunton.

19511. Dynamo-electric and electro-dynamic machines. Mawdsley.

19594. Alternating-current transformers or economy coils. Davies.

19595. Arc lamps. Davies.

20146. Sound-strengthening appliance for telephone stations Oprendek and Röder.

20197. Construction of metal troughs for laying electric mains. Lachman.

20201. Apparatus for covering electric conductors with insulation. Heyl-Dia.

20264. Connections for electric mains. Burnet.

20466. Electric apparatus for exploding mines. Evershed and Vignoles, Limited, and Evershed.

20631. Automatic electric carriages and appliances for the transport of light goods or traffic. Dubs and Laffitte.

21615. Socket joints of metallic telegraph and like poles. Chambers.

23852. Devices for indicating and measuring pulsatory or varying magnetic fields. Dietze.

1901.

5306. Conductors, conduits, and collectors for electricity on railways and the like. Sayer.

10088. Apparatus for treating affected parts of the body with heat, light, or electricity, in certain cases simultaneously. Timar.

14967. Apparatus for refining metals by electrolysis. Lake. (Betts.)

15146. Trolley stands for electric cars. Marks. (Parker and Paton.)

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15335. Trolley catcher or controller for electric cars. Earll.

15349. Regulating devices for motors. Boult. (Soc. Anon. d'Electricité et d' Automobiles Mors.)

15714. Electric alarms. Vidl.

15801. Holders for electric incandescent lamps. Hubbell.

15845. Electric fans and motors therefor. Brown.

16062. Electric sparking devices for internal-combustion engines. Simms and Bosch.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Sept. 7	814	735	+ 79	—	—
Birmingham Tramways	,, 14	4,810	4,580	+ 230	164,895	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 13	583	511	+ 72	18,412	16,599*b*
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 14	1,234	1,329	- 95	15,946	15,850
Bolton Corporation	,, 15	1,556	1,478	+ 78	53,813	43,095*b*
Bradford Corporation	,, 8	1,191	679	+ 512	29,963	16,155*b*
Bristol Tramways Company	,, 13	4,011	3,683	+ 328	—	—
Carlisle Tramways Company	,, 14	191	214	- 23	2,362*b*	2,254
Central London Railway	,, 14	5,658	4,833	+ 825	—	—
City and South London Railway	,, 15	1,836	1,506	+ 303	20,230	16,528
Cork E. T. and L. Company	,, 12	524	502	- 21	17,285	15,245*b*
Darwen Corporation	—	—	—	—	—	—
Dover Corporation	,, 14	276	275	+ 1	8,144	7,692*b*
Dublin & Lucan Electric Railway	,, 15	117	121	- 4	1,589	1,330
Dublin U. T., electric cars	,, 13	3,794	3,839	- 45	—	—
Dublin S. District, Electric	,, 13	968	1,079	- 111	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 14	13,706	9,932	+ 3,774	—	—
Halifax Corporation*	,, 15	2,427	1,862	+ 565	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 15	1,326	1,637	+ 311	14,651	19,078
Liverpool Corporation	—	—	—	—	—	— *b*
Liverpool Overhead Railway	,, 15	1,607	1,719	- 112	18,966	19,206
Oldham-Ashton-Hyde Tramways	—	—	—	—	—	— *b*
Portsmouth Corporation	,, 14	1,047	—	- 105	—	—
Potteries Tramways	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 15	3,815	—	—	—	—
Southampton Corporation	,, 11	959	792	+ 166	—	—
Southport Corporation	—	—	—	—	— *d*	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. *b* From Jan. 1. *d* From April 1. 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £506 decrease.
Barcelona Ensanche y Gracia, £51 decrease. Barcelona, £154 increase.
Brisbane, £39 decrease.
Buenos Ayres and Belgrano Electric, £342 increase.
Calcutta, £134 increase.
Cape Town (month of Aug.), receipts, £14,799; expenditure, £7,009.
Mexico Electric (month of Aug.), receipts, £17,900; expenditure, £10,800.
Perth Electric, £229 increase.
Port Elizabeth (month of Aug.), receipts, £3,151; expenditure, £1,844.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅝-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	9 16-11/16
—— Ordinary, 1-125,000	1 ..	⅝-¾
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6¾
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4¾-5¼
Brush Electrical Engineering, Ordinary	2 ..	1¼-1¾
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	110-114
—— Ordinary	5 ..	15-16
—— 5 per cent. Pref.	5 ..	5⅜-6¼
Crompton and Co.	3 ..	3¼-3⅜
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	⅛-¼
—— 5 per cent. Debentures	5 ..	1¼-2¼
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	85-90
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16¼-17½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21½-22½
—— 4 per cent. Debentures	100 ..	101-104
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10¼-11¼
—— 5 per cent. Cum. Pref.	5 ..	5¾-6¼
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-100
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10¼
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	7⅞-8¼
—— 7 per cent. Preference	5 ..	8¼-8⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7¼-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105
Chelsea Electricity Supply	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	11½-12⅝
—— 5 per cent. Debenture Stock	100 ..	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-103
County of London and Brush Provincial, Ordinary	10 ..	8-9
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	103-106
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5⅞-6¼
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5⅜
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13-14
—— ,, 85,001-98,769	5 ..	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-114
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7¾-8¼
—— £2½ Shares, New	4½ ..	7-7½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5¼-6¼
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	8¼-9⅛
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	12-13
Electric Railways.—		
Central London, Ordinary	100 ..	102-105
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	99-102
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	51-54
—— Ordinary	10 ..	5-5¼
—— 4 per cent. Debenture Stock	100 ..	113-118
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	92-95
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4⅛-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-128
Blackpool and Fleetwood Tramroad	10 ..	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6-6¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14-15
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11¾-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	123-126
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅝-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	104-107
—— Prov. Cert., all paid	100 ..	98-102
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅛-1⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5¼-5⅜
—— 4 per cent. 1st Mortgage Debentures	100 ..	103-106
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22¼
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	105-107
New General Traction, Ordinary	5 ..	3-3¼
—— 6 per cent. Cum. Pref.	10 ..	4¼-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-10¼
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8s. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	3⅜-3⅞
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅜-4⅞
—— 4 per cent. Deb. Stock, Red.	100 ..	95-98
—— 3½ per cent. Deb. Stock, Red.	100 ..	95-98
Oriental Telephone and Electric Company	1 ..	⅛-¼

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NOTES.

Long-Distance Telephony.—In about a month or two the London-Brussels cable will be laid. In this connection it is interesting to note the result of some tests which the Post Office authorities have been conducting to see how far it is possible to speak and be heard intelligibly by means of telephones. It has been found that conversation can be carried on between Liverpool and Paris. Further north than Liverpool the speaker can only be heard in Paris under the most favourable conditions.

Durham College of Science.—The governors of the above college have issued their calendar for the session 1901-2. In electrical engineering Mr. Wm. M. Thornton, M.Sc., M.I.E.E., is the lecturer. The arrangements for this session include two courses of lectures, one suitable for second-year students who have attended the junior physics course, the other more advanced and required for the third-year of the degree course in electrical engineering. Attendance in the laboratory is required one day a week for second-year students and two days a week for third-year students.

Projected New Cable to the Philippines.—A New York message announces the incorporation of the Commercial Pacific Cable Company, with a capital of £20,000, for the purpose of laying a cable from California to the Philippines. The route taken will be *vid* Honolulu, and it is believed that the cable will be completed within two years. It will connect all the Philippines with the cables to Japan and China, and will thus reduce the cable rates from the United States not only to the Philippines, but also to China and Japan from 30 to 60 per cent. We note that the company is not asking for any subsidy or guarantee.

Electricity in the Navy.—We hear that in a month or so the Admiralty will commence a series of experimental tests with a view to the extension of the use of electricity for subsidiary purposes on warships. In practically all the men-of-war at present afloat the capstan, steering engines, ventilating fans, and the derrick hoists are worked by steam power. It is in regard to the controlling of this class of plant that we understand the impending tests will be made. The cruiser "Hogue," now being completed at Devonport, is being equipped with an extensive electrical plant, and all the auxiliary gear will be worked by electricity in addition to the gun and torpedo armament. It is probable that the tests will be conducted on board this vessel, which will shortly be ready for sea.

Telephonic Communication with Italy.—Very shortly Italy will be in possession of its first international telephone connection. The new line is almost completed, and runs between Milan, Turin, and Paris *vid* the Mont Cenis. A few months later will witness the inauguration of a second international telephone line between Milan and Zürich. There only remains now to be constructed a comparatively short section between Como and Chioasso on the Swiss frontier. The establishment of these lines will have the effect of placing Italy in telephonic communication with London by way of Paris, and with Berlin through the Zürich line. It is, rumoured, however, that negotiations will shortly be entered into with a view to the construction of a direct telephone line between Milan and Berlin. Many improvements in the inland telephone and telegraph service are also reported to be engaging the attention of the authorities in Italy.

Motors for Consumptives.—Dr. Dawson Turner, M.D., vice-president of the Scottish Automobile Club, has discovered a new use for motorcars. Writing to the *Times*, he remarks on the great future the automobile may have before it in effectually administering the open-air treatment to consumptive patients. Dr. Turner has been very much struck by the beneficial effects produced by a 30 to 50 miles motorcar drive. Along with a feeling of marked exhilaration, an increased appetite, and improved sleep, there is a heightened healthy glow which after a few days' treatment tends to become permanent. The tendency to cough is much diminished. To those in charge of sanatoria the doctor suggests the advisability of combining a daily run on a good motorcar at a pace fully up to the legal limit with the ordinary open-air treatment. The patients should be placed in front of the car, so as to avoid any dust thrown up by the wheels.

Telephone Competition.—At Glasgow the National Telephone Company are not able to offer the same opposition to the municipal undertaking as at Tunbridge Wells, for the following reason. It seems that when the license under which the National Company are working at Glasgow was granted, a clause was inserted that the rates should be the same as those in a number of other towns mentioned in Scotland and in the North of England. It follows, therefore, that the company cannot reduce their tariff in Glasgow in order to fight the Corporation without giving a corresponding reduction in those other towns referred to, where they are not experiencing any competition. This prevents the company from giving a preferentially low rate to their Glasgow subscribers at the expense of the subscribers in other parts of the country. It was by these preferential rates that the company in the old days killed out any local opposition they had in other places.

French Electric Illuminations.—Electricians in this country will doubtless be gratified to hear that the whole of the official electrical illuminations at Compiegne in connection with the visit of the Emperor of Russia to France were carried out on entirely English lines. The system adopted was that known as the E.L.B. system, and if we accept a correspondent's account in the *Times*, the illumination devices alone carried 12,000 lamps, whilst no fewer than 500 garlands of lights were provided, and, further, 3,000 yards of illuminated festoons. At Dunkirk, also, the same system was applied to the illumination of the prefecture buildings and the town hall. Altogether some 3,000 lamps were employed. The Transatlantic liner "La Gascogne" was lit up in the same way, as well as one of the French cruisers, the latter, it is said, being an experiment for future illumination of the French men-of-war. In view of the prejudice which English electrical inventions usually meet with abroad, the above facts are interesting as showing that such prejudice is on the wane—at least, in France.

Whitworth Scholars.—The list of successful candidates in the competition under the Board of Education, South Kensington, for the Whitworth Scholarships and Exhibitions, 1901, has been published. Scholarships of £125, each tenable for three years, are awarded to Mr. Chas. E. Handy, aged 24, engineer, of Plymouth; Mr. John E. Jagger, aged 24, draughtsman, of Manchester; Mr. Albert Wilson, aged 23, engineer, of Pontefract, Yorks; and Mr. Jas. C. Macfarlane, aged 24, draughtsman, of Cathcart, N.B. The following gentlemen are awarded exhibitions of £50 each, tenable for one year: Messrs Thomas P. Shilston, Arthur Baker, George W. Phillips, George H. Andrews, John S. Nicholson, Henry F. C. Walsworth, Thomas G. John, Harry J. Wickham, John Good, James C. Smail, Gilmour E. Brown, George E. Piper, Alexander Gray, Arthur H. Sturdee, Harry Topham, Reginald Lavender, William H. Snow, Richard E. Barber,

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Harold Scragg, Harold E. Morrow, Thornton Knowles, John Ingham, Percy M. Bennett, Ernest G. Beck, Alfred G. Fox, Harold Fowler, Frank Lord, Thomas Chester, William E. Gardner, Roland W. Parry.

Cables and Telegraphs.—The International Tele graph Bureau at Berne, Switzerland, recently issued a comprehensive report, furnishing some interesting data with regard to the submarine cables of the world. At the present time there exists as many as 1,380 Government cables, with a total length of 24,907 miles. There are also 370 cables owned by private companies. These give a total length of 198,929. So that altogether there are 1,750 cables in existence, with a mileage of 223,836. The Eastern Telegraph Company is the largest private concern, operating as it does 93 cables, with a length of 45,765. The cable from Deólen, near Brest, France, to Cape Cod, Mass., is described as the longest laid, having a length of 3,674 miles. It was built in 1898 by the Compagnie Française. From the source interesting information is available concerning land wires in Europe and the United States of America. It is estimated that in the States there is a total of 222,587 miles of telegraph lines and 1,118,086 miles of wire. For all Europe the total mileage of line is 425,600, and of wire 1,585,267. It will thus be seen that the United States possesses over one-half as much line as all the countries in Europe together, and over two-thirds as much wire. Comparing the mileage of wire to population, America has one mile of wire to every 77 persons; Great Britain and Ireland has one mile to every 130 persons; Switzerland has one mile to every 222 persons; and Belgium has one mile to every 321 persons.

Electric Fire-Damp Indicator.—Mr. G. Léon has devised in France an electrical fire-damp indicator, by means of which it is claimed the proportion of fire-damp in a mine may be determined at any instant. In describing the new method, the *Scientific American* refers to the indicators now in use, which are based upon the halo given by a flame in the air containing fire-damp. Mr. Liveing, an English engineer, has devised an electric indicator based on the difference in redness of two platinum wires heated by the same current and placed in pure and in contaminated air. This method will show about $\frac{1}{2}$ per cent. In the present method Mr. Léon uses instead the difference of electric resistance of two platinum wires heated to about 1,000deg. C. by the same current. One of the wires is stretched in a sealed glass tube, and the other (for the fire-damp) placed in a wire gauze case. The two wires form the two branches of a Wheatstone bridge, the other two branches being formed of suitable resistance wires, in this case of 1·3 ohms each. For the galvanometer of the bridge a Chauvin and Arnoux instrument is used, giving a deflection of 100 divisions for 50 milliamperes. Two cells of accumulators give the current, and the resistances are adjusted till the needle remains at zero when both wires are in pure air. When the air contains fire-damp the galvanometer is deflected two divisions for $\frac{1}{1000}$th part of fire-damp These deviations are about proportional to the quantity of gas. In conclusion, the author considers that it may even be possible with his apparatus to establish fire-damp observing stations, and thus contribute greatly to the scientific study of the subject.

The Inner Circle.—Two or three of our daily contemporaries this week have published interviews with Mr. Yerkes on the question of the electrical equipment of the Inner Circle From what Mr. Yerkes told the reporters it would seem that a solution of the problem as to what system of traction is to be adopted is as far off as ever it was. In the words of the American financier himself: "The controversy between the Metropolitan Company and the District Company is no nearer an amicable solution than it was long ago. There has been considerable correspondence between the two companies, resulting in practically nothing. The Metropolitan Company, while making a show of being in a great hurry, has changed its tactics, and now that the arbitrator has been appointed, is asking for delay." Mr. Yerkes goes on to state that while the Metropolitan Company have written a letter to the arbitrator, in which they urgently request that more time be given them, the District Company are urging that the matter be taken up at once. We are quite with Mr. Yerkes when he says: "Considering the fact that both companies are losing a great deal of money by virtue of being compelled to run their trains by steam, it is really remarkable that both should not join in earnestly requesting the arbitrator to proceed as rapidly as possible." That Mr. Yerkes feels very strongly indeed on the present state of things may be gathered from his concluding words: "I have no reluctance whatever in making this statement—in fact, some time ago the vice-chairman of the Metropolitan Company wished that all business regarding the two companies should be made public."

The Singkep Commutator.—At last year's meeting of the British Association, Mr. David P. Todd described the Tripoli commutator—a mechanical device which he employed at that station on May 28, 1900, for operating the eclipse instruments automatically. The fortunate accident of locating the instruments on the roof or terrace of the British consulate made it possible to drive the cords from the commutator barrel by gravity. This method, however, could not be conveniently used except under like circumstances of elevation. To operate the instruments at Singkep, Netherlands Indies, was a very different problem, and led to the devising of two improvements in this type of mechanical commutator which make it universally adaptable to the needs of both astronomers and physicists. These improvements Mr. Todd described in a paper before the British Association at Glasgow a few weeks ago thus: Instead of a single barrel or drum, he used as many drums as there were instruments to be operated. Each drum was provided with a collar and set-screw, so that the process of adjusting one instrument and its automatic movements did not disturb the adjustments of others already made. In the second device, instead of employing gravity as a power to turn the drums, they were turned by hand, timed accurately to the motion of a pendulum; and the commutator cords, after unwinding from the several drums and doing their work in tripping the escapements, were returned over pulleys, each to its individual drum, where they wound up on one side just as fast as they unreeled from the other. This simple arrangement easily gave accommodation for the 80ft. of cord required by the 6 minutes 20 seconds' duration of totality.

Bremer Arc Lamp.—Mr. Laporte read a paper before the International Society of Electricians in Paris the other day, giving the results of tests of the Bremer arc lamp made in the central laboratory of electricity in Paris during the last exhibition. The characteristic features of the Bremer lamp are the arrangement of the carbons, which are nearly vertical, but form an acute angle; the regulation of the arc under the influence of a magnetic field, the regulation being made automatically by the intensity of the current; and the use of a special positive carbon, the composition of which is still kept secret. For a 43 to 45 volt and nine-ampere lamp the special positive carbon has a diameter of 7mm., while for the negative carbon a Siemens carbon of 6mm. diameter is used. The special positive carbon has a considerably higher specific resistance—12,300 microhms centimetre—that of the Siemens carbon

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being between 8,300 and 9,400. The positive carbon contains a certain number of metallic salts, and during combustion rather large quantities of deposits are formed, magnesia being the principal constituent. This magnesia is deposited on a screen above the arc, which then acts as a reflector and produces a favourable distribution of the light. The colour of the light is peculiar; it is between the colour of the light of incandescent lamps and that of ordinary arc lamps without globe. The results of photometric tests and the comparison with an ordinary arc lamp show that the consumption of watts per candle for the ordinary arc lamp is about twice that for the Bremer arc lamp, the exact ratio taken from the table being $200 \div 117$. Referring to the results of his tests, the author says: "It cannot be denied that these figures are favourable to the Bremer lamp. The only point which still needs to be cleared up is whether the price of the special carbon may not offset the advantage put in evidence by the photometric tests."

Accidents on British Railways.—Fatal accidents on British railways appear to be slightly on the decline. Mr. Francis Hopwood's general report to the Board of Trade on railway accidents in the United Kingdom during 1900 has just been issued, and it is gratifying to note that the figures, as compared with 1899, represent a decrease of nearly 13 per cent. in fatalities, but an increase of about 12 per cent. in cases of injury is shown. Taking into consideration accidents occurring on railway premises with those in connection with the movement of trains, the total number of personal casualties reported last year was 1,325 killed and 19,572 injured. Of passengers, 135 were killed and 2,426 injured—that is to say, one in every 8,461,309 journeys was killed, and one in every 470,848 journeys was injured. So it will be seen that the great proportion of the casualties fell upon the railway companies' own servants. In his general observations, Mr. Hopwood has not failed to deal with the increasing demand made on railway companies to take protective measures against accidents affecting both passengers and servants. The following statement, for instance, is at least encouraging: "It is understood that the question of the provision of some improved system of fog-signalling, especially the provision of some mechanical or electrical appliance for the protection of lines during the interval which in the case of sudden fogs must often elapse before the fog signalmen arrive at their posts, is still under the consideration of the railway companies, and the matter is of so much importance that it should receive their serious attention." We do not know that up to the present the railway companies have shown any great inclination to adopt such devices as Mr. Hopwood refers to. It is high time, however, that some conclusion should be come to in the matter, and it is not too much to hope, we think, that a little pressure from the right quarter would have the desired effect.

Electric Furnace.—A patent has been granted in the States to Mr. H. A. Irvine for an electric furnace, which is an extension of the De Laval "electrolytic furnace." The new electric furnace consists of a hearth and side walls of packed carbon, surmounted by an arch and feed hopper. Carbon electrodes connected to opposite terminals of the source of electricity project through the cover of the furnace and into proximity with the hearth, the circuit being at first closed through a mass of granular coke, but in further operation by a layer of conductive slag derived from the charge itself, and maintained constant in volume by tapping the excess through the top holes of the furnace. In operation, a charge consisting of a mixture of phosphate rock and carbon, with an added flux to form the conductive slag, is fed into the furnace and the circuit closed. The flux may be basic, acid or neutral, according to the character of the phosphate treated, the essential point being that it shall determine the accumulation of a fused electrolyte in quantity sufficient to cover the furnace hearth, and to provide a path for the current between the carbons. Upon this molten bath of slag the remainder of the charge rests, and is progressively smelted by the uniform and moderate heat developed by the resistance of the electrolyte. Terminals in electrical connection with the hearth are provided in case it should become necessary to change the path of the current for any purpose. Commenting on the new device, our New York contemporary, the *Electrical World*, says that these electrolytic furnaces are essentially continuous in operation, for the slag and charge are non-conductors when cold, and if the furnace were allowed to cool difficulty would be experienced in again starting it. An obstacle inherent in the type of furnace, and one which will probably prevent any extended application of the principle, is the difficulty of securing a lining material for the hearth which shall be infusible, neither fluxed nor oxidised by the supernatant slag, and at the same time so highly resistant as to carry no appreciable proportion of the current. It would seem doubtful whether "packed carbon" is fully capable of meeting these conditions.

The Proposed Electric Railway to Brighton.—The announcement that "surveys are now being made for settling definitely the route of an electric railway from London to Brighton" looks like business, and one could almost imagine that the British Parliament had ceased to exist, or that its sanction to the scheme had already been given. So far as we know, however, up to the present no application for powers to construct an electric railway to Brighton has been lodged, although there was some mention of it some months ago. Parliamentary committees nowadays want a lot of convincing, and assuming application for powers to carry out the scheme be made in the next session, a large expenditure of money and tedious enquiries might only result in sanction being withheld. The daily Press, however, has taken up the subject in a very hopeful way, and we think it must be apparent to everyone that an electric railway to Brighton would be an immense public benefit for many reasons, not least of which is the cheap rate at which passengers could be carried. The present railway route to Brighton, it is pointed out, is 51 miles in length, but the line of the electric railway will be less than 48 miles long, and will run almost in a straight line due north and south. There will be two generating stations, one at Lambeth and one in Brighton, capable of developing 12,000 h.p. The carriages will be on the Pullman-car principle for both classes, propelled on the multiple-unit system. Whatever tunnelling is required will be done on Greathead's system, so successfully used in the construction of the Blackwall Tunnel. Convenient terminal stations will be constructed both in London and Brighton—that in the Metropolis is to be situated in Westminster, while the Brighton station will be close to the Hotel Metropole. Trains will be run to Brighton every half-hour throughout the day, and thus the necessity of puzzling over a timetable will be obviated, and that will be not the least of the advantages of the new railway. Another probably of greater importance to London holiday makers will be that the first-class return fare will be only 5s., instead of 15s. as at present, and the third-class return will be reduced from 8s. 5d. to 3s. The surveys for the new railway are being carried out by parties of railway surveyors under the direction of Mr. F. H. Cheesewright, M.I.C.E. Should the necessary powers be obtained and the lines made, the proposed half-hourly schedules will have to be changed. The

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morning and evening rush will have to be provided for by much more frequent trains.

Errors in Diffraction Gratings.—On the occasion of the recent annual meeting of the British Association at Glasgow, Mr. H. S. Allen, M.A., B.Sc., read an instructive paper on the effects of errors in ruling on the appearance of a diffraction grating. The following is a short abstract of the same: "If a spectroscope be adjusted to view a single spectral line, and the eye-piece of the observing telescope is removed, the diffraction grating is seen illuminated by monochromatic light; but in general the image is crossed by a number of dark bands parallel to the rulings on the grating. The bands may be better studied by focussing the observing telescope on the surface of the grating instead of on the slit of the collimator. The object of this paper is to explain the mode of formation of these bands. In an absolutely perfect grating, all the light going to form the spectral line of any particular order is brought to a single focus by the objective of the telescope, and the emergent cone of light is bounded by the image of the grating formed by the objective (the distance between the grating and the objective being greater than the focal length). In the case of a grating containing two rulings differing by a small amount the light from each portion will be brought to its own appropriate focus, and the two emergent cones of light will be bounded by the corresponding parts of the image of the grating. A screen placed in the position of this image would be uniformly illuminated, but if it were moved nearer to the lens the boundary between the two rulings would receive light from both the cones or from neither of them, according to the relative positions of the foci. If the screen were moved further from the lens the effect would be exactly reversed, so that a light band in one case becomes a dark band in the other. The theoretical results, which have been verified by observation, may be summarised as follows: Orders on the right of the central image (the observer is supposed to be facing the grating):—Case 1: in passing from a wide to a narrow ruling in going from left to right; focus in, light band; focus out, dark band. Case 2: in passing from a narrow to a wide ruling in going from left to right; focus in, dark band; focus out, light band. Orders on the left of the central image: the results just given must be reversed. The bands disappear when the telescope is focussed exactly on the grating.

On the Necessity for Postulating an Ether.—Mr. B. Hopkinson read an interesting paper on this subject at the meeting of the British Association at Glasgow this year, of which we give an abstract: The difference between those who say that there must be a medium to transmit gravitation and those who deny its necessity is a purely metaphysical one. All the facts of gravitation can be described or expressed without any reference to a medium. In like manner it would appear so far as terrestrial phenomena go that the facts of light transmission can be so described, in which case the necessity of an ether for conveying light is again purely metaphysical. We may say that a luminous body, A, causes a disturbance at P in its neighbourhood; the disturbance is properly represented by a vector at right angles to the line joining A to P, and its amount is $\frac{F(r-Vt)}{r^2}$, where t is the time, r the distance A P, and V a velocity. Aberration is expressed by saying that if A be in motion relative to P, in a direction at right angles to A P, the disturbance experienced at P is the same as that which would be produced by a similar luminous body at A at rest relative to P, where $\frac{A\,A'}{A\,P} = \frac{\text{velocity of A}}{V}$ and A A' is in the direction of motion of A. There is here no mention at all of a medium, but a complete account is given of the cardinal optical phenomena. This mode of expressing the facts, however, fails to cover the phenomena of spectroscopic double stars. The periodic doubling of lines in their spectra shows these stars (apparently single as seen in a telescope) to consist of two components moving one about the other with an orbital velocity which can be computed from the displacement of the lines. When the two components are in the line joining the star to the earth, there is no doubling of the lines, but one component is moving to the right and the other to the left with this orbital velocity. Now, according to the above-stated expression for aberration, or any expression which only involves the motion of source and receiver relative to each other, the two components should, when in the line of sight, be apparently separated owing to the difference of their motions relative to the earth. The angular amount of the separation of the two components would be equal to $\frac{\text{twice orbital velocity}}{\text{velocity of light}}$, an amount sufficient in some cases to be visible to the naked eye. The star would, in fact, appear periodically to be double, the doubling occurring alternately with the displacement of the lines in the spectroscope. Since no such doubling takes place, we infer either that aberration cannot be completely expressed in terms of relative motion of source and receiver, or that the accepted theory of these stars is wrong. The former alternative, which seems the more probable, forces one to recognise a something other than matter to which the motion of matter can be referred. In fact, it may almost be said that in this way the ether is made manifest to our senses as having position. This reason for postulating an ether differs in kind from the metaphysical reasons usually advanced. It may be described as furnishing a logical necessity for an ether.

Telegraph Codes and Rates.—Mr. C. Edmondstone Ross, examiner of accounts, Public Works Department, India, has forwarded for our perusal a memorandum which he has submitted to the Bureau International des Administrations Télégraphiques at Berne on the use of a new "three-signal" letter-cipher for the economic transmission of telegraphic messages, both inland and foreign. As Mr. Ross states, his suggestions are distinctly revolutionary in character, and we may add for ourselves that they require very attentive study in order that they may be clearly understood. From a careful perusal of his paper we gather his ideas to be as follows: Under existing telegraphic regulations figure-cipher messages are permissible in international traffic, but letter-cipher is prohibited. With the figure-cipher the number of telegraphic signals is uniform for each figure—*i.e.*, five signals for each figure which represents one letter of a word. Such messages are charged for at the rate of five figures to a word—that is to say, 25 signals to a word. Mr. Ross has satisfied himself that a letter-cipher message composed entirely of three-signal letters possesses all the advantages, for signalling purposes, of the cipher messages, with the additional merit that only three signals go to a letter instead of five to a figure. This gives a saving of two signals for every letter of a word transmitted. In comparison with figure-cipher messages (the charge for which, it must be remembered, is based on the number of signals required—*i.e.*, 25 to a word of five letters) the system of three-letter messages would allow of eight letters being transmitted with one less signal at the same cost. That is how the new method "would tend to materially reduce the present charges for telegraphic correspondence." Of course, a code would be necessary, and Mr. Ross thinks it would be a comparatively

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simple matter to compile a vocabulary of dictionary words n ordinary use, assigning to each word a certain number of the same sort of letters, each of which require the same number of signals. Mr. Ross also suggests the possibility of devising a signalling apparatus to carry his ideas into effect. It will be seen that as compared with the "five-figure" system the method proposed by Mr. Ross is decidedly an improvement. But it is not to be compared with the ordinary code system, by the use of which one or two words may represent a whole message, and so reduce the cost of transmission to a minimum. We think, however, that considerable value attaches to the method proposed by Mr. Ross as a substitute for the figure-cipher, and as such will no doubt be deemed worthy of consideration at the International Telegraph Conference which is to be held in London next February.

Street Traffic.—"The future may be with the motor-car and the specially-constructed alternative main road; it may, on the other hand, be with the flying machine; the present is with the tram—tram plus the tube!" Thus it is that Mr. J. Clifton Robinson, of the London United Tramways, in a letter to the *Times*, humorously dismisses Colonel R. E. Crompton's scheme for solving the problem of the congestion of street traffic and the overcrowding of our English towns. In his address before the Mechanical Section of the British Association at Glasgow on "Street Traffic" Colonel Crompton prophesied in favour of the future of the motor-omnibus, and it is only natural to find Mr. Robinson, as representative of perhaps the most go-ahead tramway campany in the kingdom, taking up the cause of the electric tram. Colonel Crompton stated, for instance: "With crowded omnibuses, almost touching one another, and yet going at a fair rate of speed—at eight miles an hour—14,000 passengers could be carried from a given point per hour." Dealing with this, Mr. Robinson shows that it would require nearly 550 omnibuses to carry 14,000 passengers. There are, it is true, points in London where omnibuses pass at the rate of 500 an hour—the Mansion House, for example—but at these points the average speed is nearer one than eight miles an hour; and as to get his carrying capacity Colonel Crompton would have to create like congestion throughout his entire route, he would find his speed restricted to a space which would make his omnibuses worse than useless as a means of "carrying our workers from their homes in the country to their places of employment in the towns," for which the great desideratum is rapid transit. Mr. Robinson proceeds: "The essential elements of the ideal system for dealing with street traffic are great potential carrying capacity, reasonable speed, low fares, and a minimum of interference with ordinary use of the roadways. Electric tramways—and, so far, electric tramways alone—fulfil these conditions. In the combination of tram and tube lies the solution of present-day problems—the tube railway (as in the case of the Central London) from the heart of the City to the point at which the street railway becomes practicable, and from that point electric tramways through the suburbs to the country beyond. The London United, with its electric cars running every 2½ minutes to Acton, to Ealing, to Hanwell, to Southall, to Chiswick, to Kew, to Brentford, to Hounslow, has made a practical beginning; and when its authorised extensions are completed, when from the heart of London radiates the system of tube railways forecasted by the report of the Parliamentary Committee last session, and when the outer terminus of each 'tube' is the starting point of an electric tramway reaching out into the country beyond and connecting up the outlying districts with each other and with the Metropolis, when these things are done—as they will be long before Colonel Crompton invents his practicable motor-omnibus, to say nothing of the construction of his chimerical main roads—then the great problems to which the attention of the British Association was drawn will have been solved."

Induction Motors for Electric Railways.—In view of the interesting discussions which took place at the International Engineering Congress at Glasgow recently, and also of the great question as to the system of electric traction to be used on the underground railways in London, it is well to follow all that is written on the subject in other countries. At the recent Buffalo convention of the American Institute of Electrical Engineers, there were two papers in which this subject was brought up for discussion. The first of these was entitled "Electric Railway Apparatus," and was contributed by Mr. E. J. Berg. The other was by Mr. A. H. Armstrong, and was called "Notes on Modern Electric Railway Practice." Up to the present we have only seen an abstract of the latter paper. In it the author is, on the whole, unfavourable to the induction motor for railway purposes. He points out that it eliminates the cost of labour at the sub-stations, and also the sub-stations themselves, as far as the running machinery is concerned. The author's idea appears to be that transforming stations will still be required. We believe that on the Continent certain of the largest firms would even advocate the abolition of transforming sub-stations, in which case they would collect at from 10,000 to 15,000 volts and carry the transformers on the train to reduce this voltage to a reasonable one for the motors. The objections brought by Mr. Armstrong against the induction motor may be summed up briefly as follows: The constant-speed quality of the induction motor demands a much greater output from the central station when ascending gradients, as the practical uniform speed has to be maintained, which is not the case with the direct-current system. The induction motor also can only give a certain maximum torque, and this decreases with the square of the impressed voltage. In this respect the motor is not so convenient as the direct-current series-wound motor. In selecting an induction motor for service on heavy lines, care must be taken that this maximum torque at starting is sufficient to get the train under way when it is standing on any of the gradients. The author also states that in consequence of the great demand for energy when the trains are going uphill at full speed, the sub-station arrangements of the distributing system will have to be very amply designed. Another objection is the magnetising current, which is more than in the case of the ordinary induction motor, because for railway work a larger clearance has to be allowed. Mr. Armstrong goes on to show that if the main lines of America are equipped with three-phase motors, there will be a break in system where these lines enter towns, as the large street railways are already at work on the direct-current system. This is the most serious objection, but it hardly applies so much in this country, where the street tramways and the main lines of the steam railways are as a rule quite independent. The last objection which we notice in the abstract is that of the efficiency of the system when accelerating. The author states that whereas with direct-current motors 70 per cent. efficiency can be obtained when accelerating, it is not usual to get more than from 40 to 45 per cent. efficiency from the induction motor. This is a most important consideration for lines having frequent stops, and it is because of this that we do not think the three-phase system designed by the Ganz Company is the correct one for the underground railways in London, while it certainly has great advantages for main lines.

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THE NEW POWER STATIONS OF NEW YORK CITY.

BY OUR OWN CORRESPONDENT.

During the recent convention of the American Institution of Electrical Engineers a most interesting tour of inspection was made of the latest power stations supplying electrical energy to New York City, a few details of which may be of interest to our readers as being indicative of the present position of central-station practice on the other side of the Atlantic.

Generating Station of the New York Edison Company.—The first visit made by the party was to the Thirty-eighth-street station of the New York Edison Company, who supply the bulk of the general public electricity supply in the city. This station, which will eventually have a maximum capacity of nearly 150,000 i.h.p., and cover a ground area of 54,000 square feet, is being equipped with the following plant: 56 Babcock and Wilcox boilers, each capable of evaporating about 20,000lb. of steam per hour at a pressure of 200lb. per square inch, and the same firm's type of superheaters, capable of superheating 200deg. at the boiler stop valve. The boilers are arranged on two floors, each having a central firing gangway, the coal being delivered to the stoker hoppers from storage bunkers at the top of the building. In the engine-house there will be 16 Westinghouse vertical three-cylinder compound engines, 75 revolutions per minute, direct coupled to 3,500-kw. three-phase, 25-cycle, 6,600-volt flywheel generators, having an overload capacity of 4,520 kw. for three hours. Two of these sets are being erected and six more are in course of construction. This station is intended to supply in bulk to various sub-stations throughout the city, where step-down transformers and rotary converters will be located, and the energy will be delivered into the distributing mains at 2 × 110 volts direct current.

The most notable feature in this installation is the introduction of superheating, for as far as could be gathered it is the first instance in the States of the adoption of superheaters with anything approaching seriousness. Possibly owing to the comparatively low price of fuel, but more probably to the very strong conservatism which is so evident in American engineering practice, superheating is practically unheard of; and many of our English engineers will view with interest, not unmixed perhaps with amused wonder, the fact that the first attempt at its utilisation should be made with temperatures verging on 600deg. F. That, with so little previous experience to guide them, our American friends can have successfully anticipated all the troubles incidental to the use of steam at high temperatures is hardly possible, and its performance in this new station will be critically watched on our side.

The station, being situated on the East River, is arranged to run condensing, but our correspondent was informed that the condensed steam would not be utilised as boiler feed owing to the difficulty of oil separation, in spite of the fact that the feed water, being taken from the city supply, would cost something approaching £8,000 a year. One would have thought that in view of this enormous expenditure some of the various forms of exhaust oil separators would have been tried between the engines and condensers, or that some method of distillation for dealing with the brackish tidal water would have been considered.

Although not applying so particularly to the electricity supply of New York City, it is interesting to note how backward American station engineers are in appreciating the advantages of the use of high-voltage lamps. As before mentioned, the main supply in New York is 2 × 110-volt direct current, and when the remodelling of the system which resulted in the design of the new three-phase station was considered, the feasibility of supplying the city direct at low pressure with high-voltage lamps was dismissed as impracticable, partly because of the number of small 110-volt motors on the circuits, but mainly because there was not a satisfactory lamp on the market. And it is not only in New York, but in all the principal installations throughout the States, that this (from an English point of view) backward state of things exists.

In the United Kingdom, notwithstanding the loving halo of protection with which the Board of Trade envelopes the consumer, our station engineers have long since foreseen the tremendous advantages of 200-250-volt supply, have by their demand forced highly satisfactory lamps from the manufacturers, and, having surmounted the small troubles incidental to the change-over, are now reaping equally with their customers the benefits of progress. Our cousins, however, although unhampered by legislation, have remained behind, and now seek to hide their conservatism under the cloak of benevolence towards their *clientèle*!

Generating Station of the Manhattan Street Railway Company.—An interesting visit was made to this half-completed station, which is to supply the energy required by the elevated railways of New York City after their conversion from steam to electric traction. On a ground space of 80,000 square feet will eventually be placed the following equipment: 64 Babcock and Wilcox boilers, each capable of evaporating 15,000lb. of water per hour at 150lb. per square inch steam pressure; and eight combined vertical and horizontal Allis engines, 75 revolutions per minute, coupled direct to 5,000-kw., 11,000-volt, 25-cycle, three-phase generators. The energy will be delivered at high pressure direct to sub-stations, where it will be passed through static transformers giving about 600 volts on the secondary. Thence rotary converters will transform it into direct current at 500 volts. By far the most interesting feature of this installation is the type of engine adopted, which is almost unique. A combination has been made of two vertical and two horizontal single-cylinder engines, the former being fitted with high-pressure and the latter with low-presure cylinders. The four connecting rods drive on to two overhung cranks, the generator being placed between the only two main bearings possessed by the plant. The advantage claimed is great simplicity combined with the high number of eight impulses per revolution. Considering the length and shape of the steam connections between the cylinders, however, it would seem that the greater uniformity of turning moment will only be obtained by a considerable sacrifice in steam economy, with which such a low periodicity appears hardly necessary for the sake of parallel running only. The 11,000-volt switch-gear which has been specially designed by the General Electric Company for controlling the output of these giant generating sets is naturally of exceptional interest. The levers which lift the three double oil break contacts are actuated by a combination of electric motor and friction clutch instead of by compressed air, as in the case of the Niagara installation.

Station of the Metropolitan Street Railway Company.—The generating plant required for supplying electrical energy to the whole of the vast tramway system of New York City is contained in a substantial building covering about 50,000 square feet on the banks of the East River. The total equipment, which is nearly complete and at work, is as follows: 87 Babcock and Wilcox boilers, each capable of evaporating 8,000lb. of water per hour at a pressure of 150lb. per square inch, and 11 vertical cross-compound Allis engines, 75 revolutions per minute, direct coupled to 3,500-kw., 6,600-volt, three-phase, 25-cycle alternators, manufactured by the General Electric Company. The energy is transmitted at high pressure to rotary converters placed in sub-stations at various parts of the city.

The present practice in the design of large steam-driven power stations in the States is well indicated by these three latest examples, and can be briefly summed up thus: water-tube boilers supplying steam to slow-speed vertical compound engines driving multiphase flywheel generators.

WALTHAMSTOW ELECTRICITY WORKS.

The large works which the Walthamstow Urban District Council have erected for the supply of electric light and power in the district were formally opened on Friday evening last. The fact that the Council have put down a gas-engine plant at the generating station lends considerable interest to the undertaking. The station itself is situated in what appears to be a newly-opened-up part of the town, and is built on some two acres of land purchased for the purpose. So far back as 1895 the Council obtained the necessary powers to undertake the electric lighting of

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the district controlled by them, but it was not until the next year, when Mr. J. Enright was appointed consulting engineer to the scheme, that it began to assume practical form. A loan of £41,000 was obtained, and two years later the foundation stone of the generating station was laid. Mr. Enright strongly advocated the putting down of a gas-engine plant at the station, and the Council, placing implicit faith in the recommendations of their consulting engineer, unanimously approved his scheme. The works are now in full swing, and electricity is being supplied for both public and private lighting.

The buildings were designed by Mr. Enright and erected by workmen directly employed by the Council. The main building measures 123ft. in length by 79ft. wide. The engine-room is 123ft. long by 46ft. wide, and running parallel with it is the battery-room, measuring 74ft. by 20ft. A spacious suite of offices, with stores, are provided overhead. The gas-house is located on a piece of ground immediately adjoining the main building. Here are installed two gas generators, with purifying apparatus. The gas passes from the gas-house by means of pipes to a good-sized gas-holder outside, from which the supply is obtained for driving the machinery. The plant inside the engine-room consists of three Westinghouse gas-engines of the three-cylinder type, each of 100 b.h.p., with dynamos coupled direct. The system of distribution is the three-wire system, delivering to the consumer's terminals at a voltage of 230. In the station a rotary balancer is used to balance between the two sides of the three-wire system. There are also two independent boosting machines, each driven by a motor, and taking current from the 'bus bars at 230 volts. These boosters can either be used in charging the two batteries of accumulators, or, if found necessary in the future, can be employed in connection with any of the feeders in order to boost up the voltage at times of heavy load. The engines are started by compressed air, which is stored in a reservoir at about 120lb. In this way the time often spent in starting up gas-engines is saved entirely, and they can be got to work very quickly.

As regards the running of these machines, we understand from Mr. Enright that he has obtained a perfectly uniform speed, and that no trouble whatever may be anticipated in the future from this source. Mr. Enright has also satisfied himself that the Westinghouse gas-engines are not liable to back-fire, which, unfortunately, has hitherto been one of the chief objections to employing gas-engines in central stations in this country. Another ground of complaint has been the heavy vibration accompanying the running of gas-engines, but in this respect Mr. Enright assures us that in the present case the vibration has been reduced to a minimum. Speaking from our own experience, we must say that when we visited the works at Walthamstow we detected no more than the average vibration experienced with running machinery in central stations when steam-driven engines are in use.

As before stated, the dynamos are coupled direct to the engines, and were supplied by the Helios Company. The switchboard is composed of panels of white marble, and rests on a platform 30ft. in length. Messrs. Frank Suter and Co., Limited, were the principal contractors for the plant and machinery, the sub-contractors being the British Westinghouse Company for engines, the Dowson Economic Gas Manufacturing Company for gas plant, and the Tudor Accumulator Company for storage batteries. Messrs. W. T. Henley were the contractors for the underground mains, conduits, and road work. There are four feeders, with an average length of 1,200 yards, and a fifth having a length of 2,600 yards. They are of the two-wire concentric type. The middle wire of the network is brought back into the station from two points about equidistant from the works; these two middle-wire returns are then connected together at the switchboard. From the feeding point the cables are laid on the solid system in earthenware troughs, 18in. in length, through the various streets. At present the principal streets are lighted by 63 arc lamps, each of about 1 400 c.p. The lamps, which were supplied by Messrs. Oliver and Co., Limited, are run in circuits of nine across the two outer wires of the three-wire network. These arc lamp are controlled by switch gear in the base of the standards at the beginning and end of each circuit. On each of the arc lamp columns there are two incandescent lamps, which are also in series across the 460-volt main. These incandescent lamps are controlled by a single switch in one-end lamp pillar, by means of which when the arc lamps are switched out the incandescent lamps can be switched on at exactly the same time. In order to do this an independent switch lead is run through the circuit for the one pole of the incandescent lamps. In addition to the incandescent lamps on the arc lamp-posts a number of the gas lamps have been converted to incandescent electric lights, and these also are arranged to be switched on and switched off conveniently from central positions, so that the lamplighter is not required to go to each individual post in the district.

As regards private lighting there is an immediate demand equal to 5,000 8-c.p. lamps. Orders not yet fulfilled by the Council and promises bring this figure up to 12,000. Reverting to the generating station itself, the premises have been built with an eye to early extensions of plant. Indeed, extensions are now under consideration, and it is proposed at once to go in for larger units of at least double the size of the present ones, say about 250 h.p.

At the opening ceremony on Friday evening a spacious marquee, which had been erected on the ground immediately adjoining the works, served to accommodate the large number of guests who had accepted the invitation of the Council to witness the inauguration of the undertaking. Notwithstanding the heavy storm which was raging outside, the company were in the best of spirits when Councillor J. R. Friend (chairman of the Electric Lighting Committee) rose to open the proceedings. The speeches of those occupying the principal places on the platform were listened to with deep interest, testifying to the sympathy which is felt with the Council throughout the district in their electric lighting undertaking. Councillor Friend gave a short *résumé* of the history of the scheme. He was sure the Council had done the right thing in putting down a gas-engine plant at the station. Mr. Enright, their consulting engineer, had assured them that the Westinghouse gas-engines had no back firing, and there was little or next to no vibration. In his opinion they had a splendid and economical system—one of the best in the United Kingdom, and he prophesied a complete success for the electric lighting undertaking. Mr. J. Enright then described the works at some length. Extreme uniformity in the speed of the engines had been obtained in this installation, and this fact had made it possible to couple the engines direct to the dynamos without the aid of belting. A vote of thanks having been accorded to the chairman of the Council (Councillor Ogilvie, J.P., for presiding, the company proceeded to the generating station, where the Chairman formally declared the works open. Mrs. J. R. Friend, wife of the chairman of the Electric Lighting Committee, then switched on the light, and was presented with a couple of charming bouquets. A general inspection of the works by a large number of the visitors was afterwards made, and the company separated.

STREET-LIGHTING.

In these days of competition it is specialisation that succeeds, and the firm who devotes expert attention to one particular branch of a subject does good to the whole profession. In this spirit the Improved Electric Glow Lamp Company have taken up the difficult question of street-lighting, and we are sure that they will share in the benefits which the profession will derive from the labours of their experts. In the first place, the lighting of streets is a matter which is not easily judged, and this has made the company's work a difficult one. It is usual for decisions as to street-lighting equipments to be left rather largely in the hands of committees who have no knowledge of the essential facts of illumination. The gentlemen composing these committees take much time considering the best shape of lamp column, and perhaps do sometimes see lamps alight in the lanterns designed for these. They then too often decide that the arrangements of

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lamps and reflectors which appear the most brilliant to the eye are the best. There could not be a more fallacious way of selecting the lanterns and reflectors for incandescent street-lighting, and those who have any doubt on this question would do well to pay a visit to the show-

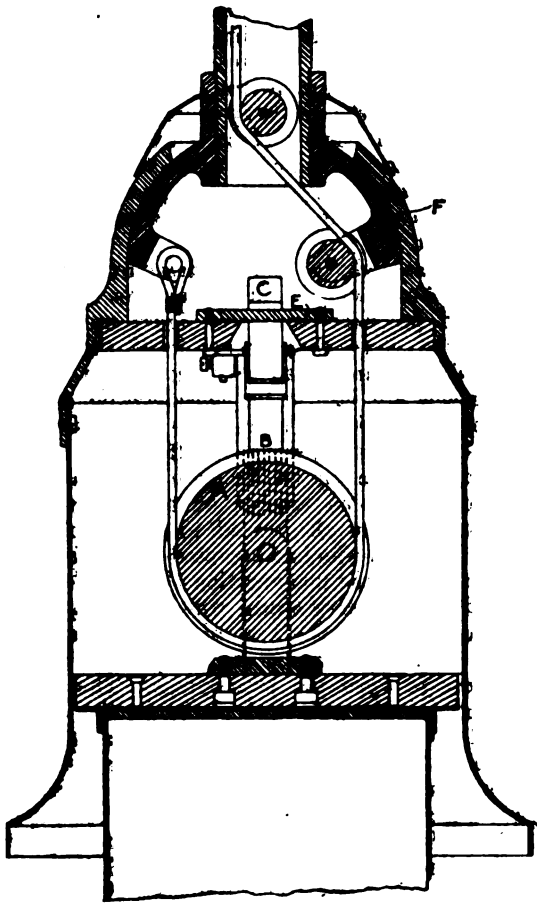
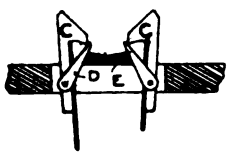


FIG. 1.—Section of Harrison's Patent Arc Lamp Lowering Device.

rooms of the Improved Electric Glow Lamp Company, at No. 7, Great Newport-street, W. This firm has recently issued a new pamphlet on street lighting, in which the various accessories they have specialised for this work are



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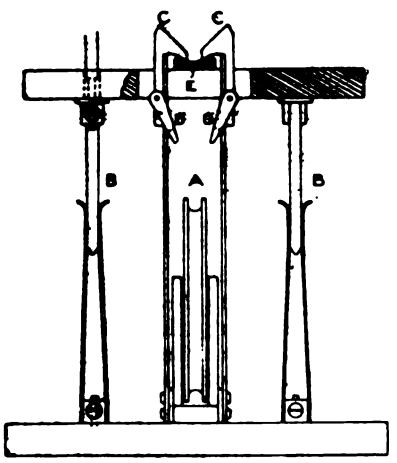
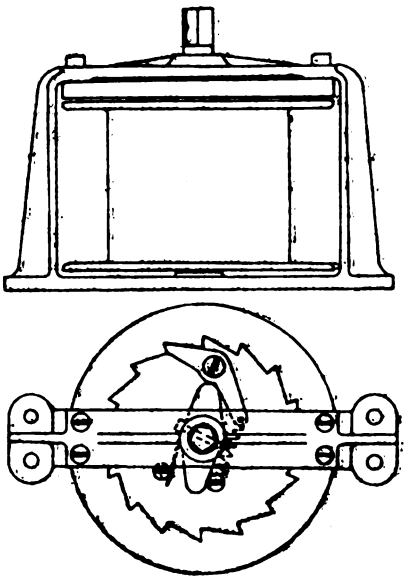


FIG. 2.—Details of Clutch and Contact Gear.

clearly illustrated. In spite of this and the excellent curves and results which are given at the end of the pamphlet, we think that the borough electrical engineers and even our consulting engineers would do well to pay a visit to the showrooms in question, and to witness a few experiments of the photo-meters which are there available for making comparative trials. As regards the point referred to above respecting the apparent brilliancy of lamps as being exceedingly deceptive, an interesting experiment can be made with two incandescent lamps made by the above firm. Each of these lamps has a silvered back in order to reflect the light in the most useful direction, but the glass of one is prismatic to break up the rays of light which are reflected. When looked at side by side the idea received is that the lamp with the prismatic glass is giving much more light, and would be the more suitable for street-



FIGS. 3 AND 4.—Plan and Elevation of Safety Switch for Arc Lamp Raising.

lighting. When, however, these two lamps are put side side in the photometer, and tested consecutively, it is found that the reverse is the case, and that the plain glass lamp is really at least 100 per cent. more effective. The same thing applies to other types of certain reflectors and globes which have been designed for street-lighting, and which when viewed from the pavement appear to give an exceedingly good light in the required direction, because the points of light are numerous. Here, again, experiments often show that there is not the light given out which would be the case if a more simple method of

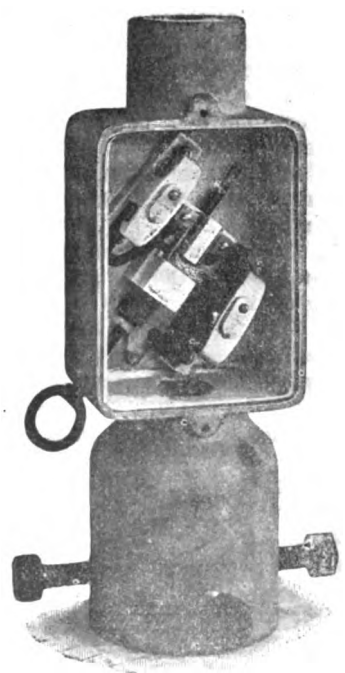


FIG. 5.—Standard Switch and Fuse Box for Incandescent Electric Pillar.

distributing the same were employed. The great object in street-lighting is not that the space immediately round the lamp column should be brilliantly illuminated, but that the whole of the pavement line and the roadway should be equally illuminated, so that those using the street are not

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confused by alternately having to traverse a brilliantly lighted and an almost dark portion of the street. The curves to which we have referred to above as appearing at the end of the pamphlet, show how well the incandescent lamps and fixtures designed by the Improved Electric Glow Lamp Company have succeeded in giving this equal illumination. The polar curve of candle-power from the one lamp when combined with another placed, say, 100ft. away, gives a result that the company are to be congratulated on. The same firm have also taken up the manufacture of arc lamps for street-lighting purposes, so that they are now able to undertake full contracts for all that is required for electric lighting in both main and side streets. Leaving the design of the arc lamp on one side, we notice an interesting device for raising and lowering arc lamps which should commend itself to electrical engineers. Drawings of this we reproduce in Figs. 1 and 2. The pulley supporting the arc lamp is denoted by A in these figures, while the contacts which complete the circuit when the lamp is raised to its highest point are denoted by B B. The letters C C are two steel hooks, which support the whole weight of the lamp under normal conditions, so that the weight does not come on the cord. When the lamp has to be lowered, the first operation consists in raising it some 1½in. to 2in. higher than its normal position. This brings the pivoted pieces, *d d*, up beyond the supporting block of steel, E. If the lamp is then lowered, the condition of affairs is as shown in the same sketch above (Fig. 2). These pivoted blocks, *d d*, then come into such a position as to mask the ends of the hooks, C C, so that the whole lamp can be lowered on the ratchet. An interesting point in the design of this ratchet (Figs. 3 and 4) is that the handle cannot be removed unless the weight of the lamp is being taken by the hooks, C C. The great advan-

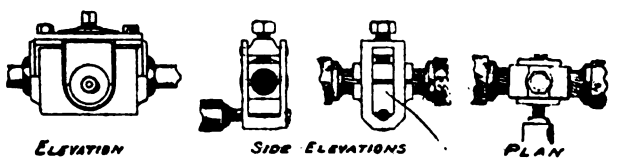

FIG. 6.—Details of Connection.

tage of this system of supporting is that the lamp is completely isolated when lowered, so that it can be trimmed without any danger to the lamp attendant, and also that the cord supporting the lamp is not always in tension. In Fig. 5 we give a view of the usual switch and fuse box used by the company for their incandescent street-lighting work. The fuses are of the enclosed type, in which the fuse wire is bound to go in a small asbestos-lined chamber. Experiments have shown that with this type of fuse 500 volts can be broken without causing damage either to the fuse block or to the case surrounding the same. Another interesting speciality now being manufactured in quantity by the firm is the street box for connecting on to these lamps. We have not illustrated these boxes, as they, although well designed, are not strikingly novel, but we give in Fig. 6 a view of the very neat connecting clips which are used in the same. The boxes are so designed that the cables have not to be cut when inserting a box in the length of any main in order to take off the tee. The clip is so designed that the small branch conductor is clamped against the one side of a block of gunmetal, the upper side of which is under the main cable. A single screw then at the top of the clamp draws the branch conductor firmly against the underside of this block, at the same time securing the upper side most firmly against the main conductor. Another advantage of this clip is that the branch conductors are at a lower level in the boxes than the main conductors, so that there is no difficulty with the one conductor crossing the other when both positive and negative mains are in the same street boxes, as is usually the case. We have not referred to a great many interesting points in the list of the Improved Electric Glow Lamp Company which we should have liked to have done if we had more space available, but we would advise our readers to spend some time at Great Newport-street, and to make some experiments themselves on the distribution of light from the apparatus designed by the company's experts under the supervision of Mr. T. Harrison Hadyn.

RECENT TRAMWAY PRACTICE.*

BY JAMES MORE, JUN., M.I.C.E., F.R.S.E.

(Continued from page 411.)

The question of first cost is another important point to consider, and it is often good policy to adopt the cheaper high-speed units to get the line installed quickly and cheaply. Table 15 gives the consumpt of several existing installations. Several of the results had to be converted by estimation and calculation from consumpt per kilowatt per hour to indicated horse-power per hour and *vice versâ*, so that probably they may be a decimal out of truth They are sufficiently accurate, however, to give a rough comparison between the different installations. It may be said, in passing, that this applies to all the comparative tables throughout the paper.

GENERATORS.

It will be sufficient in this paper to briefly describe continuous-current generators, as they they are in more general use than alternators, the radius of distribution in towns in this country being small. The generators may be taken as all direct driven, and to the following brief specification:

Field-Magnet Frame.—The field magnet of the type and design for iron-clad armature has poles at equidistant points projecting inwards round the armature periphery. Each field magnet consists of a circular yoke divided in two portions horizontally in line with the centre of the armature shaft. The lower portion of the magnet yoke has two shoulders, or brackets, cast solid with it, one on each side, to carry the frame on the foundation or girders, as the case may be. The frame should be arranged to slide along the armature shaft sufficiently far to allow for the removal of the magnet winding without removing the upper portion of the frame or disturbing the armature. Slides or girders are generally supplied for this purpose.

Magnet Poles.—These are generally of wrought iron or soft steel, and are cast solid in the magnet frame, special care being taken to get a thorough weld in casting.

Magnet Winding.—The field winding spools should be of sheet iron, with brass ends, and fit neatly over and around the poles. The spools are covered inside with an insulating lining about $\frac{3}{16}$in. thick, composed of mica, paper, and linen, the whole cemented together with shellac in solution. The series and shunt windings of the generator are wound as distinct coils side by side in the spool with insulation between. The series coil is set at the end of the spool next the magnet yoke, and the two windings should be of an even depth to show an unbroken surface. The winding wire should be well insulated with cotton, and the layers should have sheet insulation between. The conductors are of pure copper, and insulated moisture-proof. The armature sections should be of sufficient number to reduce the average potential differences to the proper limit.

Commutator.—The commutator hub should be mounted on, and keyed to, a sleeve extension on the hub of the armature. The bars must be of hard-drawn copper, drawn accurately to the proper section, with length sufficient to allow ample space for the brushes. The insulation between the bars should be of the best quality of mica, laid in layers, so as to break joint, and of a thickness not less than $\frac{1}{32}$in. The connections from the armature conductors to the commutator segments must be sufficiently flexible to avoid all danger of breakage from vibration, and must be fixed by rivets and solder, so to to have an equal conductivity to the armature conductors.

Brushes.—The brushes are of carbon, and of such a capacity that the current density shall not exceed 35 amperes per square inch. The brush-holders must be arranged to allow perfect freedom of access to the commutator, and so as to allow no portion of the conducting metal to come within flashing distance of the frame of the machine. There must be sufficient contact between the carbon and the holder, and the carbon must have perfect freedom to follow any unevenness that may occur in the commutator The brush supports are mounted on radial studs in the holder yoke, from which they must be

* Paper read in Section VII. of the Glasgow International Engineering Congress.

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TABLE 13.—ENGINES.

Name of town.	Type of engine.	Revolutions.	Steam consumption.		Coal consumption.	
			Lb. per KW.H.	Lb. per I.H.P.H.	Lb. per KW.H.	Lb. per I.H.P.H.
Glasgow, Springburn	Horizontal compound condensing. McIntosh and Seymour.	200	22·3	15·59	8·4	5·64
Leeds	Horizontal compound condensing. Fowler's.	90 and 112	21·5	15·04	7·17	5·0
Sunderland	Vertical compound condensing. Belliss, three crank.	400	21·24	14·85	7·02	5·4
Dublin	Vertical compound condensing. Corliss, E. P. Allis and Co.	90	21·45	15·0	5·587	3·8
Aberdeen	Willans vertical central valve.	350	26·8	20·00	5·00	4·00

insulated; the yoke itself is mounted on guides, and is capable of a rotation movement concentric with the armature. This movement is made and position locked by a tangential screw and hand-wheel.

Rheostats.—Each machine is fitted with a field shunt circuit regulating rheostat.

Construction.—The mechanical construction must be of the highest throughout. The armature must be in perfect running balance, and the construction of the commutator such that the segments, insulation, etc., are firmly clamped in position so as to be secure against all disturbing effects of working. The ends of the field windings are brought out to substantial connecting terminals, easily connected and disconnected without danger of injury while being handled. The connecting terminals for the dynamo leads must be such as to have a fixed line of commutation for the brushes, so that the load may be varied from zero to 25 per cent. over the full rated load of each machine without requiring any change in the lead of the brushes or causing objectionable sparking. The machine should run at 50 per cent. overload without injurious sparking. All parts should be well finished, made to standard gauge, and be interchangeable. All bolts should be fitted and have hexagonal nuts and castings faced under both heads and nuts. All unfinished parts must be filed, rubbed down as often as possible to get an even, smooth surface, primed, painted, and varnished.

Rating Conditions.—The output is measured at the dynamo terminals. The normal current load is rated under a working E.M.F. of 550 volts at the terminals.

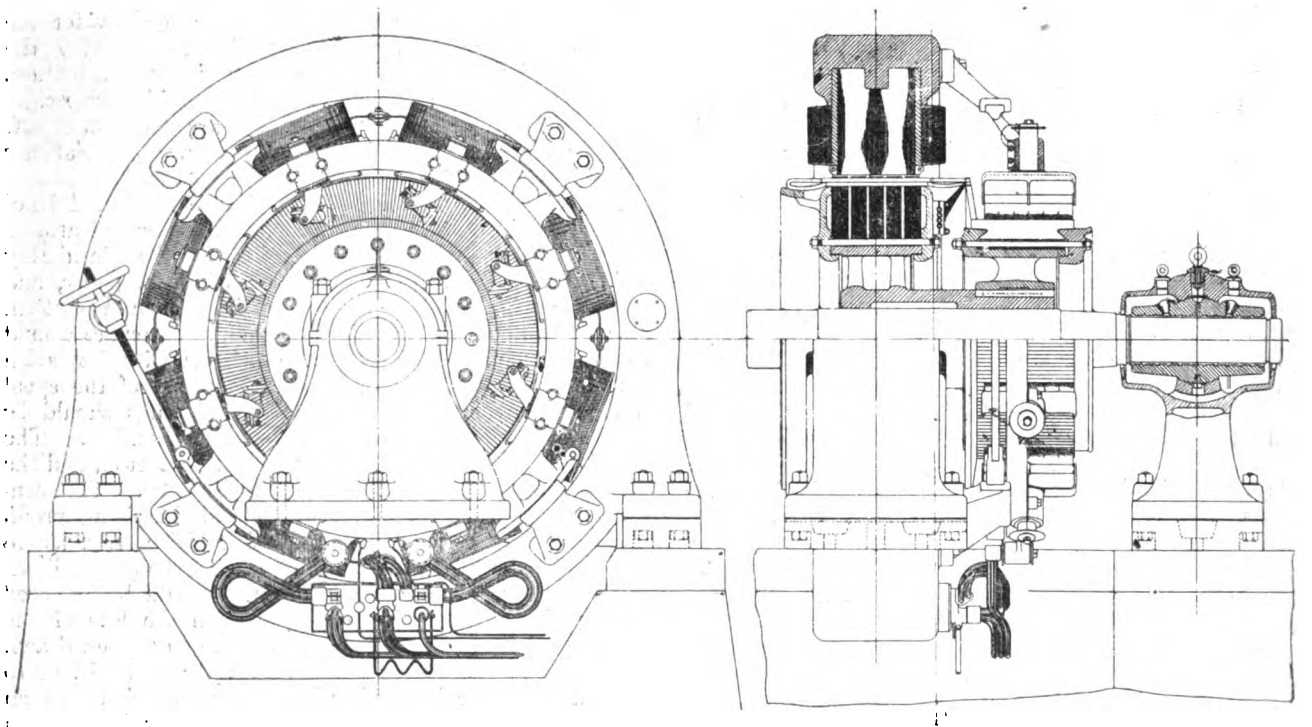

FIG. 14.

to the switch-board are placed on a special board in the pit below the machine, so that the leads do not appear above the floor.

Electrical Features.—The windings of the fields should be free from all electrical defects and properly insulated, and the individual insulation resistance of armature and field-magnet windings, with respect to the frame, should be not less than one megohm. The joint insulation resistance of the armature and field windings, with respect to the frame, should be not less than one megohm. The machine should run without sparking or heating at all loads within the limits specified. The design and proportions of the field shunt and series exciting coils must be such as to secure a practically perfect compounding from zero to full load.

Armature Reaction.—The design and proportions of the magnetic circuit in the field-magnet air-space and armature core, as well as those of the armature and field windings, The output in amperes and maximum voltage should be so related as to correspond to the formula: E.M.F. × am. = watts output. Each machine should be capable of running at its full normal load continuously for 24 hours without sparking or heating itself more than 80deg. F. above the temperature of the surrounding air. The temperatures should be measured in the usual way with a thermometer. The dynamo should run at 25 per cent. overload for one half-hour without injurious heating, and take momentary overloads of 50 per cent. without flashing even when the circuit is suddenly opened on such an overload. The efficiency should be 95 per cent. at full load and 93 per cent. at half load. Fig. 14 shows the construction of the type of generator just described, and Tables 15 and 16 show comparative descriptions of several important installations with their results in working, which may be of interest.

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TABLE 15.—Generating Plant.

Name of town.	Nature of current.	Voltage.	Generating units. Type of generator.	Number.	Capacity in kw.	Total capacity in kw.	Output in kw.-hours.	Average radius of distribution (miles).	Number of cars working (average).	Miles of route.
Glasgow, Springburn	Direct	500	Direct coupled, multipolar, Westinghouse	3	200	600	293	2	47	5
Leeds	Direct	500	Direct coupled, multipolar	2 1	750 800	2,300	800	3½	130	23
Sunderland	Direct	500	Direct coupled, four poles	4	275	1,100	180	2½	41	9
Dublin	Alternating and direct	2,500 500	Direct coupled, B.T.H.	6	550	3,300	1,000	3	201	46
Aberdeen	Direct	500	Direct coupled, bipolar and multipolar	2 1	120 200	440	50·3	3	11	3½

TABLE 16.—Motive Power.

Name of town.	Cost per Board of Trade unit.	Price paid for current purchased.	Average amperes per car.	B.T.U. per car mile.	Cost per car mile.	Number of cars.	Kilowatts per hour per car.
	d.	d.			d.		
Glasgow, Springburn	0·73	—	12—13	1·25	0·92	47	6·23
Leeds	0·67	—	13	0·917	0·6144	130	6·15
Sunderland	—	2·0	15—16	0·92	1·84	41	4·4
Dublin	0·572	—	12	0·95	0·5434	201	4·97
Aberdeen	—	1·929	9·1	0·85	1·639	11	4·6

TABLE 17.—Overhead Poles—(Tests)—Poles Fixed 6ft. from Butt.

Description.	Section.	Length.	Outside diameter.	Thickness.	Approx. weight.	Temp. Deflection	Permanent set.	Load applied at.
	No.	ft.	in.	in.	lb.			
Manchester Corporation, Pole No. 1	1	17	7⅝	·5	1,092	700lb. 6in.	1,200lb. ½in.	29½ft. from bottom.
	2	9½	6⅝	·45				
	3	7½	5 1/16	·4				
National Tube Company's Pole	1	17	8⅝	·34	870	1,000lb. 6in.	1,700lb. ½in.	Top.
	2	9	7⅝	·30				
	3	8	6⅝	·29				
Manchester Corporation, Pole No. 2	1	17	9	·60	1,353	1,000lb. 6in.	2,000lb. ½in.	29½ft. from bottom.
	2	9½	7⅝	·40				
	3	7½	6⅝	·30				

Table 20.—Specification for Hard-Drawn Copper Trolley Wire.

Conductivity, 97 to 98 per cent. at 60deg. F.

Size of wire, S.W.G. No.	Size of wire, S.W.G. Diameter.	Approximate weight per mile.	Physical tests. Ultimate tensile stress. Tons per square inch.	Physical tests. Ultimate tensile stress. Pounds per wire.	Spiral round rod. Diameter.	Twists in 12in.	On reel.	Lengths, joints per mile.
	in.	lb.			in.		miles.	
4/0	·400	2,560	22	6,200	2	10	1	4
3/0	·372	2,220	22	5,350	2	12	1¼	4
2/0	·348	1,940	23	4,900	1½	14	1½	4
0	·324	1,680	25	4,620	1	15	1½	4
1	·300	1,440	25	3,960	1	17	1½	3
2	·276	1,220	26	3,490	¾	20	2	4
3	·252	1,020	26	2,910	¾	20	2	3

Note.—The elongation in 10in. varies from 2 to 3 per cent.

Bonding.—It is necessary to bond the rails for the purpose of the return circuit to reduce the resistance, and prevent electrolysis of adjoining water and gas pipes. The Board of Trade fix a maximum drop of seven volts, and the bonding must be good to comply with this. Indeed, it is sometimes necessary to have insulated return feeders and negative boosters. There is no part of the work on an electrical tramway installation that requires or should have greater care given to it than the bonding. It is in too many cases let as piecework to inexperienced men, who consider that it is a mere mechanical operation of riveting or driving a plug. They generally have a price per joint, which includes drilling or rimering the holes in the rail flange or web, and fixing and painting the bonds. The maximum drop allowed by the Board of Trade is so small that every care should be taken, considering the cost and trouble there is in pulling up the paving, to remedy bad bonding. The writer thinks the fastening of the "Neptune" bond is the best, as it can be done from one side of the rail and requires no hold-on, and that in driving the plug the tendency is to drive in the head of the bond into the hole, and not out of it, as in the Chicago and Columbia bonds. Besides making a good mechanical job, it is necessary to have good clean metallic contact between the steel of the rail and the copper head of the bond. To get this, all burr and oxide must be removed from the hole in the rail by rimering thoroughly. It takes a little longer to drill the holes, but not so much as is generally thought. A good man with a proper drill can drill the holes about as fast as he can rimer them properly; however, most rails are drilled at the

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works, and about $\frac{1}{16}$in. diameter left for rimering. This should be done without oil. After the holes are rimered it is usual for the man to take a piece of emery cloth in his hand, and, grasping the head or terminal of the bond with the emery cloth round it, to swing the bond round so that the head revolves in the emery cloth. This is for the purpose of cleaning the skin of the copper head. It is, however, only a makeshift, slovenly method, and the writer thinks all bond heads should be made $\frac{1}{32}$in. larger, and this amount turned off in a small hand-tool fixed on a movable bench. This would remove the skin entirely, and give a clean metallic surface of soft copper. It need not take longer than the emery-cloth method, and would be much more effective. All rail joints should have at least two bonds connecting the flanges or webs of both rails past the fishplates. They should have a current capacity of the rail itself, and the heads or terminals of the bonds should have an excess of area of metallic contact with the rail. The usual practice is to have two 4/0 S.W.G. bonds to each joint. All rails should be connected with long bonds past points and crossings, and the two rails should be cross bonded every 100ft.

Poles.—The poles for carrying the trolley wires should be of such a length as to allow the wire to be carried about 21ft. above the rail level when cars with top seats are to be used. Certain firms manufacture taper poles made in one piece, but the commoner kinds are made in three pieces of different diameters, shrunk over each other while hot. They are made of mild-steel tubing of varying thickness and diameter, according to the class of pole and purpose. To give a trolley wire 21ft. from rail level, they are usually 31ft. long over all, and are planted 6ft. deep in the ground. Table 17 gives the dimensions and physical tests of three ordinary standard poles, which should be sufficient. The poles are further tested by being dropped three times on their butts from a height of 6ft. on to a solid block, and must after this test show no signs of telescoping or bursting at the joints. This, in the writer's opinion, is a somewhat severe test. The allowance for variation of diameter should not be more than $\frac{1}{8}$in. out of the true circle at any part of the tube of the larger sections 9in. to 7in., and in the smaller sections the variations should not be more than $\frac{1}{16}$in. for any tube less than 5in. outside diameter. The variation from straight in the entire pole should not exceed $\frac{1}{4}$in. All poles, excepting centre poles on the straight, should be planted with a rake against the strain varying with the amount of strain. Pull-off and anchoring poles require a rake of from 6in. to 9in

Wiring.—The overhead trolley wire is an important part of the equipment, and it is also important as to how it is hung or suspended. Within reasonable limits it is a good thing to have plenty of sectional area in the trolley wire. This allows for wear, and admits of greater current capacity, which is a great advantage under many circumstances, saving feeders, etc. The trolley wire should be made of hard-drawn copper of at least 98 per cent. conductivity at 60deg. F. of pure copper. It should stand an ultimate tensile stress of 25 tons per square inch. The variation in diameter should not exceed ·004in., and it should be uniformly circular in section, and free from scale splits and other flaws. It is usually delivered in lengths from one to two miles, and the number of joints per mile varies from three to four, being dependent on the gauge. Table 20 shows the physical tests, lengths, etc., of the trolley wire supplied by Messrs. W. H. Dennis and Co. The joints should be at least 3ft. long, and capable of bearing the same tensile breaking stress as the wire. The wire is delivered coiled carefully on reels, and it should be absolutely free from all kinks, twists, etc. There are several methods of suspending the trolley wires, each with their advantages. The first and cheapest is by fixing rosettes in the walls of the buildings on each side of the street. Provided the permission of the owners can be got, and the streets are narrow, this method is a good one. There is, however, some difficulty in getting all the proprietors to consent. In this case, side poles in the footpaths are generally used from which to suspend the span wires. This method is adopted very generally, although it is somewhat costly. All trolley wires carried by span wires give a more elastic and easier track for the trolley wheel, thus lessening the jar at the ears, consequent vibration and wear and tear. When the roadway is very broad, centre poles with two side arms may be used, and these make the most sightly poles of all. The writer, however, is not in favour of this method where it can be avoided. It is dangerous to ordinary traffic and to foot passengers. Like all methods where the trolley wire is carried in the middle of the track, if a trolley wire, span wire, or ear gives way there is danger of the trolley wire falling on the top of the car. This is a serious mechanical and electrical danger, as a passenger may be swept off the car, severely cut, or he may be injured by shock. The other method is to carry the trolley wires at the side, clear of the car, by side poles with single arms. Although this is not so correct mechanically, it has been found to answer well in practice. It is, however, in many instances carried to an extreme, evidently only to save poles or to be consistent as to system. It should in most cases be assisted by double side poles and "pull-offs" at the curves, so as to widen the angles at the ears, some of which, it may be said in passing, have been made 3ft. long, to round the angles and save "pull-offs." This is asking too much of an ear. In most installations, however, it will be found that the best arrangement is a combination of all four methods at different parts of the route, adopting each at the parts most suitable to it. Ears are of various designs, some merely clipping the trolley wire and others having the wire soldered to them. The latter method of fixing is preferable. The soldering, must, however, be properly done, and must be perfect for the entire length of the ear. This is a point that deserves more attention and supervision on the part of the engineer than it generally gets. Many accidents through falling trolley wires might be avoided if the engineer insisted on seeing every ear properly soldered. It is also generally left to the foreman of the gang to judge the amount of tension to be put on in erecting the wires. The writer thinks this is not of great moment in winter, but in summer, with a high temperature, many wires are put up much too tightly, with the result that when the temperature lowers considerably in winter and a gale of wind comes the breakages are considerable. Useful tables, giving the sag and strain due to different temperatures, will be found in Mr. Dawson's pocket-book, "Electric Tramways." The trolley wires should be securely anchored at each end of all curves.

Guard Wires.—These should be fixed at least 18in. above the trolley wires. In double lines they should be directly above the trolley wires, but in single lines, with two trolley wires close together, they should be hung, say, 9in. wider than the trolley wires. They are generally insulated from the poles, but are put in metallic contact through them at intervals to the rails. The strength and tension on them is worth attention, as when this is neglected they become a source of danger in themselves instead of a protection. Wooden insulator strips are sometimes used instead of guard wires, but in the writer's opinion they are more unsightly and not so efficient. They are generally fixed to the wires by clips about 3ft. apart. These cause an arc each time a worn trolley wheel passes, causing damage to the wire and to the wheel. The space between the wire and the wood lath in winter may be filled up with snow and ice. The division of the trolley wire into half-mile sections is done by means of what are called section insulators. These are simply ears rather longer than usual, with feeding points at each end. There is a gap in the trolley wire which is filled up by insulating material to give a continuous track for the trolley wheel from the end of one wire to the beginning of the next. In fixing the position of these, it is well to see that they are not placed on a severe ascending gradient.

Overhead Fittings.—In the above category is included the ears for carrying the trolley wire, section insulators, pull-offs, frogs, crossings, strain insulators, etc. These are too well known and too numerous to require individual description in such a paper as this. Lightning arresters are necessary along the track, as well as on the cars, and at or near the power station, to protect the generating plant. On the track there should be two on each half-mile section. Speaking mechanically, all these may be called safety or relief valves. All the large makers of electrical equipment

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supply them of different designs for various currents and purposes. The ground connection of these should be of the best possible, such as placing the copper plate in a running stream or damp subsoil. If in the latter, fine coke should entirely surround the plate. These precautions are all well worth taking, as on good earth connection depends the efficiency of all lightning arresters.

Feeders.—The distributing feeding system is a matter that requires very careful consideration, always bearing in mind that the trolley wires must be insulated in half-mile sections. It must also be taken into consideration that gradients, congested traffic, etc., must have due allowance made for them at different portions of the routes, and that the power used on these portions is greatly in excess of that on the normal portions. The feeder cables are usually insulated with bituminous compounds or paper, and are sometimes armoured and lead covered. They are laid in wood or iron troughs and run in solid with bitumen in some cases, and in others conduits are laid underground and the cables afterwards threaded from the examination pits. Both of these methods have their advantages, but the writer is favourable to the stoneware conduit. In suburban lines, where cheapness is everything, they are often laid underground bare, and where there is no paving to lift or other interference with examination, this is a good enough method. The cables, however, should be steel armoured, and the armour itself protected from moisture as much as possible by a waterproof covering. The cables are generally made of strands of annealed copper wire of sufficient capacity for the current necessary. The wire should have a conductivity of 100 per cent. of Mathiesen's standard at 60deg. F. The wires should be of as long lengths as possible, according to gauge, and properly stranded to a suitable lay. The joints of the wires must be perfect, and in making the strand the joints of the wires must be stepped so that no two joints occur at the same point in the strand. The cables should be specified in suitable lengths, delivered in one piece to these lengths. The British Insulated Wire Company's insulation is as follows for 500-volt cables: paper and paper fibre, waterproof and non-hygroscopic, of suitable thickness, according to the size of the cable, so as to answer the tension and insulation tests. The insulation is protected by single or double lead sheathing, according to the size of the cable. Where there is a double lead sheathing a layer of compound is put between the two sheaths. Outside the lead sheathing is served with jute and compound, and armoured with soft steel tape of suitable thickness. A second steel-tape sheathing is then put on to lap over the spaces left in the first, so as to thoroughly protect the lead sheathing. The cable is then finally covered with jute and compound.

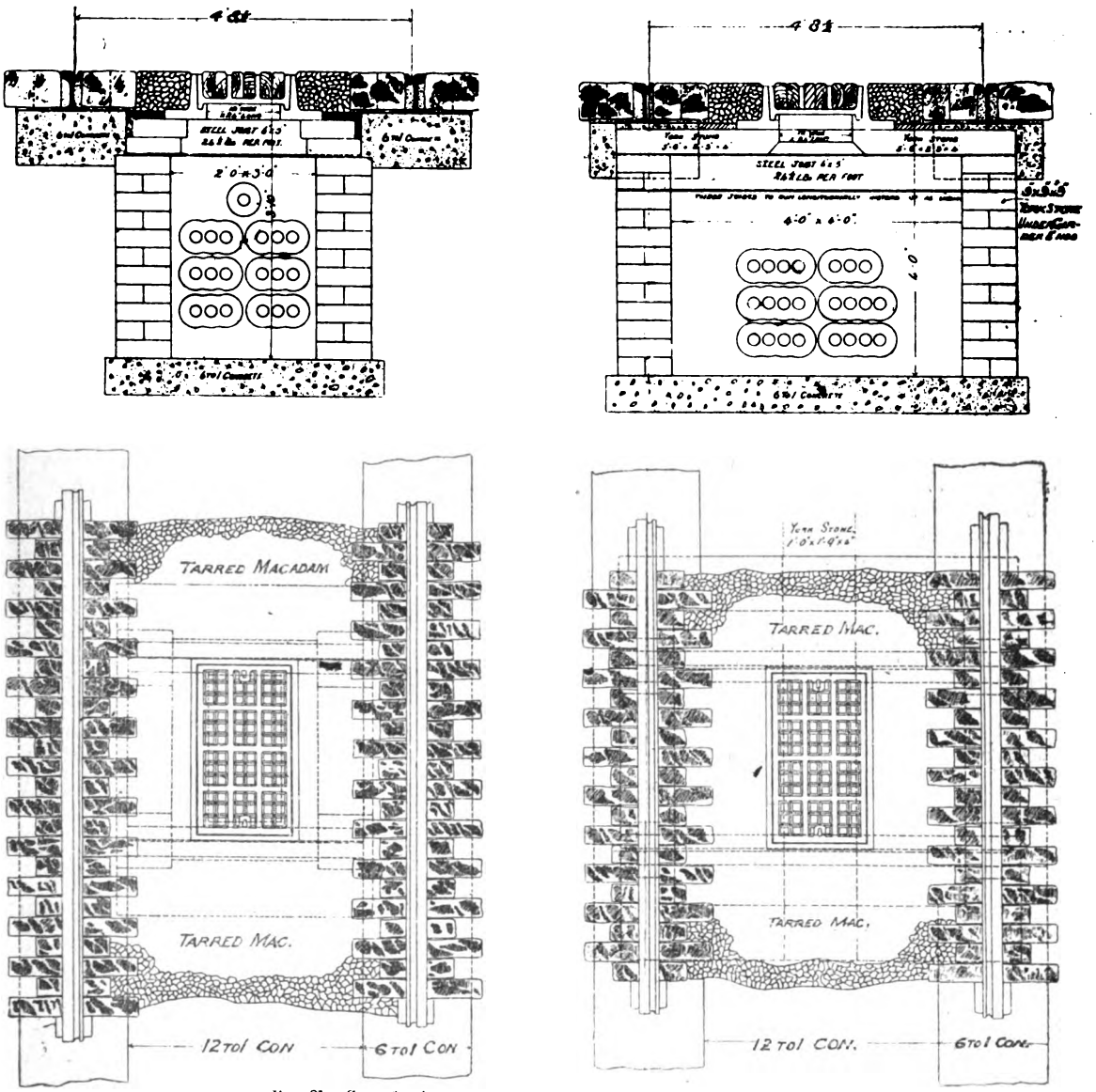

FIG. 21.—Cross-Section of Single Track and Draw Box for Country Line.

Tests at Factories.—Cables of a 500-volt pressure are tested in their lengths to stand a pressure of 2,000 volts alternating current. The insulation test is as follows: The cables are immersed in water for 24 hours and tested with an E.M.F. of 500 volts continuous current. The insulation resistance after one minute's electrification at 60deg. F. must not be less than 500 megohms. Another useful test as to the fatigue the insulation will stand in threading is as follows: A piece of cable is wound round a drum three times in one direction and three times in the opposite direction. It is then immersed in water, and must stand a pressure of 2,000 volts alternating current for 15 minutes without breaking down. The diameter of drum for cables 0·2 square inch area is 1ft. 6in. A 2ft. 6in. drum should be used for large cables.

Tests after Laying.—After laying, the cables should be tested for an hour at 1,000 volts direct current. The tests

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for half-mile sections of the insulation resistance is that at 500 volts the insulation resistance shall not be less than 10 megohms at 60deg. F. Manholes are necessary at varying intervals for drawing in the cables when ducts are used. On curves, of course, they are at closer intervals than on the straight. These manholes should be roomy enough for a man to work in, and to allow of the lead-covered cables being drawn through easily. They must be watertight and thoroughly ventilated by a trapped ventilator at the side, the manhole cover itself being watertight. Fig. 21 shows draw pit or manhole between the rails of a country line, with setts next to the rails and tar macadam between. The ducts are those of the Albion Clay Company. Feeder switch boxes are necessary at the feeding points to contain the switches for cutting out any section of trolley wire. They are generally placed on the footpath or between the tracks, or on the poles in the centre-pole system of wiring. Figs. 22,

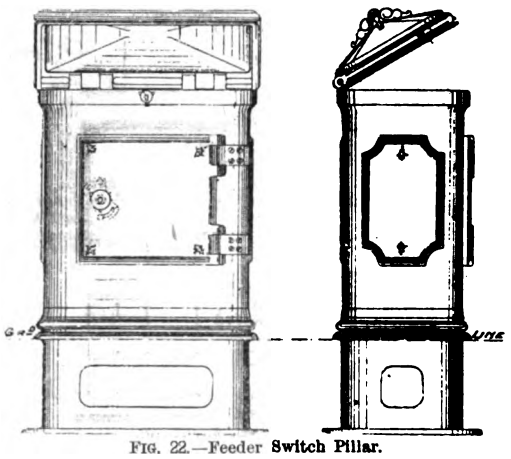

FIG. 22.—Feeder Switch Pillar.

23, and 24 show outside and inside and switch arrangement of a cast-iron feeder switch pillar to be placed on the footpath or between the tracks where centre poles are used. Fig 25 shows cover box and cut-out to fix on the poles. Fig. 26 shows cover box for fuse cut-out to be fixed on poles. Fig. 24 shows section of the feeder pillar with the fittings mounted on the panel. The panels are made either of marble or of slate. The feeder cables carrying the current from the powerstation are connected up to the 'bus bar by means of two switches. The feeder cables are brought into this box through holes below the level of the ground, which are

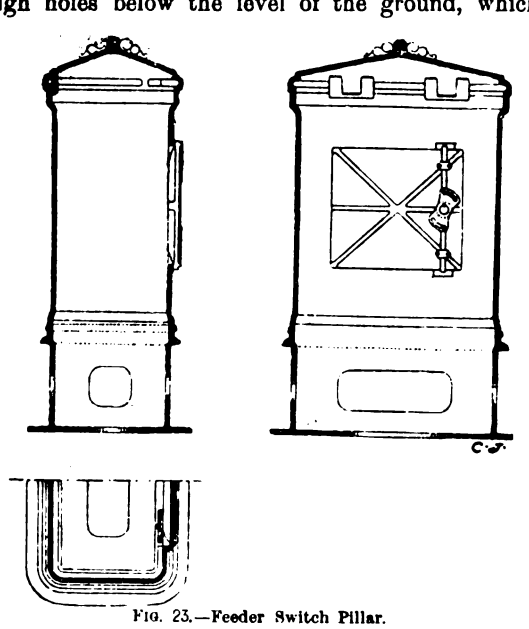

FIG. 23.—Feeder Switch Pillar.

shown on Fig. 23. The current is led from the 'bus bar to the trolley line through plug switches, which also are at the same time time fuses, the fuse wire being clamped between the two contacts of the plugs, and to prevent any accident through shock, burn, etc., shields are provided to protect the hand when removing the plug by the handle. The cables are of a highly-insulated and armoured variety, and usually pass from the upper part of the switch pillar to the pole supporting the trolley wire. They are usually taken up from the interior of the pole to a point just above the bracket arm along which they are laid and connected to the section insulator. A lightning arrester is fixed to each feeder pillar and connected to the main 'bus bar to protect the feeders from injury caused by lightning discharge. The lightning arrester fixed on these pillars is usually of the Garton Daniels or Wurtz type. The former consists of a spark gap, over which the lightning discharge can jump and so pass harmlessly to earth, but a movable plunger is so arranged that should the current from the power-house follow the lightning discharge, the plunger is actuated so as to interrupt such flow of current. The Wurtz arrester is an arrangement by which an over high resistance is inserted between the trolley wire and the ground over which no appreciation or leakage of the working current can take place, but which would allow the high-potential static discharge of lightning flash to pass

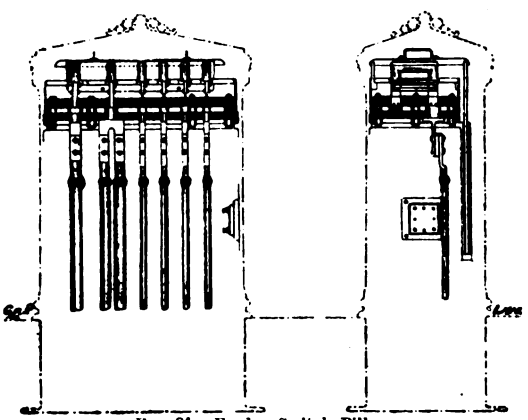

FIG. 24.—Feeder Switch Pillar.

over, and each type of arrester must, of course, be accompanied by the usual self-inductive resistance coil. The pillars are provided also with pilot boards. On to these boards the test wires are connected for making nightly tests of the insulation and leakage of the feeders; also frequently this board is arranged to take two telephone wires to enable conversation to take place between various officials of the staff who are provided with portable instruments and the power station, or to different sections on the line These test or pilot wires and the telephone wires are usually made up together as a multicore cable of No. 7/22 S.W G. Plug switches with knife contacts are shown, but in many cases ordinary quick-break knife switches are used, in which case separate provision has to be made for inserting the fuses.

(To be continued.)

THE PROTECTION OF BUILDINGS FROM LIGHTNING.*

BY KILLINGWORTH HEDGES, M.I.C.E.

The last time this subject was brought before the British Association was at the Bath meeting in September, 1888, when a joint discussion of Sections A and G was held. If I remember rightly, Sir William (then Mr.) Preece opened the discussion by saying that it was a most remarkable thing that if one wanted to know much about atmospheric electricity one had to go back to the works of Benjamin Franklin, 140 years ago. Up to the year 1881 there was not even a code of rules in the United Kingdom to guide people in protecting their buildings from the destructive effects of atmospheric electricity. To the efforts of this association we owe the first set of rules, established by a conference of various societies which was formed in 1878 and brought forward their report, known as that of the Lightning Rod Conference, the same being adopted at the York meeting in 1881.

The history of the art since then has been one of stagnation. Distinguished scientists like Prof. Oliver Lodge here, and Dr. Weber in Germany, have put forward their views from time to time, but still we see conductors erected in a manner which can be shown both by laboratory experiments and by actual reference to lightning strokes to be a source of danger instead of acting as safeguards to the buildings; also the misleading belief of an area of protection is the cause of the erection of an isolated rod, for instance, on a church tower, while the rest of the building has no conductor, or, what is more important, no metallic connection to earth.

Interest in the subject has been again revived, first in Germany by

* Paper read before the meeting of the British Association at Glasgow.

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the Electrotechnische Verein, of Berlin, who after much discussion published on July 21 of this year a set of rules and recommendations on the protection of buildings; and in this country we have the Lightning Research Committee, organised early this year jointly by the Royal Institution of British Architects and the Surveyors' Institution and with the approval of the Royal Society and Meteorological Society, members of all these institutions being represented on the committee. To explain the object of the Lightning Research Committee, I cannot do better than read you the following circular:

"Having regard to the risk of damage by lightning to which our most valuable and historical buildings and monuments are liable, and against which existing systems of protection do not appear to provide sufficient safeguards, the above committee has been appointed for the purpose of obtaining trustworthy information on future disasters from lightning, with a view to improving, if possible, the means of protection. In pursuance of this enquiry, the committee seek the co-operation of competent observers in all parts of Great Britain, in order to obtain accurate details, noted on the spot, of the effect of lightning strokes on buildings, whether fitted with lightning rods or not, and as full information as possible on the various matters indicated in the accompanying schedule of questions. Persons willing to act as observers are requested to investigate any disaster occurring from lightning in their neighbourhood, and to fill up the paper enclosed, giving as much detail as possible, and forward it to the Secretary, Lightning Research Committee, R.I.B.A., 9, Conduit-street, London, W. Should the committee desire additional particulars, such as measurements, etc., the observers will be requested to make further investigations, and any reasonable expenses thereof will be defrayed by the committee."

Our lightning conductors, as usually now arranged, do not guard against what Dr. Lodge has termed "the spitting action" at all; they may act very well as taps to discharge or quietly pass off on to the atmosphere the "induced electricity from the earth and from the buildings upon it," but as lightning protectors they are so arranged that, if actually struck by a flash, besides damaging the conductor, the building would, in all probability, be set on fire, and there is every chance that a portion of the electric current would be diverted into unearthed metal work, and in its tortuous course to earth would be very destructive. For instance, at Brussels a bar of metal, totally disconnected from anything, not pretending to lead to earth, and being some little distance below a lightning conductor, not offering itself to be struck, as a matter of fact was struck and a slight fire caused.

We have only to turn to the paper on "The Action of Lightning Strokes in Regard to the Metals and Chimneys of Buildings," read by Colonel Parnell, R.E., before the Royal Institute of British Architects in 1884, where the examples quoted are mainly those collated by the Lightning Rod Conference, to see that the whole report was bristling with failure of lightning rods as then installed; and the sooner we get rid of the popular fallacy that one or two lightning conductors will protect large public buildings, the better.

The characteristics of a flash of lightning which more particularly concern us are: (1) surging, that is due to the oscillatory character of the spark, which, unlike the currents employed for conveying electricity to a distance for lighting cities or driving tramcars, is a disruptive discharge, sudden and violent, more like the blow of a hammer; (2) self-induction, a property which gives rise to counter force or choking effect, noticeable in straight wires, but which is much more pronounced in coils of wire; (3) side flash, the result of self-induction. A disruptive discharge will often leave what would ordinarily be called an excellent conductor and side flash through the air to other much worse conductors; for instance, the lightning rod may be struck, but instead of following the course provided, a side flash may select its own path through a wall of brick or stone to a neighbouring gas-pipe or bell wire. The often-quoted example of this danger is the accident at All Saints' Church, Nottingham, about 1870, when the discharge passed from the lightning conductor through a solid wall of masonry 4½ft. thick to a gas-pipe. A photograph appeared in one of the magazines a short time ago showing about 20 oxen lying dead along the line of an iron wire fence, thus practically illustrating the surging effect of a lightning flash which may cause great damage. That these cattle were killed by a side flash from the line of the fence may be inferred from an incident mentioned at the discussion on lightning conductors before the British Association in 1888; a number of horses placed in a row were struck, the first and the last of the row being killed and the others not touched by a lightning discharge.

Unquestionably wire fences as now constructed serve as death traps to cattle in many countries. The Director of the Iowa, U.S.A., Weather Service in September, 1898, says: "These reports show that of the 256 head of live stock killed by lightning, 118 were found in close contact with wire fences, and also that as there were no ground wires to the fences, over 44 per cent. of the losses were caused by contact with the wire charged by a lightning stroke which struck the fence at a considerable distance from the point where the stock was killed."

One hears a great deal of the intensity of a lightning stroke, and various surmises have been made as to the number of volts required to cause a flash to leave the clouds and dart through the atmosphere—a medium which is of such high resistance that with the most powerful electric currents that are in general use, 1ft. of air space is considered perfect insulation. On this subject we have the interesting experiments of Sir William Preece with the Warren de la Rue battery, which were published in the British Association report of 1880, and more recently the experiment of Prof. John Trowbridge (published last year) with 150 plate-glass condensers 18in. by 20in., ⅛in. thick, charged to 20,000 volts by means of 10,000 Planté cells. The professor has since increased the charge to 42,000 volts, and by use of Leyden jars he has obtained a pressure estimated at 2,000,000 volts. He remarks: "I cannot go higher for the interesting reason that air at atmospheric pressure becomes a fairly good conductor beyond 2,000,000 volts, and it is impossible to charge Leyden jars to this potential or to produce sparks in a laboratory of greater length than 7ft. To obtain the manifestations of 3,000,000 volts it would be necessary to put the apparatus in an open field, at least 30ft. from the ground, and remote from all other objects. Jars and circuits charged for this high voltage emit a luminous discharge to the floor of the room and to the brick walls, and indicate by this inductive discharge the presence of steam-pipes 20ft. distant. The air breaks down quickly under this powerful electrical stress, and behaves like a rarefied gas."

It is well known that lightning shatters stone and pulverises the finest growth of the forest, and this must be due to the quantity of the electric discharge, which has for some extraordinary reason been greatly underestimated. Herr Pockels has devised an ingenious arrangement for measuring the currents that pass through a lightning conductor by testing the residual magnetism in bars of basalt, which were placed cross-wise near a lightning conductor and tested after a lightning discharge had passed. On examination of two bars thus exposed at the observation tower on Mont Cimone in the Appenines, it was inferred that the currents were respectively 10,200 and 5,330 amperes. It was held that the maximum current which had passed by or through the lightning rods was quite double these figures, as the bars were not tested till several months after the lightning discharge, and had in the meantime suffered vibration, which would partially demagnetise them.

In the very interesting paper by Colonel Parnell which I have alluded to, there is a careful analysis of many disasters occurring to buildings fitted with lightning rods, and showed that there were 828 separate instances of mechanical force exercised on various substances, as against only 228 of heat. I quote the following extract: "Most persons would doubtless imagine that dry woodwork was more likely to be charred or burnt than to be forcibly rent without a mark of scorching; but the reverse is the case. Also in respect of metals, few would believe that this agency was more apt to break or bend metals than to fuse them, but this is the fact. In regard to the direction of the mechanical force on 34 per cent. of the incidents, evidence is furnished of a more or less upward direction."

Without desiring to endorse the whole of Colonel Parnell's suggestions as to the means of protection to be adopted, I wish to place on record that he was probably the first to state that a metal rod run up the most prominent portion of a building offers a very small protection to the whole structure, and if one turns to the more recent paper of Dr. Oliver Lodge, F.R.S., which was read before the Institution of Electrical Engineers on April 25, 1889, it will be seen that the professor states "that the problem does not end with the actual rod, as the current passing through it at the instance of a flash is so enormous that a very high difference of potential exists between the conductor and the earth, however well the two are connected, hence great circumspection must be exercised as to what metallic conductors are brought near or into contact with it. If one end of a rain-water gutter is attached to a struck lightning conductor, the other end is almost certain to spit off a long spark unless it is also metallically connected to earth." Also, Prof. Kirchoff, of Berlin, writes: "The mechanical effect of an electrical discharge is greatest where the electric fluid springs from one body to another. Where the lightning leaves the conductor its mechanical effect is again exerted, so that the rod is torn, melted, or bent."

The expression mechanical force hardly expresses what occurs when a flash actually strikes a building. Take, for instance, the case of Stradbroke Church, Suffolk (Observation No. 5 of the Lightning Research Committee): "North-west pinnacle knocked off; turret to south-west shattered; door to turret leading on to roof of tower thrown off, leaving no trace that a door had ever hung there; bells and clock not injured; flagstaff smashed; top of flagstaff 28ft. from lead roof; many stones scattered to a great distance in all directions." Here and in other similar cases which have come under my observation, the action is more like the explosion of one of the ordinary mines used in warfare. This is made by simply digging a hole at an angle, the ground in which the explosive is placed being tamped with bricks, rubble, etc., and the earth replaced on the top. The mine when fired throws the mass in the line of least resistance, but does not necessarily split the stone in pieces. At Little Staughton, last year, almost the whole of the steeple was hurled in all directions. On examination, however, few of the stones were found broken, and none appeared to have been actually split into pieces by the lightning stroke, with the exception of the stone cap which held the iron support of the weather-cock, and this stone was neatly divided.

Modern Lightning Protection.

Setting aside the opinions of those who consider it is cheaper to insure than to spend money on protection, even architects dismiss the question by a short note at the end of their specifications, "provide a proper lightning conductor," without a word as to where it is to be placed, and, what is more important, how it is to be connected to earth. Insurance offices, too, seem to ignore the question of protection altogether, as no difference is made in the rate per cent. on a building scientifically protected—those on which there are perhaps one or two lightning rods—and other structures without any conductors at all. An insurance surveyor told me that he thought there was little to choose in the two latter risks, if the conductors, as is too often the case, were allowed to get out of order; but to say that it is impossible so to protect a building that the risk of lightning is not reduced to a minimum, is to confess that we in England are far behind Continental nations in the attention which has been paid to this subject.

German practice has been for a long time in advance of what we have been accustomed to here. The recently issued rules of the Electrotechnische Verein, which I have recently referred to, are only the elaboration of a system which has almost universally been adopted for the protection of public buildings in Germany. For instance, at Cologne Cathedral the work is very carefully executed, and of a design which might be followed with safety. Stranded copper cables are used, and these invariably run through galvanised iron stanchions with flat feet, by which they are bolted to the stonework. To avoid galvanic action setting up between the iron and copper, the eyes of these supports

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are bushed with lead. They keep the conductor about 7in. away from the structure, or sufficient to enable the cable to be stretched tight and not run round projections in the manner we are accustomed to see here. For this purpose there are tightening screws at several points. A somewhat similar arrangement is used for the horizontal conductors which run each side of the roof, being kept well away from it. The terminals of the lightning rods are almost always plain spikes without branches, but a building has many of these, both on the highest portions and along either the tops of the walls or ridge of roof, the whole being connected together by the horizontal conductor, which is usually run in the method described. A timber shed near Frankfort had these vertical rods about 15ft. apart, and a petroleum storage tank at intervals all round its circumference.

The Palais de Justice, Brussels, may be mentioned as a well-protected building. It is hardly necessary to go into the details of the installation by the late Prof. Melsen at the Palais de Justice, as it is very similar to that at the Hotel de Ville, which has been described in the text-books. Briefly, the Melsen system consists of a network of metal rods connected together at the top and furnished with an aigrette or bundle of eight 4mm. copper rods spread out like a feather, so that after passing along the roof the terminal points project so little that they can hardly be seen from below, but yet break up the area of the building so as to leave little space unprotected. Copper is used for the conductors, but where they descend, a special iron box is employed, in which they are embedded in zinc, and from this the down rods can be continued in iron and also connected to the rain-water pipes and other ironwork of the building. The provision for earth connection is very ample in the case of the Hotel de Ville. There are 24 iron rods ¾in. in diameter; of these eight are fastened to the spigot of an iron pipe 2ft. in diameter, which is suspended in a well in the courtyard, another third is connected with one of the principal iron mains of the water supply of the town, and the remaining series are taken in a similar way to a large iron gas-main. That the earth connection is efficient may be gathered from the fact that the Palais de Justice was struck soon after completion, and that no more damage was done than the partial fusion of some of the points of the aigrette which received the flash.

The Melsen system has been used to a certain extent for the protection of the public buildings in Paris, but French architects seem to prefer the long single point, probably because it is more easily adapted to the elaborate weather vanes and finials which are so largely used, presumably for the embellishment of buildings of importance. The standard rod or *tige* is 6m. high, the diameter at base about 0·06m., tapering to nothing at the point; the rod is firmly connected to the woodwork of the roof, and the copper or iron conductor is fixed at the base by means of a shackle. The conductor is usually kept away from the building by means of supports, and is very carefully led into moist earth, or, in the case where the foundation is of rock, connected to a network of wires which run for a very considerable distance under the surface, with the idea of obtaining as large an area as possible. Where a well can be used, the earth connection is prepared by plaiting up galvanised iron strips so as to form a basket, which contains a sort of grapnel which is attached to the conductor, the basket being filled with coke and lowered into the water.

American Practice.

The "lightning-rod man" is well known to all settlers out West, and his pertinacity in introducing his wares has made his profession a synonym for "smartness." As a rule the protection afforded is very small, and when the author was engaged in railway engineering in the United States he often found the end of the wrought-iron rod to be simply driven a short distance into the ground. An earth connection giving good results may be constructed by driving a pipe into the ground so that its perforated end rests in moist earth; its upper end is left about 6in. below the surface, thus it can be watered artificially or by the rain. To assist the collection of moisture, a large sleeve is placed outside furnished with a perforated top and set flush with the gutter. With slate or wooden roofs, bands of tin plate or galvanised iron are often placed underneath the slate covering on rafters of the roof, being connected at the top with the "air terminal" conductors, and below with the gutters and rain-water pipes as previously described; in the case of a mansard roof the sheet metal or flushing is also connected to the system. It is stated that if all the connections are properly made, so as to secure good electrical connection between themselves, the rain-water pipes, and the earth, there is no liability whatever of the woodwork or other material about the roof being set on fire or damaged, or any person beneath the roof being injured by the electricity in a lightning discharge while passing through the combination on its way to earth.

Time will not allow us to follow this subject. The question which interests us at the present time is: Are our public buildings efficiently protected? Several have lately come under the notice of the author, but it will be perhaps sufficient to review the methods formerly adopted for the protection of St. Paul's Cathedral. In 1898 the author was asked to report on the condition of the lightning conductors, which were, he was informed, put up in the year 1872, having taken the place of the original system, erected under the advice of the Royal Society about 144 years ago. The new series were considered at the time as examples of the most advanced system of protecting our national cathedral from disaster from lightning; the spire of old St. Paul's having been partially damaged from this cause three times, at last it was set on fire in the reign of Elizabeth in 1561 and totally destroyed. It is interesting to note that the Lightning Rod Committee (among whose members were delegates from the Royal Society and from the Royal Institute of British Architects) appears to owe its formation to enquiries made by the Dean and Chapter of St. Paul's.

Tests were made of the resistance of the so-called earths, and actual measurements were given. A later examination showed that the cables did not make good electrical connection with the iron framework of the ball and cross, but were connected to a circular piece of cable which had been led round the ball, and from this the actual conductors descended until they met the system previously described as lying on the dome. The joints were in every case simply wrapped and unsoldered, consequently they had become in many instances quite loose, and almost everywhere the electrical connection would be of high resistance by reason of the oxidation of the copper. The work had evidently been executed with care, as the ends of the cable forming the earths, when the drain round the structure was in use, were probably always kept in running water, and the insertion of these ends into or around the drain pipes, which were insulated from the earth, was carried out at a much later date. Generally this installation may be considered an average specimen of the method adopted for protecting our public buildings; if, since these installations were made, the joints have not been renewed and earths carefully tested, the coefficient of safety has probably greatly diminished, and although one sees the usual array of rods, spikes, and so-called conductors, their utility as electrical appliances is practically nil. The reason we do not hear of more disasters is partly due to good luck, and also to the fact that most of these buildings are in large towns, and the warm air ascending from the numerous chimneys in the vicinity helps to lessen the violence of thunderstorms; but should a direct flash strike an insufficiently protected edifice a disaster may occur, similar to that at Rockliffe Church in Cumberland, where about 50ft. of steeple was destroyed in a thunderstorm last year.

For the rearrangement of the conductors, the plan recommended by the author, taking into consideration the large amount of copper cable already disposed about the building, was, first, to run three new cables from the metal work of the framework supporting the cross to the roof of the dome (making inter-connection with the iron supports of the structure); there connecting them with the eight existing conductors, and reuniting them at the base of the dome to the existing system, which is increased by running a new ½in. seven-ply copper cable on the top of the parapet entirely round the building. From this horizontal conductor, aigrettes, consisting of five pointed copper rods, were tee'd at intervals by means of special brass boxes tinned inside, into which the cable was placed, the aigrettes first secured by binding, and the whole united by running in hard solder. Wherever practicable, this method of uniting the conductors would be adopted, and boxes were prepared suitable for crossings of almost any angle. However, in consequence of the exposed position, and the rule against open fires or blow-flame lamps, many of the joints have to be made by soldering, this method not possessing the advantage of poured joints, as in course of time, no matter how intimate the surfaces are, oxidation is sure to take place. Great difficulty was found in securing efficient new earths. Two sets of conductors were, one, united to the hydraulic main supplying power to the organ, and the other to the 8in. water-main; this was made by cleaning the outside, then wrapping the strands of the conductor around it, enclosing the whole with a metallic clamp, which was filled with molten lead and screwed up tight.

The present cathedral is surrounded by the foundations of the previous structure, so that not only is the ground very dry, but it is difficult to make a small excavation through the *débris*. A new form of tubular earth was designed. It consists of a perforated wrought-iron pipe, furnished with a steel shoe, which was, after some trials, sunk to the requisite depth to secure moist ground; the stranded conductor was dropped in the pipe, being soldered to the cap at top, and shielded from injurious electrolytic action by wrapping it in a lead tube. The pipe has a bend at the upper end which projects above ground, and is closed by a plug so that water can be poured down. There are other earths of ordinary copper plate buried in a mixture of charcoal and broken electric light carbons, and the old system of conductors are also attached to all these new earths, and it is also proposed to establish connection with the ends of the rain-water pipes, where they look out of the stone wells down which all the conductors are led.

Westminster Abbey.

There were so few conductors, and the earth connections were so unsatisfactory, that the author designed a new system, consisting of ⅜in. seven-strand copper cables, which are run horizontally along the apex of the roof of the nave and cross transepts, and continued over Henry VII.'s Chapel. From these are led similar conductors to the towers, lantern, and other higher parts and downwards to the earths. The conductor is strained through special hold-fasts at a distance of about 6in. from the structure. The horizontal conductors are furnished with about 30 aigrettes, at intervals of about 30ft., each of these being made of four pieces of solid copper, and are united to the horizontal conductor by means of a special joint-box, containing pockets, in which the rods and cable are placed, the boxes being then filled up with solder. All joints are made in a similar manner, and it may be reasonably expected they will last as long as the cables, and that their electrical conductivity will not be lessened, as is the case with ordinary soldered joints.

Earths.—The Abbey is built on sand, which is particularly dry, therefore in order to obtain a low resistance a small pipe is laid from each earth to the nearest rain-water spout, and so placed that a certain quantity of rain-water will be deviated, sufficient to keep the charcoal moist in dry seasons. The tubular earth already described was used in some cases where there was not space enough to lay a copper plate. The pinnacles with which the structure is surrounded are each protected by ¼in. solid copper wire connected to a small general conductor, laid horizontally on the lowest roof and connected to the lead roofing.

The object the author had in view was first to assist the dispersion of the so-called negative electricity collected on the building by numerous points, and, secondly, to provide so many good conductors to earth that should any portion of the structure receive a direct lightning stroke, no matter what side flashing or surging took place, the danger to the structure would be negligible, provided the earthing arrangements are kept in order.

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The rule to be adopted for the protection of large public buildings is not to run up unsightly spikes above the highest point, but to cut up the surface area into as many points of discharge as possible. An American expert compares points to "a number of small water-pipes connected with a large reservoir; if you have enough of them, and sufficient time, you may drain the largest reservoir. Furthermore, when some sudden rise or flood occurs in the reservoir, these minute drains may be of service in keeping the height of the water down. A single large conductor, be it rod or tape, on the other hand, is more like a large drain which is shut off until the flood is imminent; the gate is suddenly opened, and we try to compel the torrent to keep the provided path. It sometimes does, but when the flood is heavy overflows occur."

The increase in the number of points and the cross connections, which form a sort of protective network, necessitate a larger number of earth connections, the number depending almost entirely on the ground plan of the building.

The German rules of the Electrotechnische Verein may be summarised as follows: "Special attention is drawn to the fact that the conductors of the buildings must be in metallic connection with the earth, and that they ought to go round the building, especially round the top of the roof, and, if possible, on all sides of the roof, and then lead to the ground in the shortest possible way, avoiding all sharp curves. Metallic parts in the building and masses of metal, especially those in contact with the earth and offering large surfaces, are to be connected together as much as possible and to the conductors. In order to decrease the cost, consideration should be given to utilising the pipes upon the building, and all metallic parts should be made use of where possible. Conductors of iron are generally used, and should not have a sectional area of less than 50 square millimetres if interconnected, and not less than 100 square millimetres if unconnected. If the conductors are of copper, half these sections is sufficient. All connections to have a metallic contact surface of not less than 10 square centimetres. Conductors must be repeatedly tested."

Many local boards in Prussia insist upon lightning conductors being fitted on public buildings, such as schools, town halls, hospitals, and churches. The regulations vary with the different local authorities. In Frankfort the Municipality have the following: "The erection, alteration, and repairs of lightning conductors must be in accordance with the scientific rules now in force. The conductors must be of pure copper, and of not more than seven strands. House owners must have their lightning conductors examined at least every two years, and an examination is also required in the case of the erection of, or alterations or repairs to, a lightning conductor which has been struck. Designs and specifications of proposed erections must be submitted to the local board, and for the accuracy of the same the house owner is responsible."

In Paris the more important of the rules of the Municipality refer to the earth connections—for instance, the license for the Big Wheel contained a clause to the effect that "the conductors must be put in electrical connection with *la nappe de l'eau souterraine*, and shall not have a resistance of more than 10 ohms."

In isolated private houses it is well to run a small copper wire up each of the chimney stacks and connect all these conductors with a horizontal cable, which may, if the run is long enough, have short aigrettes. The earth conductors are led downwards from each side of the roof. If suitable arrangements can be made when a building is being erected, a modification of the American system of using gutters and water-pipes as the conductors can be adopted, and will then add only a nominal cost to the fittings usually supplied. It is almost impossible to draw up a set of rules to be universally applicable. Each building should be carefully studied, firstly, as regards its position with neighbouring structures: secondly, as to the disposition of the metal employed; and, thirdly, with reference to the subsoil and its suitability for earthing the conductors.

The author will conclude this paper in the same way as that read by Dr. Oliver Lodge before the Institution of Electrical Engineers in 1889 by bringing forward as suggestions the following recommendations, for many of which the author is indebted to Dr. Lodge:

1. Joints should be avoided when possible, also sharp bends and roundabout paths to earth. A conductor detached from the building is safer than one in close contact with it.

2. The conductors should be kept a short distance from the building by means of supports, which must not be insulated. If joints are necessary, the stranded wires must be spliced and soldered and tape must be riveted and soldered. All joints, tee and other connections, also the union of air terminals or aigrettes to the cable, should be made by splicing or careful binding, and then protecting the joint by a metal box, which is to be filled with hard solder.

3. The conductor should be of a standard size throughout, and of sufficient area to withstand rough usage; also the wires or strands should not be too small, or they may become brittle with age. A solid conductor may be used, but not one of tubular section.

4. Lightning conductors are costly to renew. Iron perishes quickly, copper very slowly; therefore, use the latter. Rod is better than flat ribbon, but a stranded conductor is more convenient.

5. It is not wise to erect very tall pointed rods above the roof of a building; a number of points above the ridge is better than only a few. Any part of a building is liable to be struck; and to make quite secure, every prominent part of the outside should have a horizontal conductor running along it. This horizontal conductor should be furnished with air terminals, preferably in the form of fleur-de-lys or aigrettes at distances proportional to the area to be protected. The terminals should be well pointed, but need not be plated or tipped.

6. The orthodox rule, "Connect all pieces of metal to the lightning conductor," requires modification, thus: "Connect all pieces of metal to each other and to the earth, but not to the lightning conductor."

7. Earth all ventilating and rain-water pipes, gutters, etc., independently of the lightning conductor.

8. A good and deep earth should be provided, if possible, independently of water-mains; but if the conductor at any part of its course goes near water-mains, it is best to connect to them.

9. Take care before connecting to water-mains that they have leaded, flanged, or screwed joints, and not caulked with red lead and oakum; also avoid the neighbourhood of small-bore fusible gas-pipes, and indoor gas-pipes in general.

10. After selecting a suitable place for the earth-plate or tubular earth, arrange for keeping it moist either by watering or causing a rain-water pipe to discharge in the neighbourhood.

11. Protect the metallic conductor where it leaves the ground, both from accidental or malicious injury, and from the natural deterioration which will in time take place.

12. Test at intervals not greater than one year.

13. Protect all flagstaffs by a conductor projecting a few inches above the top. If the pole is on a metallic roof, this should also be connected to earth.

14. Note that a building once struck is liable to be again damaged, and special care should be taken in protecting it.

In conclusion, I would warn those who have to specify the method of protection to be adopted not to put any faith in the generally received opinion, "that a certain space contiguous to a lightning rod is completely protected by it; so that if the rod is raised high enough a building in this protected region is safe." There is nothing more illusory, as there is no space near a rod which can be definitely styled an area of protection, for it is possible to receive violent sparks or shocks from the conductor itself, not taking into account the phenomena which I have endeavoured to explain under the head of "Surging and Self-Induction." The best that can be said in favour of the present system of lightning conductors is that they afford incomplete protection, and are far from being efficient.

It appears anomalous that large sums of money should be spent on the protection from fire of our museums, while the question of protection from lightning is simply ignored by the department in whose care they are placed. For instance, the Victoria and Albert Museum has one conductor (it was struck last year, but fortunately the damage was confined to the destruction of an electric main, which served as a lightning rod, as it was laid on the wall separating the Imperial Institute from the museum). The National Gallery apparently had no conductor until the flagstaff was recently erected, and this is the only approach to safeguarding the building from lightning stroke, although many thousands are being spent to buy up the adjoining property. The British Museum authorities rely on the copper roof for protection, which is very doubtful, and the flagstaff was on my visit unprotected. The Tate Gallery appears to have no lightning conductor, and the system on the Houses of Parliament, originally installed with great care, is said to be faulty, and requires attention. The Victoria Tower, which was struck in 1868, was again damaged a few months ago. The ecclesiastical authorities are, with some exceptions, indifferent, and having had some rods put up haphazard suppose that they act as a fetish or charm, or as a quack specific to cure all lightning plagues. Having visited some dozen cathedrals in the provinces, in only one was there any attempt to protect the whole of the structure, and that was at Canterbury, where the arrangement of the conductors was faulty, in that a stroke of lightning which had travelled through perhaps half a mile of space would not, as the generality of lightning-conductor makers expect, tractably follow the copper tape, some of which had almost right-angle bends. However, Canterbury stands at the head of the other cathedrals which were inspected in that the conductors have recently been overhauled and rejointed, and the earth connections tested.

At Chester the conductors were insulated and led into loose sockets close to the ground, so that any passer-by could disconnect them from earth. Time will not allow a criticism of all the buildings visited, but I must point out that the well-preserved Minster at York has only three conductors, which, according to information received, had not been tested or overhauled for very many years. Our cathedrals and museums are of national importance, and if it is found necessary on the Continent to have a thorough system of protection and frequent inspection, surely it should be done here, as the initial expense could be spread over a number of years, and the annual upkeep would be sufficiently provided for by a 1 per cent. rate on the sum spent for structural repairs. The amount of damage to property by lightning stroke is enormous, and this will be a record year from a financial point of view. Most people think that almost every church has a conductor, whereas not 10 per cent. are so provided; in fact, although there is sometimes a recommendation from the archdeacon that the churchwarden should put up a conductor and see that it is kept in order, if the vicar wishes to safeguard his church the cost usually has to come out of his own pocket. The insurance offices do not seem to care whether a building is protected or not, as no individual office likes to insist on the erection of lightning conductors for fear of diverting business to its rivals.

The Lightning Research Committee are collecting facts by means of the assistance of observers throughout the country who are qualified by position and training, and when a sufficient number of observations are recorded it is thought that the science of the matter will be much more advanced than by trying to theorise too much on the imperfect knowledge and facts which we possess at present.

Snoqualmie Power Extension. — A vast extension of the Snoqualmie power transmission system is about to be taken in hand. We note that the company has placed an order for 250,000lb. of aluminium wire cable, which will more than double the capacity of the system. Coincident with this, the enlargement of the generating station is now in progress, and an additional penstock will be installed, having 50 per cent. more capacity than the original ones. The new penstock is intended to feed three water-wheel sets, each one of which will drive a direct-connected Westinghouse 5,000-h.p. generator.

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SECTION G.

The Engineering Section of the British Association is usually organised with considerable skill, but this year was not encouraging to earnest journalists. The secretary to the section had some idea that copies of the presidential address were as valuable as diamonds from Kimberley—at any rate, we applied to him half a dozen times for a copy just before the address was delivered, but were told to apply afterwards. We did not apply, nor do we intend to do so. He seems to have a great idea of his own importance, and imagines the journalist to have nothing else to do but wait his convenience and fall in with his views. It will be well to inform this gentleman that it is far less important to journalists that any particular meeting should be reported, than it is to readers of papers that they should receive the credit due to them for time and knowledge expended in the preparation of papers. Among some few young and inexperienced secretaries there seems to be an idea that the giving an early copy of a paper to a journalist is conferring a favour of great value. The sooner that view is put out of their minds the better. The general secretary has always been exceedingly anxious to assist journalists to the utmost extent, and it only needed a walk to his office to have obtained a copy of the paper referred to; but why put men to that inconvenience when plenty of copies of a paper are immediately to hand? It is the duty of the sectional secretary to save trouble to the general secretary when possible, and not increase the labour he has necessarily to undergo during one of these annual meetings. Probably there was no time during the history of the Engineering Section of the British Association that the organised facilities, for reporting that section, were better than while Mr. Conrad Cooke acted as secretary, but then he had a personal feeling in the matter, and understood the difficulty of adequately reporting a meeting of many sections. Enough of criticism of inexperienced secretaries—and a brief reference to Colonel Crompton's address as far as we recollect it The three leading topics related to tramways, automobiles, and standardisation. The question of roads, congested traffic, and road surfaces were dealt with as important, but there was no new information on those subjects, except that the president gave credit to a recent writer as the originator of suggestions which are neither new nor practicable, but have been discussed by experts—real experts, not amateurs of that ilk—and rejected. One of Colonel Crompton's suggestions was the paralleling of main roads. He truly said that since the time of mail coaches the main roads of the country remained very much as they were, but he forgot or overlooked the fact that practically the paralleling of main roads had since that time been accomplished by the construction of main lines of railway throughout the country. Surely the construction of railways tended and tends to relieve the traffic of and the congestion upon ordinary roads due to increase of population and business. Colonel Crompton's point, however, was that tramways tended to block rather than to help road traffic, and that the true solution of many of the present troubles was to be found in the increased use of automobiles. This is quite true, but some of the troubles of tramway working might be modified and minimised by better organisation. Whether the public like it or not, one reform will have to come, and trams will only pick up and put down at certain stopping-places. The indiscriminate picking up and putting down passengers leads to a great increase of time necessary to work the traffic from point to point, but more important still from the technical point of view, it leads to

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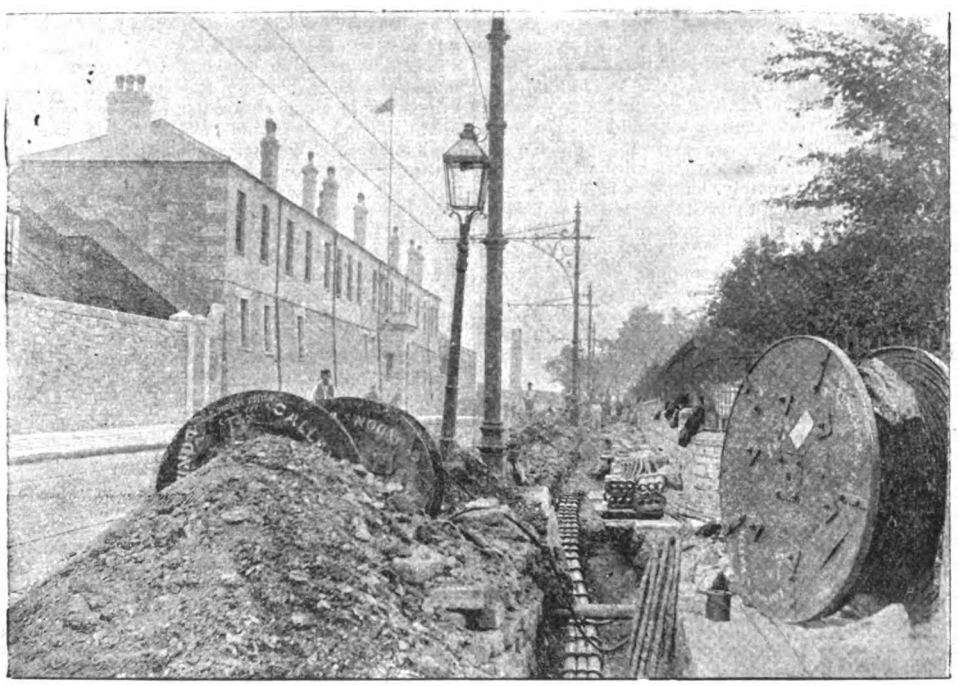
a greater strain on the machinery and an excessive maintenance charge. When we come to discuss the question of road surfaces in connection with automobilism, we open up the widest possible subject. Is it not singular that all our authorities are equally lax in making experiments? These are left to private enterprise, and private enterprise naturally experiments in directions which look to have a direct money value to individuals. The automobile clubs and manufacturers, with a little aid from learned or semi-learned societies, are to experiment on automobile traction on roads. The road surfaces will probably be chosen to give the best results; but why cannot the various authorities join in and obtain accurate results from all kinds of roadmaking materials and with road surfaces not specially selected, but of the ordinary character obtainable with the materials employed? It is usual to say all manner of hard things about London street surfaces, and they may correctly be described as unfit for a civilised community. No one knows this better than the road surveyors themselves. They do the best they can under the existing conditions of things, and while it is permissible to construct a street surface one day, pull part of it up the next, and then patch the broken-up part, no surveyor will be able to show good work. They never have a chance, and if they had the chance, parsimonious councillors would prevent the making the best of the chance.

MAINLAYING AT DEVONPORT.

The accompanying photograph gives a good idea of the work being done by the Callender Cable and Construction Company. Under the large contract for cable this company has received they have to lay all the following types: single-core, two-core, and three-core cables for both arc and incandescent work. The pilot cables are in four sizes, containing respectively 3, 6, 9, and 12 cores. The concentric feeders have copper conductors of sectional areas of ·3 by ·4 square inch, while the neutral feeders are ·2 cables. All the above are lead-covered and armoured for laying direct in the ground. Above the cable hard-burned tiles are laid to protect the same and to warn workmen when re-excavation is going on. By the side of these armoured cables, three-way stoneware ducts of Messrs. Sykes's patent type are laid as shown in the illustration. The Devonport work is being supervised on behalf of Messrs. Callenders by Mr. H. Schiassi, who has already laid four feeders totalling 5,000 yards of cable and also 1,500 yards of distributing mains.



Cable-Laying by the Callender Cable and Construction Company at Devonport.

PORTSMOUTH TRAMWAYS.

On Tuesday last a section of the Portsmouth electric tramways was officially opened. The proceedings connected with the ceremony were satisfactory from every point of view. The attendance of invited guests was large, the streets through which the gaily-decorated cars passed were crowded with admiring townsfolk, the plant acted as if it were performing ordinary operations under ordinary circumstances, and everything went merry as a marriage bell. In due course we hope to give a technical description of this work, but in the meantime congratulations are due to Mr. Rotter, the engineer to the undertaking, to Messrs. Dick, Kerr, and Co., and to Messrs. Macartney, McElroy, and Co., the contractors, for the success attending their work.

MODERN COMMUTATING DYNAMO MACHINERY, WITH SPECIAL REFERENCE TO THE COMMUTATING LIMITS.*

BY H. M. HOBART, M.I.E.E.

Of recent years the improvements in continuous-current dynamos that have received the greatest attention have generally related to some strictly radical departure from the straightforward type, such as to pole-face windings, to divided poles, to reversing lugs, and to many other interesting and often fairly effective devices.

Although none of these have as yet become extensively introduced, it would be by no means correct to infer that for that reason they are impracticable or in any way inferior to the more usual types. One or other of them may eventually, aided by especially opportune circumstances, be brought—or forced—into extensive use, and then, if actually an improvement, will become incorporated in the generally accepted type. The element of chance in matters of this sort has of late years made a deep impression upon the writer. Having taken for a very long time an especial interest in dynamo design, it has, nevertheless not been practicable, for long intervals together, for him to give it his undivided attention, and it has been interesting, although rather discouraging, to find such deep-rooted conservatism in this branch of an industry generally believed to be characterised throughout by abnormally rapid development. It has never to the writer seemed necessary to resort to the special features referred to above, since there has always been, and is still, ample room for improvement in the ordinary type; sufficient room, he believes, to very greatly modify our view, as to what should constitute a first-class dynamo.

The writer has been led to these reflections, as already intimated, by

* Paper read in Section IX. of the International Engineerin Congress, Glasgow, 1901.

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the realisation that his ideal of a system of dynamo machines, or, rather, that approach to it which it would at first sight seem so extremely simple and rational to carry out, and so highly desirable, as well from the broad commercial as from the technical standpoint, remains year after year apparently almost as far as ever from accomplishment. In individual machines one may, by the greatest persistency, manage to arrange to get one or the other feature introduced, and occasionally such features find favour and become more or less widely adopted; much more generally, whatever their merits, they are laid aside, frequently from no deeper motive than from a consideration of the commercial expediency at the moment, modified by a conservative tendency to retain old types as long as practicable. It is proposed in this paper to set forth certain views regarding the continuous-current dynamo-electric machine. No features of very especial novelty are claimed. The designs described do not depart radically from machines at present on the market, but to construct a consistent system, embracing machines of all the various ratings required by a single manufacturing firm for successfully entering the field, is another matter altogether from designing a single excellent dynamo, and it is from this broad point of view that it is proposed to discuss the subject.

The first point to be emphasised is the predominating influence which the normal voltage of a machine should have upon its proportions. Contrary to the ruling tendencies, there should in many features be greater differences between a 500-volt and a 100-volt machine for the same output and speed than between two machines of the same voltage and very different outputs. Of course this has been recognised for a long time, and one very often sees instances where the design is correct, considered from the standpoint of the rated voltage. But concerns standardising lines of comparatively small machines of many listed ratings, from very small sizes up to 100 kw. or even higher, are reluctant to admit the economy of fully observing this principle. So comparatively recently as eight or ten years ago there were but very few exceptions to the custom of using, for a given output and speed, the same magnetic circuit, the same armature spider and commutator shell, and often even the same armature coils and the same commutator segments, for 500, 250, and 125 volts. In those days great confidence was still felt in many quarters in the possibilities of double, triple, etc., windings, both two-circuit and multiple circuit, in cross-connections, in interpolated segments, and in other devices which work out very satisfactorily in the calculating and draughting offices, and especially in the shop. The writer's own opinion is that most of such windings are distinctly inferior. Firms have been heard of who assert that the results in the testing-room and after installation are in every respect beyond criticism. It is, nevertheless, not at all exceptional to learn at a later date of their having discarded these methods. The writer most certainly believes that the simplest windings are in the end by far the most satisfactory, and that by making suitable use of them they suffice for all ordinary requirements. But in those days, with all these special windings and connections to choose from, nothing was easier than to arrange that, for instance, the four-pole dynamo for 500 volts should have a two-circuit single winding, the 250-volt machine should have the same winding connected as a four-circuit single winding, and for 125 volts the dynamo could be connected up into a four-circuit double winding.

As to the commutator, there then existed various rules with which it was known to be very desirable to comply, but these offered inconveniences, and it was sometimes decided to use the same commutator for all three voltages, carbon brushes, then more of a novelty, for 500 volts, and copper brushes for 250 and 125 volts. Just why it should have been expected that copper brushes would be much more practicable for these lower voltages it is not now so easy to imagine, but it must be remembered that the standard of excellence was at that date altogether different from the standard of to-day. A commutator which, when running with load, could be described as anything less than very hot was then decidedly the exception; and as to sparkless collection of the current, machines in those days termed excellent would to-day never leave the manufacturer's shop. The practicability of shifting the brushes in proportion to load was, in the case of generators, only just beginning to be questioned, and large machines in which overloads could be thrown off with impunity were not easily to be found.

There is a remarkable persistency in old types, and even in the latest product of the foremost manufacturers of the present day one has no difficulty in finding numerous traces of these ideas. One rarely encounters low-voltage machines in which the commutators are anywhere nearly so liberally proportioned for their requirements, from the heating standpoint, as in machines for high voltage. On the other hand, the machines for high voltage have not by far so liberal a factor of safety as regards insulation as have those of lower voltage; and the former have, as a rule, disproportionately greater losses in the armature windings and core and in the field spools, and often are rated at a higher speed to avoid the difficulty of having a proportionately greater number of armature conductors with the attendant increase in space due to the greater sub-division and to the higher insulation requirements. It would appear to be quite correct to permit these tendencies to a certain extent, as a concession to the expenses of manufacture, but certainly very much more regard should be shown than is now the case to the designing of machines with reference not only to the kilowatts capacity but to the volt and ampereage as well.

There is, however, one point possessed in common by machines of greatly different voltages but for the same output and speed—namely, the mechanical energy to be transformed into electrical energy, or *vice versa*. Hence it would seem natural and desirable that base, stands, bearings, and shaft should be identical for all voltages. By the methods now to be described this may readily and, the writer believes, most economically be obtained.

Numerous tests have satisfied the writer that the magnitude of the reactance voltage per commutator segment is of the very first importance in determining the performance of the machine from the commutating standpoint. It is of far more importance to have low reactance voltage per segment than to have low armature strength, as expressed in ampere-turns per armature pole. In fact, it is nowadays the writer's practice—speaking broadly—to make the armature strength as high as practicable so long as this is consistent (and it generally is) with low cost of effective material, with practicable proportions of field, armature, and commutator, and, above all, with obtaining minimum reactance voltage. The writer would be inclined, from this rough practical standpoint, to estimate the harmful influence of armature strength upon commutation as proportional to, at most, the square root of the armature ampere-turns per pole.

Next should be pointed out, that the higher the voltage, the more is the least practicable thickness of the commutator segment apt to be the limit in determining the number of segments per pole-piece, and hence the number of armature-turns or coils per pole-piece. This consideration, together with the greater proportion of the available space on the armature periphery, which should, in the 500-volt machine, be devoted to insulation, and the greater cost of the labour associated with the windings and insulation, make it much less practicable to have so high armature strength in a high-voltage as in a low-voltage machine. But on the other hand, in the high-voltage machine the commutator's duty (because of the low amperage) is light. It requires to have devoted to it but a small portion of the distance between bearings, thus leaving ample room for employing, for high voltages, a weak armature (as expressed in ampere-turns per armature pole), but one occupying, owing to the consequently greater necessary cross-section of its magnetic circuit, a large proportion of the total distance available between bearings.

A still more influential consideration tending toward a widening of the armature proper in the high-voltage dynamo, is that the centrifugal force at the commutator periphery limiting the commutator circumference, and the thinness of the segment limiting the total number of segments, one should, in order to obtain a sufficiently large number of segments, to ensure a low reactance voltage per segment, employ fewer poles in the high-voltage dynamo than in that for lower voltage. And that is precisely what one wants for other important reasons—namely, from considerations relating to the design of the commutator—since the high-voltage (low amperage) commutator comes short enough even with few poles, but it is only by means of comparatively many poles that we secure—with low voltage (high amperage)—machines of desirably low amperage value of the current per set of brushes to permit of a reasonably short commutator.

Now, as to the most desirable commutator diameter, the writer believes that the limiting peripheral speed should be set very high. Especially on the large diameters occurring in direct-connected units there should be no difficulty, since for a given peripheral speed the centrifugal effects are inversely as the diameter. In any case, it is purely a question of using a sufficiently liberal amount of material in the mechanical construction of the foundations, base shaft, and commutator to ensure a perfectly true continuous commutator surface, absolutely free from any vibration whatsoever. For a high-voltage machine, a large diameter enables the reactance voltage to be maintained low in virtue of the large number of segments per pole thereby secured (the permissible minimum thickness of segments being the limit). For low-voltage machines the necessary radiating surface for transmitting the high current is the limit, and the greater the diameter the less need be its axial length. Hence, governed by these two considerations, it is fairly logical to choose the same diameter of commutator for all voltages for a machine of a given output and speed. It is furthermore very practicable to also employ for all voltages the same diameter of magnetic yoke, of bore, and of armature laminations, the variations with the rated voltage being limited to width of magnetic circuit, of armature core, and of segments, as well as to windings, to numbers of slots and segments, and to the number of poles. As at first stated, all essentially *mechanical* parts—base, stands bearing, and shaft, as well as distance between bearings—are entirely independent of the voltage, so that *absolutely* the same drawings, patterns, and castings are used for all voltages. Since of the *variable* parts, magnetic frame, armature punchings, armature spider, commutator spider, and brush-holder supporting ring the diameters are the same for all voltages, it is practicable, by the exercise of care and ingenuity, to arrange to use the same drawings and substantially the same patterns, the latter being arranged for special modifications for being extended and shortened for the different voltages. This is roughly indicated in the sketches of Fig. 1, in which, however, no claim is made to have worked out the plans for interchangeability in correct detail. In the sketches the brush-holder supporting rings are different for the three voltages. This also could have been avoided either by special proportioning of the width of the magnet yoke, or by a special brush-gear supporting frame fixed directly on the base. The sketches in the figure relate to a line of four machines by which it is proposed to illustrate the application of these principles. Each model is worked out for three dynamo voltages—115, 230, and 550. The number of poles, outputs, speeds, and voltages are set forth in Table I.

TABLE I.

Number of poles for—			Rated output and speed—	
115 V.	230 V.	550 V.	Kw.	R.P.M.
6	6	6	80	580
8	6	6	100	500
8	6	6	125	450
8	8	6	150	425

In Fig. 1, side and end elevations of the 100-kw. model are given for each of the three voltages. In Table II. are set forth the leading dimensions and some other data for all the four machines of the series.

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It is proposed next to give, in a series of tables, some further particulars of the designs.

Current Density in Armature Conductors.—The current density in the armature conductors ranges from 390 amperes per square centimetre in the 80-kw. machine, down to 360 amperes per square centimetre in that for 150 kw.

Insulation and "Space Factor."—By space factor for the slot is denoted the ratio of the total cross-section of copper in the slot to the area of the slot—*i.e.*, to the product of its width by its depth.

A rather interesting result in connection with these designs is that relating to the cost of "net effective material" per kilowatt. For the entire range of capacities (80 kw. to 150 kw.) and voltages (115 volts to 550 volts) this varies but little from the average value of 16·3s. per kilowatt, being (on account of the corresponding rated speed) independent of the rated output, and (on account of the basis of the design) practically independent of the voltage, the variations above and below the mean value of 16·3s. per kilowatt being entirely irregular, and rarely over 7 per cent. But the total factory cost will be less per kilowatt the greater the capacity, since, in large capacities,

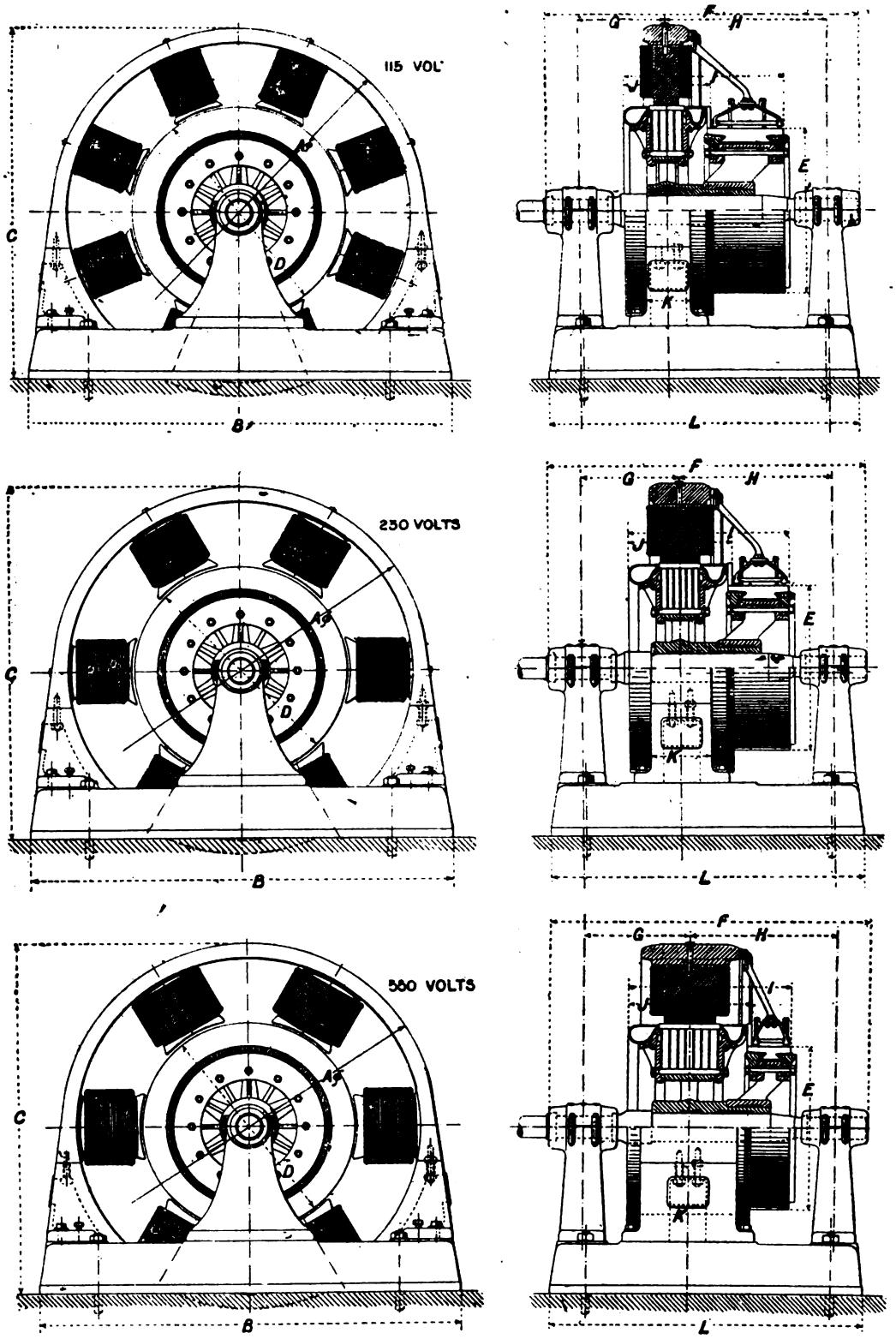

FIG. 1.

In these machines it is very uniformly, as set forth in Table VI., wherein are also given the corresponding guaranteed insulation tests, and, for the insulating materials employed, the required total thickness of slot insulation from copper to iron.

It will be seen that the 115-volt armatures and commutators are run as high toward the heating limit as practicable, in order to keep the machines down to the same over-all dimensions as for the higher voltages. The commutators of the 550-volt machines are cooler than necessary, the limit in their case being the permissible current density at the brush contacts, this being for all voltages taken at five amperes per square centimetre.

the "net effective material" constitutes a higher percentage of the total factory cost. The basis on which the cost of "effective material" was calculated, is:

	Pence per kilogramme.
Armature copper	24
Field copper	24
Commutator segments	24
Magnet yoke and cores (cast steel and wrought iron)	4·5
Pole-faces (cast iron)	3·0
Armature laminations (sheet steel)	3·6

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TABLE II.

Number of poles.	Kilowatts output.	Revolutions per minute.	Voltage.	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	Length of laminations between flanges.	Number of ventilating ducts.	Width of each ventilating duct.	Effective length of armature laminations.	Diameter of magnet core.	Radial length of magnet core.	Number of armature slots.	Width of slot.	Depth of slot.	Number of commutator segments.	Thickness of segments at surface (excl. insulation).	Length of segment from commutator connection to outer end of commutator.	Armature conductors per slot.	Height of armature conductor.	Width of armature conductor.
6	80	580	115	1366	1650	1300	740	610	1325	340	660	620	330	215	1350	125	3	10	80	155	190	60	16·2	28·0	240	7·2	290	8	11·1	2·7
6	80	580	230	1366	1650	1300	740	610	1325	390	610	620	430	250	1350	170	5	10	108	170	190	96	10·4	29·5	384	4·2	190	8	12	1·2
6	80	580	550	1366	1650	1300	740	610	1325	420	580	620	500	400	1350	282	6	10	200	225	190	102	11·5	19·0	510	3	120	10	6·3	1
8	100	500	115	1585	1900	1500	900	710	1450	370	730	710	395	190	1470	125	3	10	80	130	210	102	14·5	30·0	408	4·7	315	8	12·3	2·3
6	100	500	230	1585	1900	1500	900	710	1450	420	680	710	470	260	1470	165	5	10	104	175	210	108	11·8	30·0	432	4·4	230	8	12	1·6
6	100	500	550	1585	1900	1500	900	710	1450	460	640	710	550	420	1470	248	6	10	169	232	210	114	11·4	22·5	570	3·2	160	10	8	1
8	125	450	115	1813	2210	1740	1070	790	1650	395	875	720	370	200	1660	125	3	10	80	152	235	112	14·0	30·0	336	6·7	350	6	11·7	3·1
6	125	450	230	1813	2210	1740	1070	790	1650	445	825	720	460	300	1660	160	5	10	99	195	235	130	11·0	30·0	390	5·6	250	6	11·7	2·1
6	125	450	550	1813	2210	1740	1070	790	1650	485	785	720	550	435	1660	220	6	10	144	235	235	156	10·6	25·0	624	3·1	170	8	8·6	1·2
8	150	425	115	2114	2470	2030	1200	840	1735	390	940	770	350	275	1740	125	4	10	77	154	250	120	14·0	32·5	360	6·9	400	6	12·2	3·7
8	150	425	230	2114	2470	2030	1200	840	1735	450	880	770	475	300	1740	160	5	10	99	165	250	144	12·0	33·0	576	3·7	275	8	12·5	1·8
6	150	425	550	2114	2470	2030	1200	840	1735	500	830	770	580	330	1740	220	6	10	126	235	250	168	11·4	26·0	672	3·2	170	8	9	1·4

TABLE III.

Voltage.	Armature ampere-turns per pole.			
	80 kw.	100 kw.	125 kw.	150 kw.
115	4,640	5,550	5,700	7,300
230	3,710	5,220	5,880	5,800
550	2,050	2,880	4,000	5,100

TABLE IV.

Voltage.	Reactance voltage per segment.			
	80 kw.	100 kw.	125 kw.	150 kw.
115	1·9	2·7	2·1	2·7
230	2·0	2·5	2·5	2·8
550	1·8	2·4	2·4	2·7

TABLE V.

Voltage.	Average voltage per commutator segment.			
	80 kw.	100 kw.	125 kw.	150 kw.
115	2·9	2 3	2·7	2·6
230	3·6	3·2	3·5	3·2
550	6·5	5·8	5·3	4·9

TABLE VI.—Insulation and "Space Factor."

Voltage.	Guaranteed insulation test from copper to iron at 20deg. C. for one minute.	Thickness of insulation from copper to iron.	"Space factor."
115	2,500 R.M.S. volts.	1·2mm.	·53
230	3,000 ,, ,,	1·3mm.	·41
550	3,500 ,, ,,	1·5mm.	·32

The mica insulation between commutator segments is ·76mm. thick.

TABLE VII.

Kilowatts. Rated output.	Radial depth of gap (in mm.).	Peripheral speed in metres per second.		Centrifugal force at the periphery in kilogrammes per kilogramme.	
		Armature.	Commutator.	Armature.	Commutator.
80	6·0	22·5	18·5	139	115
100	6·5	23·5	18·6	126	100
125	6·5	25·5	18·6	122	90
150	7·0	26·8	18·7	121	85

TABLE VIII.—Armature Losses in Kilowatts at 60deg. C.

Voltage.	80 kw.			100 kw.			125 kw.			150 kw.		
	Core	C^2R	Total	Core	C^2R	Total	Core	C^2R	Total	Core	C^2R	Total
115	1·8	2·5	4·3	1·3	4·0	5·3	2·5	5·3	7·8	3·4	6·9	10·3
230	2·0	2·3	4·3	2·1	3·6	5·7	3·4	5·0	8·4	3·9	6·9	10·8
550	3·3	1·5	4·8	3·6	2·1	5·7	3·9	4·5	8·4	4·3	6·2	10·5

TABLE IX.—Commutator Losses in Kilowatts at 60deg. C.

Voltage.	80 kw.			100 kw.			125 kw.			150 kw.		
	Friction.	C^2R	Total	Friction.	C^2R	Total	Friction.	C^2R	Total	Friction.	C^2R	Total
115	1·6	1·4	3·0	2·1	1·7	3·8	2·5	2·2	4·7	2·8	2·8	5·6
230	0·8	0·7	1·5	1·0	0·9	1·9	1·2	1·1	2·3	1·4	1·3	2·7
550	0·3	0·3	0·6	0·4	0·4	0·8	0·5	0·5	1·0	0·6	0·6	1·2

TABLE X.—Field Copper Losses at 60deg. C

Voltage.	80 kw.	100 kw.	125 kw.	150 kw.
115	860	1,140	1,400	1,650
230	840	1,000	1,350	1,650
550	1,030	1,240	1,450	1,640

TABLE XI.—Total Losses at 60deg. C. in Kilowatts.

Voltage.	80 kw.			100 kw.			125 kw.			150 kw.		
	Con.	Var.	Total	Con.	Var.	Total	Con.	Var.	Total	Con.	Var.	Total
115	5·4	3·9	9·3	6·0	5·7	11·7	8·2	7·5	15·7	10·1	9·7	19·8
230	4·8	3·0	7·8	5·6	4·5	10·1	7·8	6·1	13·9	9·2	8·2	17·4
550	5·8	1·8	7·6	6·7	2·5	9·2	7·7	5·0	12·7	8·8	6·8	15·6

TABLE XII.—Commercial Efficiencies at 60deg. C.

Voltage.	80 kw.			100 kw.			125 kw.			150 kw.		
	F.L.	¾ L.	½ L.	F.L.	¾ L.	½ L.	F.L.	¾ L.	½ L.	F.L.	¾ L.	½ L.
115	89·5	88·7	86·3	89·5	89·0	87·1	89·0	88·0	86·0	88·5	87·7	85·6
230	91·1	90·2	87·7	90·7	90·2	88·1	90·0	89·2	87·0	89·5	89·0	87·0
550	91·3	89·8	86·5	91·5	90·2	87·2	90·8	89·8	87·5	90·5	89·7	87·6

TABLE XIII.—Thermal Constants for all Four Machines. Watts per Square Decimetre Peripheral (Cylindrical) Radiating Surface at 60deg. C.

Voltage.	Armature.	Commutator.	Field spools.
115	About 55	57	10
230	,, 50	40	10
550	,, 40	28	10

Although for the prevailing prices it was more economical to employ cast steel for the magnet yoke, the writer would prefer cast iron, as he attributes great importance to stability. In some countries the relative prices for these two materials would also make it more economical to use cast iron for the magnet yoke. The writer believes that—while not remarkably low—the cost of 16·3s., when figured on this basis, per kilowatt of "net effective material" is, for designs for these ratings, speeds, and voltages, excellent for high-grade machines. The writer would have liked to give comparative figures of this sort for machines of various firms when based strictly on the same guarantees. It would be of great interest to know what others have accomplished in this respect.

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From 200 kw. upwards there has been, for the last two or three years, practically no demand for continuous-current machines of less than 200 rated volts. Hence at present 115-volt machines for outputs above 200 kw. may be regarded as special, and the principles set forth need, in these larger sizes, only be considered as applying to machines for 230 volts and 550 volts. It is, however, not unlikely that with the increasing demand for electric energy for the various electro chemical and electro-metallurgical processes, lower voltage continuous-current machines of large capacities will again be required. But in all probability the great variety of voltages employed would necessitate their generally being special machines.

(To be continued.)

SUNDERLAND ELECTRICITY ACCOUNTS.

From the accounts of the Sunderland Corporation electricity works for the year ended March 31, 1901, it apears that the total expenditure on capital account to date amounts to £122,433. Abstracts of the revenue account, general balance sheet, and statement of electricity generated, sold, etc., are given herewith.

REVENUE ACCOUNT.

Expenditure.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Coal	£4,190 4 5	
Oil, waste, water, and stores	422 7 8	
Wages	1,336 16 2	
Repairs, etc., of buildings and plant	410 10 7	
		6,359 18 10
Distribution of Electricity.		
Repairs of mains and services	248 6 7	
Repairs of meters, etc.	92 0 10	
		340 7 5
Public lamps—attending and repairs		214 11 2
Rents, Rates, and Taxes.		
Rents payable		128 16 10
Rates and taxes		591 16 4
Management Expenses.		
Salaries—Engineers		719 16 2
Clerical staff		355 6 5
Collectors		79 14 2
Stationery and printing		46 15 5
General establishment charges		257 16 6
Special charges—insurance		177 9 1
		9,272 8 4
Amount carried to net revenue account		7,253 14 9
		£16,526 3 1

Cr. Income.	£ s. d.
Sale of current per meter	15,441 2 9
Public lighting	718 6 10
Rental of meters and other apparatus	330 12 3
Sale and repairs of lamps and apparatus	1 2 0
Rents receivable	30 0 0
Charging batteries	4 19 3
	£16,526 3 1

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Capital account—amount received	122,805 0 0
Balance to credit—net revenue account	1,257 0 2
Sinking fund account	236 2 4
Consumers' deposits	1 10 0
Balance due treasurer	6,012 2 11
	£130,311 15 5

Cr. Assets.	£ s. d.
Capital account—amount expended for works	122,433 8 10
Stores on hand	1,394 9 2
Sundry debtors for current supplied	6,475 17 5
Amount advanced for incidentals	8 0 0
	£130,311 15 5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		1,331,844
Quantity sold: Public lamps	83,192	
Quantity sold: Tramways	256,240	
Quantity sold: Private consumers by meter	879,336	1,218,768
Quantity used on works		57,468
Total quantity accounted for		1,276,236
Quantity not accounted for		55,608
Number of public lamps		54
Total maximum supply demanded (kilowatts)		1,114

Trade Marks.—We have received in pamphlet form some articles on trade-marks, written by Mr. Ernest Salaman, which have recently appeared in certain trade journals. To those interested in such matters the collection must prove of considerable value.

CARDIFF ELECTRICITY ACCOUNTS.

From the accounts of the county borough of Cardiff electricity works, just issued, it appears that the total expenditure on capital account to March 31, 1901, amounted to £101,286. We give herewith abstracts of the revenue account, general balance sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Coal or other fuel	£2,538 2 10	
Oil, waste, water, and stores	394 16 9	
Wages at generating stations	1,223 17 8	
Repairs and maintenance, etc.	299 12 10	
Sundry other expenses	95 18 7	
		4,552 8 8
Distribution of Electricity.		
Wages and other remuneration	37 9 7	
Repairs, maintenance, etc., of mains	144 15 10	
Repairs, etc., of transformers	118 19 2	
Repairs, etc., of apparatus	129 2 9	
		430 7 4
Public Lamps.		
Attending and repairs	240 16 7	
Renewals of lamps	159 18 10	
		400 15 5
Rents, Rates, and Taxes.		
Rents payable	54 8 0	
Rates and taxes	610 12 0	
		665 0 0
Management Expenses.		
Salaries—engineers' department	519 18 1	
Clerical staff	240 10 6	
Auditor	25 0 0	
Collector	101 13 4	
Printing and stationery	111 11 6	
General establishment charges	203 9 9	
		1,202 3 2
Law expenses, etc.		3 2 5
Insurances, etc.		60 19 10
Expenses for certification of meters		30 0 0
Total expenditure		7,344 16 10
Amount carried to net revenue account		4,208 19 2
		£11,553 16 0

Cr. Income.	£ s. d.
Sale of current per meter	9,716 13 11
Sale under contracts	90 3 6
Public street-lighting	1,654 17 10
Rental of meters and other apparatus	213 5 11
	11,675 1 2
Less irrecoverables written off	121 5 2
	£11,553 16 0

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Capital account—amount received	80,601 9 1
Sundry creditors—consumers' deposits, £174. 19s.; various, £2,068. 0s. 7d.	2,242 19 7
Amount due to treasurer	21,680 16 11
Amount due to Cardiff Corporation waterworks account	68 3 10
Sinking fund	6,111 4 2
Balance of proceeds of action at law, Corporation *v.* Ferranti	959 6 4
Balance at credit of net revenue account	1,657 18 6
	£113,321 18 5

Cr. Assets.	£ s. d.
Capital account—amount expended for works	102,305 11 8
Stores on hand	1,177 6 1
Sundry debtors for current supplied	3,548 5 10
Other debtors	30 4 7
Suspense account (renewals of arc lamps)	66 6 3
Amount due from borough fund account	174 7 0
Amount due from Cardiff Urban Authority	534 12 9
Cash in hand of engineer	20 0 0
Investments, etc., of funds for redemption of stock	5,465 4 3
	£113,321 18 5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		917,005
Quantity sold: Public lamps	144,173	
Quantity sold: By contract	4,452	
Quantity sold: Private consumers by meter	539,924	688,549
Quantity used on works		45,055
Total quantity accounted for		733,604
Quantity not accounted for		183,401
Total maximum supply demanded		729

Number of public lamps, 87 arcs, 73 incandescents.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

415. It is stated in pocket-books that lightning conductors should have no abrupt bends. What is the reason (if any) of this rule, and would a right angle be considered an abrupt bend? I have noticed hundreds of lightning conductors with abrupt bends.—J. C. R.

416. What is the most practical way of determining the "curve" of single and polyphase alternators, both before and after manufacture?—R. S.

ANSWERS.

Question No. 409.—Two steam alternators of same type and size are running fully loaded in parallel on the 'bus bars. The cut-offs of the engines are set the same, and the field of both are taking the same exciting current. There is an appreciable motor current between the two. What is the best way to stop this?

Best Answer to No. 409 (*awarded* 10*s.*).—The conditions which must be fulfilled for the successful running of alternators in parallel are, briefly: (*a*) the number of alternations per second must be identical in each, which in similar machines means that the revolutions per second must be the same all through: (*b*) the machines must have the same E.M.F. in each case; (*c*) the curves of E.M.F. in each machine must coincide in phase—*i.e.*, the *momentary* values of E.M.F. must be the same.

The conditions described in the question show that the revolutions of each machine per minute are the same in number, and, further, the machines will have the same effective E.M.F., since the fields have the same strength in each case. The reason for the "motor current" between the machines is probably to be found in condition (*c*) not being fulfilled, for although the revolutions are the same and the field strength and cut-off point are identical in each case, it may be that the momentary values of E.M.F. are not the same at *each* point, even though they correspond at *some* points on the respective curves of the two machines, say the points of no E.M.F. For the momentary E.M.F. is produced according to the usual law of "number of lines of force cut per second"—*i.e.*, it depends upon the rate of cutting of the field by the conductors of the armature. As the conductors are constant in number and the field remains the same, the E.M.F. depends directly on the angular velocity of the conductors—*i.e.*, upon the angular velocity of the crank of the engine. If this crank angular velocity were uniform throughout a revolution, then the E.M.F. would follow a curve determined solely by the type of the magnetic design and pole-pieces, etc., of the alternator; and hence, if the two machines were in phase at one point, they would be in phase all through a period. But the crank angular velocity is not uniform, owing to the variation in the crank effort during a revolution. The tangential effort is found by multiplying the total piston pressure by

$$\frac{\sin(\alpha+\beta)}{\cos\beta},$$

where α is the angle between the crank and the line of the piston's motion, and β is the angle between the connecting rod and the line of the piston's motion. This factor varies from 0 when $\alpha = 0$, and reaches a maximum when $(\alpha+\beta) = 90$ deg., which occurs before the half of the piston travel, since β is finite and positive. With no inertia of moving parts present, the angular velocity of the crank would be proportional to this varying tangential pressure, and even though a large flywheel mass is used the velocity must vary slightly during the revolution, else, of course, the flywheel would not be effective. Hence there is always a certain residual variation in the angular velocity of the crank which is communicated to the armature. Hence the curve of momentary values of E.M.F. is distorted from the curve which would be obtained from a uniformly rotating armature, being higher than the ideal curve in places where the crank velocity is above the average, and lower in the opposite case. Now, unless these variations disturbing the curves, which would otherwise be identical in the two

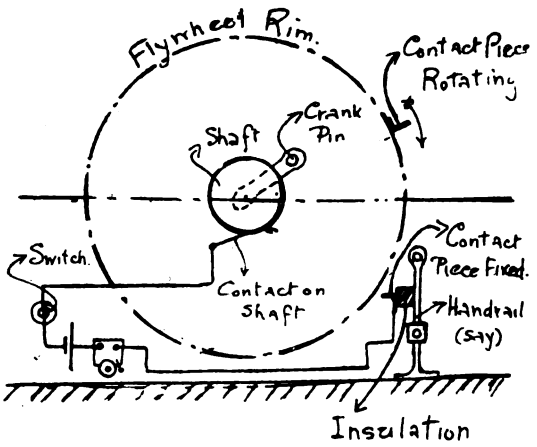

FIG. 1.

machines, can be timed to occur synchronously in the two sets, it is obvious that there will be variations between the momentary values of the two E.M.F.'s due to the crank efforts being out of phase, and these differences will cause the "motor currents" described in the question. The best and only way to stop this is to have the cranks running in phase as regards angular position, and then the variations occur simultaneously in each, and so the E.M.F. curves will be identical at all points, and there can be no motor current.

A method of getting this result, which the writer has seen adopted on the Continent with the best results, is to have a

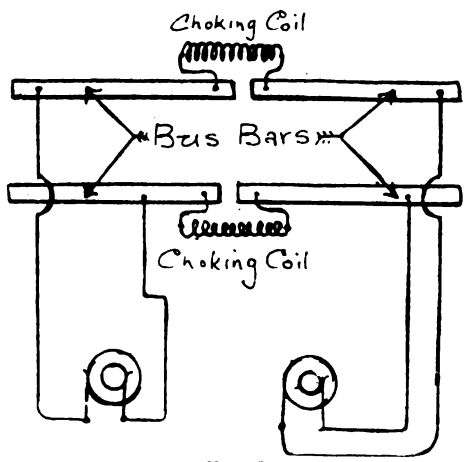

FIG. 2.

small contact piece, say, of spring brass or copper, projecting from the flywheel rim on the engine and rotating with it. This is fixed in each case at the same position (see Fig. 1) relatively to the crank—it is quite immaterial where so long as it is identical in each case. Then, in a given fixed position, a contact piece is put so that the rotating piece touches it once a revolution. This may be fixed on the handrail surrounding the machine, or on the ground or anywhere convenient. The two are arranged so that they touch at a fixed and identical angular position of the crank in each engine, so that if the two are touching at the same moment, and continue to do so in successive revolutions, the cranks are evidently in phase. As the alternators themselves are likely to have identical dispositions relatively to the crank angular position, this

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really serves as a "phase indicator," and all that is required is to see that the effective E.M.F.'s are the same before switching in. The rotating contact piece is not insulated from the flywheel, and the fixed one (which is insulated) is connected to the shaft by means of a light brush or piece of spring copper, the latter connection being made through a small battery and bell, which rings when contact is made. Hence the motor currents will be avoided if the alternators are run so that the bells ring simultaneously each revolution. A push-button may be provided to switch the bells out when the machines are running all right. Note that this can only be applied to machines where the number of revolutions per minute is the same in each. Unless the engines are identical, even if the revolutions correspond, the difference in the α and β of each will cause a want of identity in the crank phase, and if the revolutions are different in each case nothing can be done in this way, because there is no chance of getting the crank phases to correspond. In the latter case the 'bus bars are sometimes divided into two parts, which are connected together by a coil of very high impedance, which will act as a "choking coil" and prevent the "motor currents" reaching an excessive amount; this is shown in Fig. 2. But in the case mentioned in the question some such indicator as the bell will act perfectly, and ought to effect a certain cure.—T. C.

Answer to No. 409 (*awarded* 5*s.*).—The causes of a motoring current between fully loaded alternators of exactly the same type in parallel, are either excess of excitation in one machine or some form of dissimilarity in the voltage curves of the two machines. If one machine is excited so as to develop a lower voltage than the other when both are running at the same speed, the natural

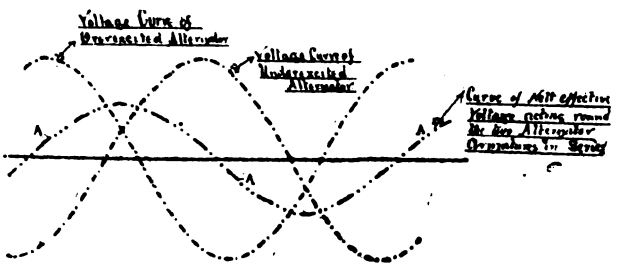

FIG. 1.

tendency is for some load to come off the under-excited machine, and so allow the speed of that machine to increase sufficiently to equalise the voltages—*i.e.*, this is what would occur with continuous-current machines run in parallel on the stop valves. In the case of alternators, however, though the tendency is the same the actual result is different, for as soon as the armature in its attempt to increase in speed has got the merest fraction of a revolution ahead of the over-excited armature, the phase relations between the two voltages have altered, and an equalising effect due to this change takes the place of an actual speed increase. The phases of the two voltages, instead of being in exact opposition, become somewhat as in Fig. 1, with the result that a so-called "motoring" current passes round the alternators in series, due to a voltage whose amount is given by the curve A, and which is equal to the algebraic sum of the ordinates of the two voltage curves at every instant. This voltage (and the corresponding current) is *ahead* of the voltage of the under-excited alternator in phase and *behind* that of the other machine, thus tending to strengthen the field of the former and weaken that of the latter, and so equalise the voltages. In spite of the fact that the two alternators in question are excited at the same current, it is quite possible that, due to some difference in the air-gaps or quality of iron, one of them may give a higher voltage than the other, with the above result. If this is the case, it will be easy to remedy the defect by altering the exciting current of one or the other machine until the motoring current disappears.

Should alterations in the excitation have little or no effect on the motoring current, it would point to the fact that the above is not the cause, and that inequalities exist between the voltage curves of the two machines. Such inequalities would, the alternators being exactly alike, probably be due to the uneven turning moment of the engines. This would be especially likely to occur with single-cylinder engines, but even with two and three crank ones, particularly if badly balanced, a small inequality exists which is sufficient to produce a perceptible motoring current. This current would have a frequency of from two to six periods per revolution only, which is low enough to cause the ammeter needle to swing in unison, and is, therefore, fairly easily distinguishable from the previously mentioned type of current, which has the same periodicity as the alternators themselves. Currents due to uneven turning moment only exist when the irregularity occurs at different instants on the different engines, thus causing sometimes one and sometimes the other alternator to have a momentarily higher voltage. The cure for such currents consists in not only synchronising the alternators electrically by means of the ordinary synchroniser, but also mechanically by getting the cranks on the two engines to occupy the same positions relatively to the pistons at the same instant. This is often effected on the Continent in the case of the single-cylinder engines commonly used to drive large slow-speed alternators by fixing a small contact piece on the stationary frame of each alternator, which makes contact with a brush on the rotating part and so rings a bell once every revolution. By adjusting the speeds of the two engines before putting the alternators in parallel until the two bells ring at the same instant, it is possible to synchronise the cranks exactly and so practically avoid the difficulties due to uneven turning moment.—Q.

Answer to No. 409 (*awarded* 5*s.*).—The condition of things as stated in the question is usually associated with stations where alternators of the coreless disc armature type predominate. Assuming that the alternators in question are directly coupled to high-speed engines, each fitted with variable "cut-off" and throttle-valve governors, I should say that any motoring was due to one of the following: (*a*) The cut-offs of the engines are probably too high for the load they are doing, thus giving the machines a chance to motor should they so desire. If this is so, a gradual reduction of the cut-offs will no doubt stop the motoring. (*b*) Perhaps the exciting current of the machines are unequal. This should be equalised and the effect noted. Or the machines may be over-excited, thereby causing them to be very unsteady: this should also be brought down to the normal, and the effect noted. (*c*) The governor gear of one of the sets may be sticking, thus causing it to run either too fast or slow. The gyrometers should be consulted to ascertain if this is the case. (*d*) The steam pressure is perhaps considerably above the ordinary. If this is the case, either one or both of the sets should be gradually put on the stop valve until normal pressure is regained. In the event of the steam pressure being normal, and the above resources having no effect, I should try putting both the sets on the stop valve. Failing any of the above, I should carefully investigate the curves of each machine.—ALFRED JAMES RYAN.

Answer to No. 409 (*awarded* 5*s.*).—It is a good plan to try shifting the field resistances of the alternators to make sure that the trouble is not due to the field ammeters reading differently. If, however, this is tried unsuccessfully, we must look to the governors, which in all probability will be of the type which alter the travel of the valve by means of weights flying out due to centrifugal force, throttle governors not being so liable to this type of complaint. I have often found that the balance piston of a high-pressure valve jarring or too tight packing in the high-pressure valve gland is enough to retard the action of one of the governors, and so cause an appreciable motor current between the two alternators. Sometimes adjusting one or other of the stop valves has a good effect, and it is quite enough to keep the two machines running smoothly and without motoring current till the end of a run. The proper remedy is to overhaul the governors, and get them both to act smoothly and cut off at the same speed, etc. In some cases, however, one may desire to run a machine or a number of machines with the above disease, other more urgent jobs being in hand. In this case the best way out of the difficulty is to run one machine on the

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governors and block all the other machines (by putting a wooden block between the governor bob and flywheel rim and having it fastened to the governor bob) and running them on the stop valve, opening the stop valve further as the load increases.—S. L.

Answer to No. 409 (*awarded* 5*s.*).—In dealing with a case of this sort it is necessary in the first place to determine what is the cause of the trouble. With the data supplied concerning the two plants, it is impossible to do more than offer such suggestions as may assist in the discovery of the fault. Troubles in parallel working may be either mechanical or electrical; the majority, however, belong to the first class, and are due to one or more conditions militating against the most essential factor in parallel working—an even turning moment on the alternator shaft. Faults in this respect, which are not noticeable in a plant running separately, will still show up in parallel working. The fact that the field currents are the same strength on both alternators does not prove that the fields may not be the cause. For a given load a machine may require a very different field current when in parallel to what it does working separately. The nature of the cross current will very often afford some indication of its cause. The writer has known the ammeters of alternators in parallel to be readily perfectly steadily, yet readjustment of the fields would reduce the reading 20 or 30 amperes, this being steady cross current due to want of balance in the field. The mechanical causes which give rise to cross current are many, but a few of the more important ones may be mentioned.

Want of balance in the engine motion, flywheel, or armature is difficult to deal with, and, moreover, does not always produce the same results. Take two plants of same design and output, but with unbalanced flywheels. One time they will parallel without a movement on the ammeter needles; again, with an equally good phase, a heavy cross current develops. This is no doubt due to the fact that in the first case the cranks were in synchronism as well as the alternators. If it is known that the balance of the two plants is good, the steam distribution of both engines should receive careful attention. It is quite possible for the *points of cut-off* to be the same in both engines, and yet one engine cylinder may be doing more work on the outward than the return stroke, or *vice versâ*. This will set up a cross current which will, if the valve setting is not far out, be a fairly definite amount, say a regular beat of 20 or 30 amperes in plants of 300 kw. capacity.

If indicating the engines proves the steam distribution to be all right so far as the valves are concerned, the next frequent cause of such trouble is the governor. For parallel working, all governors, both throttle and automatic expansion, should be fitted with fairly stiff dashpots, otherwise they become too sensitive, affecting the steam admission quicker than the machine can respond to it, so multiplying small irregularities until they assume serious dimensions. To prove whether the fault is attributable to the governors, put one of the plants when in parallel on the stop valve, speeding up the governor out of action. Should this effect a remedy the governor should be examined and overhauled, as some part is probably sticking. If fitted with dashpots, leakage of oil from these will cause unsteadiness, or, perhaps, a different oil would solve the difficulty.—X.

Question No. 410.—What tools and testing instruments would be required to equip an electrical repair shop for a factory installation comprising telephones, dynamos, arc lights, and about 40 small motors?

Answer to No. 410 (*awarded* 7*s.* 6*d.*).—After about 20 years' experience with this class of work, I should say that there is no need to go to any great expense in getting the comparatively few things required to do ordinary repairs, and certainly no need for any expensive instruments beyond a voltmeter and an ordinary detector galvanometer. The chief thing is electrical knowledge and ordinary experience with the machines, telephones, etc., to enable one to know where to look for a fault when it occurs, and also to use ordinary precautions to prevent faults. Indispensable tools would be a lathe to keep the commutators in good order, and this lathe is the better for being driven by power of some kind, and would, of course, require accessories, such as chucks, cutting tools, oil, and a smooth file to make the final surface of the commutator good. Some people finish off with a burnisher, but I do not. I never use emery cloth on commutators. Other tools required would be quite ordinary and cheap—viz., pliers, hammers, spanners of various sizes to suit the nuts and bolts, calipers, screwdrivers, some copper wire of various sizes and insulation according to requirements, some wooden clamps for holding coils in place during rewinding (but this should be a rare occurrence), a rough turning winch on which large coils could be wound by hand, and a small one for small coils such as in telephones. A belt stretcher might be required for putting machine straps on tightly. If any of the machinery is heavy, some kind of hoisting tackle might be required, but often a pulley block or two is all that is required, and this can be suspended from an overhead beam or a lifting (screw or hydraulic) jack, with the aid of a few stout pieces of timber, will do quite as well as an expensive crane. Heavy things can be moved along the floor on rollers of wood or iron pipes. Insulating material, shellac varnish, Chatterton's compound, a varnish brush or two with a pot or two and some paint should also be provided, and it is a good plan to use good paint on metal and wood, and to varnish it over. A testing battery, consisting of about four or six Leclanché cells, should be provided for testing the telephone coils and circuits with the detector galvanometer, and a few pounds of sal ammoniac should always be kept in store, together with about a dozen spare zinc battery rods of the proper size. A little sandpaper (quite fine) and a few files of various sizes would be wanted occasionally as well as soldering tools and resin. "Spirits of salt" of all sorts should be kept out of the shop altogether as it is very hygroscopic, and is very likely to give trouble by corrosion. With the above simple appliances I have kept all my dynamos, motors, telephones, bells, indicators, accumulators, and primary batteries in good working order for many years. In fact, a breakdown is quite unknown here, and I believe the chief cause of this good fortune is that I do not allow any small defect to run on until it becomes too troublesome to be tolerated. "A stitch in time saves nine." And a good, conscientious, practical electrician is worth his money.—F. G. A.

Answer to No. 410 (*awarded* 7*s.* 6*d.*).—Let us first of all take the mechanical side of the question. A good lathe is almost indispensable for an installation of this size. One of sufficient size to take the armature of the dynamo would be best, so that the commutator could be accurately turned up. The lathe would often come in handy for winding resistance coils, or rewinding field-magnet coils. A bench and vice would, of course, be necessary, and a set of stocks, dies, and taps would be found very useful.

The small tools necessary are ratchet brace and bits, hack saw (for metal), ordinary wood saw, keyhole saw, chisels (for wood and iron), hammers, screwdrivers, soldering iron with adjustable bit, cutting pliers, two pairs gas pliers, files, steel rule, speed indicator, and spirit level; a gas blow-pipe for resweating broken armature connections and big joints, or, if gas is not available, a paraffin blow-lamp, care being taken to use only purified paraffin, as the ordinary blackens the joints, making it difficult to solder them.

An inexpensive and very handy arrangement for testing for broken wires, etc., is made as follows: two or three large dry cells and a bell are fitted into a box, so as to be handy for carrying about; all connections are brought through to the outside of the box and connected to the terminals, so that the battery can be used independently of the bell and also in series with it. Suppose that the batteries for a certain telephone are doubtful, connect up these dry cells (which should be kept in very good condition) and try the telephone. It is seen at once whether the battery was responsible for the failure of the telephone. This set is very handy for testing for the continuity of wires, as the bell can be heard some distance away, whilst an ordinary linesman's galvanometer has to be close at hand to see whether the needle moves or not.

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In order to test for earths on the circuits, an apparatus as shown in sketch (Fig. 1) can easily be made. If there is an earth, partial or complete, on the + main, then L_2, or the lamp on the negative side, will glow in proportion to nature of the earth. A portable ammeter and voltmeter are necessary for testing the amount of power taken by any motor, or the voltage at any distant point—these, though rather an expensive item, I have found to be very useful, especially where a lot of motors are in use; also an Evershed testing set for testing the insulation resistance of circuits, consisting of a 200-volt generator and an ohmmeter reading from 10,000 ohms to 10 megohms. For testing the distance apart of the carbons whilst burning in the arc lamps, a pair of blue

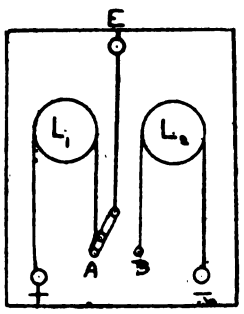
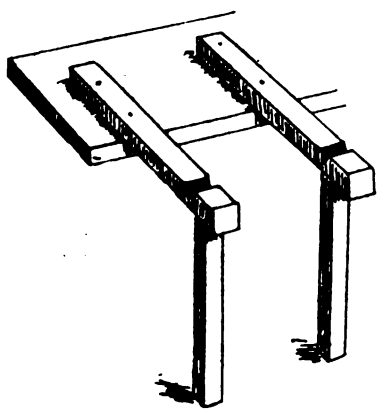


FIG. 1.

spectacles is required, or a little hand glass of blue glass must be used.

Probably the above detailed equipment would prove too expensive for the ordinary factory. Perhaps the testing set for testing insulation resistance could be the most easily done without, especially as it is a very expensive item.—W. A.

Answer to No. 410 (*awarded* 5*s.*).—With an installation of this nature, comprising about 40 small motors, perhaps one of the biggest repair items will be motor armatures and field coils, and provision should be made for rewinding these, also the arc lamp series coils, which frequently burn out. Besides repairs of this nature, which may be classed as electrical, there will also necessarily be a fair amount of mechanical repairs as, say, scraping and fitting bearings, liners, bushes, etc., together with various other incidental repairs inseparable from machinery or plant in constant use. To begin with, space should be provided sufficient to accommodate two fair-sized benches, say 10ft. to 12ft. long,



one being intended for mechanical repairs and the other for electrical repairs and testing. The mechanic's bench should be fitted with a good vice, and contain bench block, facing place, ratchet and breast drills, chisels, hammers, files, scrapers, calipers, dividers, hand-vice, L square, spirit level, shears, "gas" and cutting pliers, screwdrivers, rule, and all the tools ordinarily used by a fitter or mechanic. The electrical bench should be equipped with an ordinary linesman's detector or galvanometer, and two or three dry cells for same, to be used for finding "breaks," "earths," and short-circuits on telephone lines, and for ordinary rough testing. In addition to this there should be a small Silvertown testing set (with portable battery for 50 or 100 volts), containing a standard resistance coil, Wheatstone bridge, and sensitive galvanometer. This would be used for testing insulation of various circuits, dynamos, motors, and arc lamps to "earth," and other tests for which an ordinary "detector" is not adapted. A record of these tests (which ought to be taken once a week) should be kept in a book provided for the purpose, from which it will be noted when any circuit or machine becomes defective, and which can then be repaired and attended to without serious inconvenience. These testing instruments would be sufficient for all ordinary purposes. For winding armatures and field coils, an arrangement similar to sketch would be required. It consists of two pieces of wood about 3in. or 4in. square, screwed to bench top, sufficiently wide apart to allow armature to rest between them, and projecting, say, 2ft. from front of bench. Near the end of each a V-shaped groove is cut as shown, into which the spindle rests. It is supported by two supports resting on the floor. A smaller but similar arrangement could be made for winding arc lamps series coils, the "shunt" coils seldom burn out and are best wound in a lathe. The winder's outfit consists of flat, round-nosed, and cutting pliers, soldering bits (two or three sizes), baking iron, wooden mallet, hammer, screwdriver, sharp and blunt nosed chisels, shears, scissors, 2ft. wooden rule, calipers, dividers, marker or scriber, small gas stove, and wedges made of hardwood or, preferably, vulcanised fibre. If the repair shop is intended to be practically self-contained, to the above complement of tools, etc., might be added a lathe for turning up commutators and odd turning jobs; but this is optional, as with good motors and dynamos, receiving proper attention, commutators ought not to give much trouble.—C. J. S.

APPOINTMENTS VACANT.

Electrical Engineer, Dewsbury Town Council, £350 per annum.

Switchboard Attendant, Perth Corporation Electricity Works, 25s. per week, Sept. 28. Full particulars in our advertisement columns.

Electrical Engineer and Manager, Southampton Corporation, £500 per annum, Sept. 30. Full particulars in our advertisement columns.

Chief Assistant Engineer, Wimbledon, £150 per annum, rising by two annual increments of £25 to £200 per annum, Oct. 4. Full particulars in our advertisement columns.

Shop Manager for arc lamp business. Full details in our advertisement columns.

Armature Winders, Manchester district. Full details in our advertisement columns.

Jointer, Shrewsbury Corporation.

Shift Manager, Blackburn, £2 per week. Full details in our advertisement columns.

Switchboard Attendant, Blackburn, 28s. per week. Full details in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Cairo.—The time for receiving tenders for the electric lighting of Fayoum has been extended by the Department of Public Works until Oct. 1.

East London.—Tenders are invited for the supply of a 50-kw. alternator and engine. Tenders by Nov. 26. Details in our advertisement columns.

Stepney.—The Electrical Committee invite tenders for arc lamp columns, lamps, fittings, switchboard, etc., by Oct. 17. Details in our advertisement columns.

Poplar.—The Libraries Committee invite tenders for the installation of electric light in four public libraries. Tenders by Oct. 1. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of main switchboard. Tenders by Oct. 14. Details in our advertisement columns.

Manchester.—The Electricity Committee invite tenders for the supply and delivery of ampere-hour and watt-hour meters. Tenders by Oct. 2. Details in our advertisement columns.

Huddersfield.—The Corporation invite tenders for the supply and erection of one 600-kw. alternating-current generating plant. Tenders by Sept. 30. Details in our advertisement columns.

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Littowel.—The Urban District Council are desirous of treating with a responsible firm for the supply of electricity for street-lighting. Tenders by Sept. 30. Details in our advertisement columns.

Blackpool.—The Corporation invite tenders for poles, plinths, etc., cables, etc., overhead materials, trolley wire, and bonds, 20 electrical car equipments. Tenders by Oct. 21. Details in our advertisement columns.

Rochdale.—The Electricity Committee invite tenders for supply of feeder and distributor cables. Specifications, &c., may be obtained from Mr. C. C. Atchison, borough electrical engineer, Electricity Works, Dane-street. Tenders by Oct. 2.

Oldham.—The Electricity Committee invite tenders for the work required in constructing the proposed new generating station at Greenhill, Oldham. Specifications, etc., can be obtained on application to Mr. Arthur Andrew, Gas and Water Offices, Oldham. Tenders by Oct. 8.

Huddersfield.—The Corporation invite tenders for supply and delivery of six car bodies, mounted upon trucks and electrically equipped complete. All information may be obtained on application at the offices of the Borough Engineer and Surveyor, 1, Peel-street. Tenders by Oct. 2.

Madrid.—The Department of Agriculture invite tenders for the installation and working of an electric tramway for not more than 60 years. The route is from Linares to the mines of San Rogue and Tortilla. The deposit is 11,105 pesetas provisional, and 55,526 pesetas finally. Tenders by Oct. 17.

Sheffield.—The Corporation invite tenders for boilers (type left open), induced draught, air heating tubes or economisers, motors, fans, iron chimneys, brickwork or iron flues, and all other accessories for evaporating 120,000lb. of water per hour. Tenders by Sept. 30 Details in our advertisement columns.

Leeds.—The Lighting Committee invite tenders for the supply of a main switchboard to deal with the output of three 1,500-kw. 50-period two-phase alternators, and comprising dynamo panels, feeder panels, synchronising apparatus, etc. Tenders by Oct. 8. Details in our advertisement columns.

Newport (Mon.).—The Corporation invite tenders for the supply and erection of winches, cables, overhead construction, complete electric motorcar, and repair shop equipment. Specifications, etc., can be had on application to Mr. H. F. Parshall, consulting engineer, 8, Princes-street, Bank, London, E.C. Tenders by Oct. 21.

Leeds.—The Corporation invite tenders for supply of 50 electric motorcars. Specification, etc., may be had from Mr. Thomas Hewson, M.I.C.E., city engineer, Municipal Buildings, Leeds; or from Messrs. Hopkinsons and Talbot, consulting engineers, 26, Victoria-street, London, S.W., and 29, Princess-street, Manchester. Tenders by Oct. 15.

Halfway Street (near Sidcup, Kent).—The Greenwich Board of Guardians invite tenders for the proposed electric lighting installation at the new children's homes now building at Halfway Street, near Sidcup, Kent. Specification, etc., may be obtained and plans seen at the offices of the architect, Mr. Thomas Dinwiddy, F.R.I.B.A., 12, Croom's-hill, Greenwich, S.E. Tenders by Oct. 10.

Norway.—Tenders are invited by the Norwegian State Telegraph Department, to be received not later than Oct. 1, for the supply of telegraph wire. Specifications and conditions of tender may be seen daily between 12 and 1 on application to the Technical Division of the above department at Christiania. Besides Customs duties the Norwegian Government gives a preference of 15 per cent. to native tenders.

London, S.W.—The London County Council invite tenders for track rails and fastenings, slot rails and fastenings, tiebars and conductor tees, and roadwork and platelaying required for the construction on the conduit system of the tramway routes between Westminster Bridge, Blackfriars Bridge, and Waterloo Station respectively, and Tooting. Specifications and other particulars may be obtained from the Engineer's Department, County Hall, Spring-gardens, S.W Tenders by Oct. 8.

London County Council.—The County Council invite tenders for work to be done in supplying, fitting, and fixing lifts, motors, pumps, ventilating fans, lamps, cables, wires, conductors, switchboards, and columns, together with all supports, apparatus, fittings, and accessories which may be necessary or required for the electrical equipment of the Greenwich footway tunnel and its approaches. Specifications, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

General Post Office.—Tenders are invited for the purchase of about 40 tons of guttapercha, 100 tons of old copper wire, plates, etc., 100 tons of iron, a quantity of other metals (brass, zinc, and lead), indiarubber-covered copper wire, tools, raw and limed hide pieces, electric light wire, fittings, glow lamp tops, accumulators, dry battery cells, tarpaulin, felt, jute serving, etc., the whole being arranged in convenient lots. A form of tender, containing all particulars, can be obtained on application, by letter, to the undersigned. Tenders will be received until 10 a.m. on Wednesday, Oct. 16, 1901.

Manchester.—The Electricity Committee invite tenders for supply, delivery, and laying of the following cables: (a) three-core, three-phase, high-tension feeders, approximate length, 74 miles; (b) traction feeders, approximate length, 7 miles; (c) lighting feeders, approximate length, 3½ miles; (d) distributors, approximate length, 33 miles; (e) potential wires, approximate length, 11¼ miles; (f) arc lighting cables, approximate length, 15½ miles; (g) telephone cables, approximate length, 3½ miles. Specifications, etc., may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by Oct. 9. Full particulars appear in our advertisement columns.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a continuous-current 1,500-kw. dynamo working at from 550 to 625 volts, and the erection of these sets in the generating station of the South London Electric Supply Corporation, near Loughborough Junction. Also for three auxiliary 250-i.h.p. vertical high-speed enclosed steam-engines, each coupled direct to a continuous-current dynamo working at from 200 to 225 volts, and for the erection of these sets in the Council's generating station at Greenwich. Specifications and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a three-phase 1,500-kw. generator working at from 6,500 volts between conductors, each with an exciter, and for one 750-kw. reversible synchronous motor-generator, with exciter, designed so that either the low-tension or the high-tension side of the set will act as generator, and for the erection of these sets in the Council's generating station at Greenwich; also for nine 300-kw. synchronous motor-generators, working at from 550 to 600 volts on the low-tension side, each with an exciter, and for three 50-kw. induction motor-generators, working at from 200 to 225 volts on the low-tension side, and the erection of these sets in sub-stations provided by the Council. Full particulars may be had at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

RESULTS OF TENDERS.

Battersea.—The Council have decided to obtain six spare lamps and 33 globes from the General Electric Company, Limited, at £38. 11s.

Liverpool.—The City Council have accepted the tender of Willans and Robinson, Limited, Rugby, for supplying four steam dynamos at £2,031 each.

Heckmondwike.—The tender of Messrs. Babcock and Wilcox for an additional boiler and the necessary pipework and brickwork setting has been accepted by the Council.

Derby.—The Plant and Stores Committee have accepted the tender of Gardner Bros. and Co., Burton-on-Trent, for electric wiring of the stores depot, Nottingham-road, at £198. 1s.

Stirling.—The Electric Lighting Committee have accepted the following tenders: C. M. Hamilton, builder, £359. 18s. 8d.; D. C. Hardie, plumber, £14. 6s. 10d.; R. Foster, plasterer, £24. 18s.; Short and Fairful, joiner, £13. 11s. 4d.; J. Davie and Son, ironwork, £200.

Erith (Kent).—The Urban District Council have provisionally accepted the tender of Radford and Greaves, Drewry-lane, Derby, for the construction of (Section L) engine and boiler house, £3,275. 4s. 4d.; (M) chimney shaft, £524. 9s. 1d.; (N) sanitary work, water and fire services, £292. 11s. 2d.; (O) rain and surface water drains, £331. 1s. 7d.; (P) approach roads at site, £104. 8s.—total, £4,527. 14s. 2d.

Hammersmith.—The Borough Council have accepted the tender of the British Electric Transformer Manufacturing Company for the supply of various articles. The Council have also received the following tenders for the pipework and tanks in connection with the condensing plant: Stephens, Smith, and Co., Limited, £2,879; Fraser and Fraser, Limited, £2,746; Rosser and Russell, Limited, £2,199; Aiton and Co., £2,185; Korting Bros., £2,150; Sir Hiram Maxim Electrical Engineering Company, Limited, £1,881.

Brighton.—The Town Council have received the following tenders for installing the electric light in a portion of the Royal Pavilion:—

G. Hignett and Co., 2, North-street-quadrant (accepted)...	£309	15	0
C. G. Reed and Son, North-street	485	10	0
C. Hawkes and Walton, 10, Castle-square	398	19	6
M. A. Fileman, 99, Queen's-road	398	0	0
J. F. Phillips and Son, Richmond-buildings	380	0	0
H. J. Galliers, St. James's-street	360	0	0

All of Brighton.

Bournemouth.—The Corporation have received the following tenders for boilers, superheaters, economisers, feed pumps, pipework, and accessories: J. Thompson, £18,000; Fraser and Son, £13,339; Tinkers, Limited, £12,793; Yates and Thom, £11,877; and Danks and Co., £9,400 (accepted); Babcock and Wilcox's tender was incomplete. Water cooler: W. Watson, £3,570; Wheeler Condenser Company, £1,721; Doherty and Donat, £880; Klein Engineering Company, £859 (accepted); Couper Schwarz, £773; A. Koppel, £750. Travelling crane: H. Morris and Bartert, £1,450; Carrick and Ritchie, £365 (accepted); Chatteris Engineering Company, £363; J. Spencer and Co., £350; J. Carrick and Son, £326; and J. Hitchen and Sons, £285.

BUSINESS NOTES.

TRACTION.

Dublin.—The tramway company are considering the question of running workmen's cars.

Grimsby.—The Board of Trade inspection of the electric tramway system took place on Friday.

Halifax.—On Thursday week the Halifax-to-Southowram tramway was opened for passenger traffic.

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Merthyr.—The electric traction company intend to adopt a system of fixed stopping places on the tramways.

Hull.—Very soon the double tramway line in Ocean-place will be completed, and a public service of car will be running.

Greenock.—The Board of Trade inspection of the new electric tramway system from Port-Glasgow to Ashton took place on Tuesday last.

Salford.—Trial trips with some of the new cars are being made over the new lines this week, preparatory for the opening on the 1st prox.

Llandudno.—At their next meeting the Urban District Council will consider plans for the proposed electric tramway round the Great Ormes Head.

Rochester.—The Works Committee will shortly report to the Town Council as to the construction of a system of municipal tramways in the city.

Springhead (Lancs.).—Messrs. Hewitt and Rhodes will shortly submit a plan of their tramway scheme to a special meeting of the Urban District Council.

Padiham.—The Local Government Board have refused to sanction as a loan the money spent by the District Council in opposing the Burnley Corporation Tramways Bill.

Chilian Electric Tramway and Light Co.—The accounts for 1900 show a profit of £3,514, increasing the credit balance to £6,445, which it is proposed to carry forward.

Ham (Surrey).—The District Council will not at present support the London United Tramway Company's scheme of tramway extensions in Surrey so far as it affects their district.

Hendon.—The Urban District Council have determined to adhere to their objections lodged with the Light Railway Commissioners as to the construction of light railways in Hendon.

Electric "Tube" Extension.—In about six weeks' time the extension of the City and South London Electric Railway from Moorgate-street to Islington will be in operation.

Bury.—The General Purposes Committee intend to recommend the Council to carry out the original scheme for an electric tramway to Limefield and Fairfield, with a few modifications.

Sheffield.—The proposal that letter-boxes should be placed on the electric tramcars for the collection of mails will shortly engage the attention of the Tramways Committee in a definite form.

Erdington.—By an overwhelming majority the townspeople have agreed to support the Corporation in their application to Parliament for powers to construct and work electric tramways in the borough.

London-to-Brighton.—It is proposed to apply in the next session of Parliament for powers to build an electric railway from London to Brighton. The journey of 48 miles, it is promised, could be made in 34 minutes.

Heckmondwike.—A notification has been received by the District Council from the British Electric Traction Company to the effect that they intend shortly to construct their light railways within the Council's district, and submitting plans showing the route.

Loughborough.—The Town Council on Monday approved a report from the Parliamentary Sub-Committee relative to the light railways scheme. It is stated that the approval of the committee was thereby given to an amendment of the plan for the proposed new street from the Market-place to Toothill-road.

Brighton.—Early yesterday morning a trial trip on the new electric tramways was made on the Lewes-road route. One of the cars covered the complete route twice, the trial being attended without a hitch of any sort. A public service will be put on this route as soon as the sanction of the Board of Trade is obtained.

Ayr.—The first section of the electric tramways from Prestwich Cross to St. Leonard's Church, extending to exactly four miles, has now been finally completed. The Board of Trade inspection was announced to take place yesterday morning, and the cars were to run immediately after the inspection if that were satisfactory.

Tottington and Ramsbottom Light Railway.—We understand that the Lancashire Light Railways Company have intimated to the authorities concerned that they have abandoned the proposed line through Bradshaw, Tottington, Ramsbottom, and Rawtenstall. The enquiry fixed to be held at Bury on Wednesday was not held.

Leeds.—The tramway men in the employ of the Corporation held a mass meeting on Monday, when it was decided that in no circumstances should they agree to work every Sunday by the adoption of double shifts, as suggested by the Corporation. Sunday labour, if necessary, should, it was contended, be paid for at extra rates.

Bradford.—The opening of the section of tramways from Mytholmroyd to West End, Hebden Bridge, is likely to be delayed owing to a dispute with the Hebden Bridge District Council as to which side of the roadway the tramway poles are to be laid. The line will eventually be extended a mile further to Whiteley's Arches.

Portsmouth.—The main base line of the municipal electric tramways was formally opened on Tuesday. The first car was driven by Mrs. Kimber, wife of the chairman of the Tramways Committee. The new system has cost £360,000, and the total expenditure, including the amount awarded to the former company, has been £630,000.

Wheatley.—Major Druitt, R.E., of the Board of Trade, has held an enquiry into the objection taken by the District Council to the position of the proposed tramways in Highfield-road. The Doncaster Corporation propose to place the line on the northern side of the road, and the District Council wish them to abandon that section of the line.

Wakefield.—It is expected that, the Board of Trade having confirmed the provisional order authorising the construction of a system of tramways in the borough, the work will soon be begun. An enquiry by the Light Railway Commissioners is to be held shortly into a proposal to extend the scheme so as to serve Rothwell and Lofthouse and run into Leeds.

Dundee.—Considerable progress with the work of tramway extension in the city is reported by the burgh engineer. The track of the Ferry-road route from High-street to the west side of Market-street has been completed with the exception of the paving of about 100 yards of the margins. The work of reconstructing the Victoria-road route is advancing rapidly.

West London Tramways.—There was a breakdown of the electric tramway system between Uxbridge-road Station and Southall owing to one of the overhead wires snapping in Acton Vale. The service was temporarily suspended, which added to the inconvenience of passengers, who, on reaching Shepherd's Bush, found the Tube broken down as described elsewhere.

Liverpool.—Mr. Holmes, the city electrical engineer, has been requested to report every quarter the number of patents submitted to him, showing the number rejected as useless and the number considered worthy of further investigation by the Tramways Committee. The general manager (Mr. Bellamy) has been requested to report similarly with reference to inventions submitted to him.

Hampstead Heath.—The promoters of the Charing Cross, Euston, and Hampstead Electric Railway have received an appeal from the National Trust for Places of Historic Interest or Natural Beauty suggesting the desirability of their adopting an alternative route to that under Hampstead Heath, as now proposed, when the consideration of their Bill is resumed by Parliament next session.

Tramways in Surrey.—In reply to a suggestion emanating from Mr. J. Landfear Lucas for an electric tramway between Haslemere and Farnham, by a route connecting Hindhead, Grayshott, Headley, etc., Mr. Clifton Robinson, of the London United Tramways Company, has promised, when the question of future extensions comes to be considered, to give the suggestion every possible consideration.

Electric Traction in Italy.—According to a recent consular report, a firm of railway contractors and electricians have applied to the Italian Government for a concession to build an electric railway from Rome to Naples, by means of which the journey, occupying at present five hours, would be reduced to about 2½ hours. The scheme is reported to be under consideration by the Commissioners of Public Works.

Keighley.—The Corporation are recommended by the Highways Committee to extend their application for tramway powers, and that the provisional order to be applied for shall include not only the Worth Village section, but Devonshire-street, Devonshire-street West, Belgrave-road to Devonshire Park, Bridge-street to North-street, and from the terminus of the existing tramway in Skipton-road to the site of an intended new tramway car depôt.

Fulham.—The Borough Council have given their consent to the London County Council's scheme for a tramway from Harlesden to Putney, passing along Fulham Palace-road and Fulham High-street, the latter to be widened to a width of 60ft. by the acquisition of property on the west side of the thoroughfare, at a cost of £92,600. The Council have further agreed to contribute one-third of the net cost of street widenings, amounting to the sum of £30,867.

Batley.—The Town Council have unanimously passed a resolution requiring the Dewsbury, Batley, and Birstal Tramways Company, Limited, to sell to them the portion of their line which runs through the Batley borough. It was pointed out that no opposition had been forthcoming from the general body of ratepayers, and the belief was expressed that the adoption of electric traction, in place of the present steam service, would tend to the best interests of the borough.

Hammersmith.—The Law and Parliamentary Committee report that they have been in communication with the Board of Trade with respect to the Council's reference as to whose duty it is to enforce the regulations relating to the use of electrical power on the London United tramways, and have received a reply to the effect that it is the practice of the Department to recommend that the local authorities should undertake the duty of enforcing compliance with such regulations as those referred to.

Glasgow District Subway.—At the half-yearly meeting of the shareholders in this concern last week, the opinion was expressed that until the subway was converted to electricity there was very little hope of the directors being able to pay a larger dividend than 1¼ per cent. The chairman replied that he believed they were cheaper with the rope than they would be with electricity, but the time might come when they would have to adopt electricity for greater speed, but he hardly thought that time had come yet.

Dewsbury.—Sitting as the General Purposes Committee, the Town Council have approved the heads of agreement with the British Electric Traction Company with reference to the proposed electric tramways. The question respecting the arrangements as to the purchase of the Dewsbury and Batley tramways within the borough was also brought forward at the same meeting, and it was agreed that Mr. Sellon, the chief engineer of the British Electric Traction Company, should be appointed arbitrator in the matter.

Barnsley.—The British Electric Traction Company will be asked by the Corporation to alter the gauge of their tramways in Barnsley so as to make it identical with the proposed line from Barnsley to Doncaster. The Council have decided to support the action of the Worsborough Urban District Council in endeavouring to obtain an alteration in the scheme of the proposed light railway from Worsborough Bridge to Hoyland, so as to remove the objections against the railway because of the level crossing at Worsborough Bridge.

Scarborough.—The Streets Committee will recommend the Council to approve of the proposed tramway route from the North Side to the Spa being by way of North Marine-road, Castle-road, Aberdeen-walk,

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Vernon-place, and Falconer's-road. This does away with the necessity of running the cars along St. Thomas-street and St. Nicholas-street, to which considerable local objection has been raised. The Council are further recommended to ask the company in promoting the Bill to insert a clause providing for the running of covered-in fish cars from the pier to the station.

Cardiff.—We gather from the local Press that so far the directors of the tramway company have not given any definite reply to the offer made by the Corporation for acquiring the tramways without resorting to arbitration. All that the directors have intimated is that in the figure suggested when they met the sub-committee of the Council they did not include goodwill, a claim under which head it was not then their intention to forego. The directors have been asked for a definite reply to the offer, and it is stated they will meet shortly to finally consider the matter.

Manchester.—The recent letter of the Salford Tramways Committee stating the terms upon which Salford is willing to come to an agreement with the Manchester Corporation in relation to tramway matters has been considered by the Manchester Tramways Committee. It is reported that the committee decided to propose an exchange of running powers, and, failing an agreement for a mutual exchange, that they are prepared to recommend the City Council to refer the whole matter in dispute to the Board of Trade for arbitration, should Salford agree to such a reference being made.

Leicester.—The Town Council at their meeting on Tuesday passed a resolution to the following effect: "That the common seal of the borough be affixed to an agreement to be made between the Leicester Tramways Company and the Corporation for the sale of the undertaking of the company to the Corporation at the price of £110,210," and that "application be made to the Board of Trade for their sanction to the loan of £134,110, being the amount of purchase money required by the Corporation to purchase the undertaking of the Leicester Tramways Company, and for the repayment of £23,900 debentures of the company."

Isle of Man.—As we go to press we learn that the liquidator of the Isle of Man Tramways Company has accepted the offer of £50,000 made by the Corporation of Douglas for the horse and cable lines within the borough boundaries, and Sir James Gell, Chancery judge, in chambers, has authorised the liquidator to carry the sale into effect. The Town Council will not have to apply to the Tynwald Court for leave to complete the purchase. It is intended to convert both lines to electric traction, and the total cost of the scheme will be about £105,000. The length of the existing horse and cable tramways is about four miles.

Edinburgh.—At a meeting of the Lord Provost's Committee, it was stated that the tramway company had taken up to date no steps to pay their arrears of rent, amounting to £20,500, and in the circumstances a remit was made to the Tramway Sub-Committee to report at an early date on the different alternatives which under the lease are open to the Council to take in connection with the recovery of the money now due. These alternatives include the question of the working of the tramways by the Corporation, either temporarily or permanently. The town clerk is preparing a special report on the legal aspect of the question.

Darlington.—A proposal was considered at Friday's meeting of the Corporation from the Electromagnetic Company to lay down an experimental system of tramways on their plan, without cost if it failed. Ultimately the whole matter was referred to the General Purposes Committee. An application to the Light Railway Commissioners for an order for the Corporation to put down electric tramways to run from Harrowgate-hill to the Market-place, from Cockerton to the same centre, and also from the Market-place to Eastbourne and part of the way along Haughton-road, was definitely decided upon at a meeting of the General Purposes Committee on Wednesday.

Lancashire Light Railways.—The application of the Auxiliary and Light Railways and Tramways Company, Limited, for an order to authorise the construction of a light railway from Lytham to Preston was considered by the Earl of Jersey and Colonel Boughey, Light Railway Commissioners, on Tuesday. A large body of evidence having been given, the Earl of Jersey announced that the Commissioners had agreed not to proceed with the order, being dissatisfied with the way in which the financial position of the company had been brought before them. The company have withdrawn their application for an order to authorise the construction of a light railway from Horwich to Preston.

Bournemouth.—Most of the contracts in connection with the Corporation's tramway scheme have been placed. Messrs. White and Co.'s tenders for contracts Nos. 10 and 11 (permanent way construction, rails, paving, conduit ploughs, etc.) have been accepted at £93,721. 3s. 3d. and £58,152 respectively. Contract No. 3 (boilers, superheaters, etc.) has been let to Messrs. E. Danks and Co., of Oldbury, for £9,400. Several street improvements in connection with the scheme will have to be carried out, including proposed widening of the Christchurch-road. Centre posts will be erected from Carnarvon-crescent to Boscombe, each fitted for electric light and gas. In Poole-road the side-pole construction will be adopted.

Hyde.—Negotiations are proceeding between the Town Council and the Stockport Corporation relative to the working of the tramways at Gee Cross. As a result of negotiations it is hoped that arrangements may be made for a through tram service from the Hyde Town Hall to Bredbury Church. At present the Oldham, Ashton, and Hyde Electric Tramway Company's lines extend to Gee Cross, which is at the southern end of Hyde borough, their terminus being at what is known as the "Big Tree." Under an order recently obtained the Hyde and Stockport Corporations have power to bring the Stockport Corporation's present lines from the Bredbury boundary to Gee Cross, and should a through service be arranged with the tramway company it will be a very great public convenience.

Croydon.—Yesterday the main base line of the new electric tramways from Norbury to Purley was inaugurated with the customary ceremonial. All the horse cars were off the road when the invited guests assembled at the electricity works at noon. The current was here formally switched on, and the company afterwards proceeded to the town hall, where luncheon was served. At three o'clock the Mayoress of Croydon started the first electric car automatically by cutting the ribbon holding down her presentation bracelet—a local gift. The leading car was immediately followed by nine others loaded with guests in the direction of Purley, while another 10 cars made a run at the same time towards Norbury. A couple of hours later the cars were run for the public service, which was continued till a late hour last night.

Bristol.—A special meeting of the Town Council was held on Friday to consider two resolutions to the effect that the Board of Trade be requested to hold a formal investigation as to the causes and circumstances of all accidents which have recently occurred in connection with the undertaking of the Bristol Tramways and Carriage Company, Limited, and that a special committee be appointed to consider and report to the Council upon any questions affecting the interests of the Corporation which may from time to time arise in connection with the Bristol tramway undertaking. A long discussion took place on these motions, with the ultimate result that neither was carried. The second one was withdrawn altogether, while in place of the first the following was substituted: "That the Watch Committee be requested to report to the Council as to accidents upon the tramways of the city during the last six months."

Wolverhampton.—Regarding the controversy between the Corporation and the British Electric Traction Company, the secretary of the company writes to one of the local papers to the following effect: "The only reason for the action which the company has instituted is to obtain running powers which we contend the special Acts of Parliament contemplate and provide for, and thus to secure a through service of cars, which, however, your Corporation has hitherto refused even to negotiate for. If, therefore, your Corporation are prepared to admit the principle that running powers are essential and will be arranged (if necessary by a reference to the Board of Trade), there is no occasion for the action to proceed, and my company will at once agree not to proceed with the appeal." The above letter was considered by the Tramways Committee on Tuesday, and a reply was drafted. It is not known whether the committee decided to accept the offer of the Traction Company for a conference or not.

Central London Railway Blocked.—The "Twopenny Tube" was blocked for about an hour and a-half between Shepherd's Bush and Queen's-road on Wednesday morning. It appears that at 7.20 a.m. an engine and the forepart of a carriage jumped the points where the trains cross from one line to another at Shepherd's Bush. The fact that the officials were unable to dispatch trains from Shepherd's Bush for nearly an hour and a-half necessarily caused great inconvenience to thousands who at that time of the morning were making their way Citywards. Meanwhile, however, the trains were reversed at Queen's-road, and the cessation of working between this point and the Bank terminus did not extend over 20 minutes. We understand from enquiries made that no serious damage resulted from the accident excepting the derangement of the regular service. The derailing of the engine, however, fouled the lines which were required to bring the trains down from the depôt on to the tunnel lines, and until the engine was removed, and the slight repairs necessary made good, the officials were not able to get them down from the depôt, and that necessitated a restricted service being run until early in the afternoon, when the obstruction was removed. The disturbance of the electric current was only momentary, and at the moment of derailment.

Mersey Railway.—We announced in these columns a short while ago that the Mersey Railway Company had decided to convert their line to electric traction. Further details are now to hand to the effect that the Westinghouse Company have got the contract, and have undertaken to have the railway working electrically within 18 months from July 15 last. Under the contract the Westinghouse Company guarantees the interest on the existing 4½ per cent. redeemable first debenture stock, amounting to £249,276, until the public traffic is begun, and agrees to provide the money for the redemption of that stock by June 30, 1904. In consideration of this the Westinghouse Company will take £635,303, of which £15,303 will be in cash, and the balance in new first perpetual debenture stock. We note that at the half-yearly meeting of the railway company on Wednesday complaint was made of the amount to be paid under the contract to the Westinghouse Company, but that the motion for the adoption of the report was, after discussion, carried by an overwhelming majority. The chairman made the interesting announcement that the contract guaranteed to work the line electrically at a cost not exceeding 6¾d. per train-mile, as against 1s. 3d. at the present time.

Electric Railways and Tramways Company (Italy).—This company was recently started with the object of building electric tramways in Rome, in addition to those which already belong to the kindred Roman concern—the Tramways and Omnibus Company—as well as of carrying out the long-expected plan of connecting Rome with the small towns in the neighbourhood, such as Frascati, Grottaferrata, Ostia-on-the-Sea, Rocca de Papa, Castelgandolfo, etc., all of which are favourite summer reserts for the Italians. The company, which claims to represent the former Thomson-Houston International Company, later on known under the style of the Thomson-Houston Mediterranean Electric Company, according to a recent report of the British consul at Rome, has a subscribed capital amounting to £60,000, of which three-tenths only have been called in. The consul is of opinion, however, that the capital is not quite adequate to carry out the costly works which the directors enumerate in their prospectus. Up to the present the company has only prepared the general survey of the proposed lines, and there are no visible

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traces of its activity. Hence the British consul thinks that with a strong competitor like the existing Tramways and Omnibus Company it will be a matter of some difficulty for the company to carry out its programme.

Crewe.—The Earl of Jersey and Colonel Boughey, Light Railway Commissioners, held an enquiry on Monday into an application by the British Electric Traction Company, Limited, for an order to construct light railways within the borough of Crewe, and from the borough of Haslington. Mr. Morse, on behalf of the promoters, said that the proposed railways covered just over six miles. They ran from Crewe station to the end of West-street, and from the centre of the borough along Hungerford-road to Haslington. The estimated cost was £73,000, or £12,000 per mile. The Earl of Crewe had arranged, if the order was granted, to sell land for a generating station. It was proposed to work the cars on the overhead trolley system. Mr. Morse went on to explain that in 1897 the present promoters obtained an order from the Light Railway Commissioners to construct lines in Crewe, but afterwards the Corporation attended before the Board of Trade and got conditions inserted in the order which the company found they could not carry out with any prospect of a reasonable profit. Under these circumstances the company offered to surrender their order to the Corporation at the price it had cost them to get it, but this was not accepted, and the company did not take up the order. The Corporation afterwards proceeded with a scheme of their own, but the Commissioners refused to sanction it. The London and North-Western Railway Company, as very large ratepayers in Crewe, strongly opposed the Corporation scheme, and he had an undertaking from them that if the Corporation promoted another scheme they would object again. In fact, the London and North-Western Railway Company would oppose any scheme for constructing these light railways at the expense of the ratepayers, and the promoters had agreed, if they were successful in getting their order, that they would not sell the undertaking to the Corporation. Mr. E. H. Lloyd, for the Corporation, said the Corporation and the town were unanimous against handing over their streets to a private company, and as they had the assurance that the Corporation, in the event of this order being refused, would go for an order on their own account he hoped that the Commissioners would decline to grant the order to this private company, but would leave open a way to the Corporation to carry out a scheme of tramways absolutely under their own control. Evidence having been given in opposition to the company's scheme, the Commissioners held a consultation, and, although there was other evidence, said they considered that in the face of the unanimous feeling of the town they could not force this scheme upon them. The application of the electric traction company was, therefore, refused.

LIGHTING AND GENERAL.

Portsmouth.—Application is to be made for a loan of £23,000 for extensions of mains.

Accrington.—The Council are about to raise a loan of £9,000 for electric supply purposes.

Share Market.—There was little doing in electric supply shares during the week, but debentures were in good request.

Globe Telegraph and Trust Co.—The directors announce an interim dividend of 3s. per share on the preference shares.

Benwell.—We understand that the District Council are about to negotiate with some electrical supply companies for a supply of current.

Eastern Telegraph Co.—Payment is announced, on the 15th prox., of an interim dividend of 1¼ per cent. for the quarter ended June 30 last.

Eastern Extension and China Telegraph Co.—On the 15th prox. an interim dividend of 2s. 6d. will be paid per share for the quarter ended June 30 last.

Barnet.—It appears that the Guardians consider the estimated cost of wiring the new workhouse (about £70 to £80) will prevent them from having the work done.

Knaresborough.—The Urban District Council are considering the advisability of seeking a new Act of Parliament giving them powers to provide electric light and power and to construct tramways.

Fleetwood Electric Light and Power Syndicate.—A meeting of shareholders in the Fleetwood Electric Light and Power Syndicate, Limited, was held on Thursday at the Euston Hotel, Fleetwood.

City Lighting.—There appears to be some prospect of a compromise being arrived at between the Corporation and the City of London Electric Lighting Company with regard to public lighting in the City.

Walsall.—The town clerk is collecting information in order to enable the Town Council to decide upon the desirability or otherwise of applying to the Postmaster-General for a license to establish a municipal telephone.

Windsor Castle.—An extensive electric light installation, comprising the private and State apartments at Windsor Castle and the offices, is now being made by the Windsor Company, which lights Windsor and Eton.

Chiswick.—The Urban District Council have decided to apply to the Board of Trade on or before Dec. 21 next for a provisional order authorising them to supply electrical energy for public purposes within the urban district of Chiswick.

Change of Address.—We are informed that Messrs. Matthew Buchan and Hogarth, consulting engineers, have changed their address from 36, Hanover-street to 67, George-street, Edinburgh, and their name to Messrs. Buchan and Hogarth.

Hammersmith.—Since the last Council meeting 21 additional consumers have been connected, representing a maximum of 804 8-c.p. lamps; these added to the number previously reported show a total of 951 consumers taking current from the mains.

City and Guilds Technical College.—The new session begins on Monday, Sept. 30, at 6 p.m. The programme may be obtained at the college, Leonard-street, Finsbury, or at the head office of the City and Guilds of London Institute, Gresham College, E.C.

"**E.P.L.**"—A new home edition of this buyers' guide to the engineering, building, and kindred trades has been issued, and copies will be forwarded free upon written application to the publishers, Jas. Truscott and Son, Suffolk-lane, Cannon-street, E.C.

Mechanical Shifting of Points.—The Glasgow Tramways Committee are prepared to consider designs for mechanical point-shifting appliances. Inventors are invited to communicate with Mr. John Young, general manager, 88, Renfield-street, Glasgow.

Sheffield.—The Electric Light Committee have appointed a sub-committee, consisting of the chairman and vice-chairman (Alderman Styring and Harrison), Sir Charles Skelton, and Messrs. Fenton and Wheatley, to report to them on the telephone question.

Falkirk.—We understand that the Urban District Council are consulting Messrs. Burstall and Monkhouse as to the advisability of the Town Council going on with the electric light and on the subject generally. They will also ask private companies for terms.

Rowley Regis.—The Electricity Committee in their last report to the Urban District Council stated that very much of the work of laying cables in the district by the Midland Electric Corporation had already been carried out, and recommend the engagement of an expert.

Stepney.—The Borough Council have obtained sanction to the borrowing of £29,507 for the purpose of completing the electric light installation. A circular setting forth the prices charged for current, and the advantages to be derived therefrom, is being distributed.

Dundee.—The members of Dundee Institute of Engineers recently paid a visit to the electric tramway and lighting station in Dudhope-crescent-road, and were shown over the establishment by Mr. W. H. Tittensor, city electrical engineer, and his assistant, Mr. Mackail.

Finchley.—Mr. Edward Calvert, of Buxton, has been appointed resident electrical engineer to the Urban District Council, and is to commence his duties on Dec. 1 next. The Council have decided not to accept the proposal made by the Finchley Electric Lighting Company.

Poplar.—The Council are preparing schemes for the extension of the electric light in various parts of the borough. The Isle of Dogs will now be taken in hand, together with parts of Old Ford and Hackney Wick. A sum of £52,348 will be borrowed from the London County Council.

Direct Spanish Telegraph Co.—The directors have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent., free of income tax, on the ordinary shares, both for the half-year ended June 30, and payable Oct. 1.

Burnley.—The Guardians have decided to erect and fit up a boiler-house and workshop for the purpose of lighting by electricity the workhouse of the union, in accordance with plans to which the Local Government Board have affixed their seal. Application is to be made for sanction to the borrowing of £8,806.

Removal.—We are informed that the British Thomson-Houston Company, Limited, will shortly remove the majority of their staff from 83, Cannon-street and 26 and 27, Bush-lane to their works at Rugby, which will in future be the head office, only a branch office being retained in London at 83, Cannon-street.

Heckmondwike.—The proposed extension of plant to meet the demand of the traction company is engaging the attention of the District Council, and Mr. Hawtayne has been instructed to prepare the necessary specifications for a boiler capable of evaporating from 7,000lb. to 9,000lb. of dry steam per hour.

Fall in Copper.—There was a sharp fall in the price of copper on the London Metal Exchange this week, the quotation for prompt delivery at one time—on Tuesday—being £3 lower than on Monday. In Birmingham a similar collapse took place, which is attributed to American speculation and the consequent inflation of values.

Leicester.—The accounts of the electric lighting undertaking show as the result of the working for the half-year ending June 30 last a net profit, after paying interest on the capital of the undertaking, of £2,065. 12s. 7d. Out of this has been paid £1,068. 3s. 1d., the half-year's account of sinking fund, leaving a balance of £997. 9s. 6d.

Carnoustie.—At an informal meeting of the Council last week a notice by Messrs. Crompton and Co., London, of intention to apply for a provisional order for the burgh was discussed. Mr. Purves, C.E., Edinburgh, attended, and gave information on several points affecting the subject. The matter will come before an early meeting of the Council.

Milan.—The King of Italy will shortly visit Milan in order to inaugurate the huge hydro-electrical establishment which has been built on the Tessino. The object of the enterprise is to distribute electrical energy for various industries, and for the illumination of the town. The new installation has a generating capacity of over 15,000 h.p.

Sale of Plant.—The Dublin United Tramways Company are prepared to sell a complete electric generating plant in perfect working order, capacity 450 kw., erected at Clontarf Depôt 1897 and ceased running January, 1900; also the plant at Balls Bridge Depôt, 560 kw. capacity, erected 1896 and ceased running January, 1900. Particulars appear in another column.

London Gazette.—The partnership existing between J. W. Smith and J. S. Smith, electrical engineers (trading as J. W. Smith), 52, Bridlesmith-gate, Nottingham, has been dissolved by mutual consent. A receiving order has been made out in the estate of J. A. M. Collier, electrical engineer, Claremont-grove, Claremont-place, Gateshead, Durham, on debtor's petition.

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Battersea.—The Borough Council's central electric generating station will be opened on Saturday afternoon by Mr. Torrance, chairman of the London County Council. The whole of the work which comprises 240 arc lamps, has been carried out by the Battersea Borough Council's own workmen at a cost of £152,000, under the supervision of the borough surveyor, Mr. J. T. Pilditch.

Bedford.—The appointment of chief electrical engineer has been deferred. The Electric Light and Traction Committee have recommended that the Council make the appointment from the following: Mr. Cecil Barkham, assistant engineer, Bedford; Mr. Oswin Hansom, chief engineer, Fleetwood; Mr. Harold Morton, chief engineer, Llandudno; and Mr. R. W. L. Phillips, assistant engineer, Bristol.

Colour Photography.—The lantern arrangements for the coming season of the Royal Photographic Society's Exhibition, which opens next Monday, includes three illustrated lectures on colour photography by Mr. E. Sanger Shepherd. The dates fixed are Sept. 30, Oct. 10 and 19. These lectures, which commence at 8 p.m., will be preceded by a display of a few slides produced by various processes of colour photography.

Derby Telephones.—At Wednesday's meeting of the Executive Council of the Derby Chamber of Trade, it was resolved to send a circular to every member of the Chamber, the subscribers to the National Telephone Company, and others, asking if they would be willing to become subscribers to a municipal service, at a fee not exceeding £5 per annum, should the Corporation be willing to adopt the principle.

Personal.—Electricians from Blackpool Corporation works have been very successful in obtaining good appointments in various parts. The latest is Mr. G. F. Kenyon, who has been appointed chief engineer for the town of Chiguayante, Chili, South America. He was connected with the Blackpool electricity department in its early days, and recently was the resident engineer at Northwich. He leaves next week for South America.

Llandudno.—After discussing at length whether their resident engineer, Mr. Morton, should be paid commission upon new work to be carried out, the Urban District Council last week referred back to the Electric Lighting Committee the report submitted by them. The report recommended that extensions of buildings and plant be now undertaken, sufficient to provide current both for the light railway and for lighting purposes.

Fire Brigade.—We are told that it is proposed to equip the Rouen fire brigade with pumps driven by dynamos taking current by means of a trolley hooked to the tramway wire at the nearest point to the fire. This may be all right for France, but would hardly work in this country, where people have generally sense enough to switch off the current from the electric tramways in the case of any outbreak of fire in their close proximity.

Dudley.—The Chamber of Commerce has decided to ask the Associated Chambers of Commerce to make a vigorous protest against the National Telephone Company's innovation of supplying subscribers with local directories only and charging 10s. for complete directories. A leading manufacturer of the district wrote complaining of the new system, and a member of the chamber said that he was prepared to give up his five instruments as a protest.

New Zealand.—A proposal to light Napier by electricity, the power to be generated at the waterfalls a few miles distant, is being investigated by a committee of the Town Council. The Auckland City Council have decided to get an expert from Australia to report on the proposal to light that city by electricity. The Auckland Electric Tramway Company has offered to supply the Harbour Board with electric light and power for their wharves.

King's Lynn.—The Council have decided to make an offer for the electric launch now in use at Morecambe Bay for the purposes of ferry communication between Lynn and West Lynn. With a view of properly lighting courts and alleys, the Corporation have agreed to supply current free on condition that the fittings be laid at the expense of the property owners. It is stated that the carrying out of this conditional resolution will mean an expenditure of about £200 per annum.

Cardiff.—With regard to the accounts of the electric light and tramways department we note that, after deducting the adverse balance from the previous year's working in net revenue account, the total costs, including interest, repayment, and sinking fund, amount to £4,199. 3s. 11d., whereas the balance from the revenue account, after deducting all generation and distribution costs, together with management expenses, comes to £4,208. 19s. 2d., leaving a credit balance of £9. 15s. 3d.

New Issue.—The directors of the Calcutta Electric Supply Corporation, Limited, have decided to offer to the shareholders for subscription 10,000 shares of £5 each in order to provide the capital required for erecting and equipping a new generating station in the Alipore district of Calcutta, and for large extensions to the mains, to meet the constantly increasing demands for current. We are informed that the progress of the company is most satisfactory, and there is every prospect of a large and profitable business.

New Company.—The Leeds, Wakefield, Dewsbury, and District Electric Tramways, Limited, has been registered with a capital of £100, the object being to undertake the construction, maintenance, and working of tramways, light railways, electrical and other railways and motors, to deal in all kinds of vehicles drawn or propelled by animal traction or otherwise, producers and suppliers of electricity for the purposes of light, heat, or power, indiarubber manufacturers, makers of and dealers in tyres for cycles and vehicles, etc.

Presentation.—Mr. H. W. W. Dix, assistant chief draughtsman to Messrs. Crompton and Co., Chelmsford, was presented on Friday last with a handsome oak stationery cabinet and dressing bag, together with a framed illuminated address signed by members of the technical staff and others, expressive of their appreciation and respect. The presentation was made by Mr. F. H. Somerville on behalf of the members of the staff, and Mr. Dix, who has been connected with Messrs. Crompton and Co., Limited, for the past nine years, feelingly responded.

St. Paul's.—Good progress is being made at St. Paul's with the installation of electric light. Outside firms supply the material, but the cutting and piping for the wires is done by the St. Paul's staff. No cutting whatever is done in the cathedral except by the workmen of the cathedral, who are all well acquainted with the peculiarities of their task. Repairing, painting, and special work keep the staff pretty fully employed. Whatever is done to the fabric of the building is done under the supervision of Mr. E. J. Harding, the clerk of works of the cathedral.

Bath.—In moving the adoption of the report of the Electric Lighting Committee at the last meeting of the City Council, the Chairman stated that the undertaking was going on very well, and they had the previous night a load of 460 kw., while the heaviest load for the whole of last winter was 498, so that they might look forward to a good year. They had power for 30,000 8-c.p. lamps, and there were now 46,000 connected, but Mr. Teague told him they need not have the least anxiety with regard to getting through the winter's work with the plant they had now. Any fresh customers could be taken on with confidence.

British Electric Works Company.—An arrangement has been arrived at in consequence of the recent assize action in which Mr. Walter Glynn sued Mr. J. Atherton and other directors of the British Electric Works Company, Limited, Aston, for repayment of £1,000 subscribed for shares alleging that the prospectus contained fraudulent misrepresentations. The jury, after several days hearing, found for the plaintiff for the full amount. Other actions were pending, but the shareholders have now accepted the directors' offer to pay by instalments 20s. in the £ to the original shareholders on all shares at the time of the company's liquidation.

Padiham.—The Urban District Council have consulted Mr. Eastham as to the advisability of procuring an electric lighting order, and he suggests (1) that the Council engage a local electrical engineer to advise on the proposed area of supply; (2) a canvass of the district for an estimate of the probable demand; (3) an estimate of the probable cost of the electrical works and the probable income from them; and (4) that information be obtained from Darwen and other places as to what help could be got from destructors in generating steam for motive power. The Council have appointed a deputation to attend a conference of the authorities within the Burnley telephone district at Burnley on Oct. 3.

Rome.—The British consul at Rome, in his last report, expresses his belief that when a reduced tariff comes into force for electric lighting gas will entirely disappear from the capital, and that there should be a good market open for British electric appliances of all kinds both in Rome and in other towns of Northern Italy, where electricity is supplanting gas. The necessary concession for the electric supply of Rome has been obtained by the Anglo-Roman Gas Company, which has a reserve fund returned at £141,443, chiefly invested in real property, Italian Government Consols, and railway shares. The current is generated by water power from Tivoli, as explained in a previous note, and the company should therefore be able to sell at a low price.

Warrington.—Mr. M. K. North has held an enquiry into the application of the Corporation for powers to borrow £15,000 for electric lighting. Mr. William Henry Grimsdale, the electrical engineer of the Corporation, gave details of the proposed extensions to the station and new mains. The increased demand for electric light since the system was inaugurated in December last, is shown by the fact that at the end of January the demand was equal to 546 8-c.p. lamps; February, 1,228; March, 7,186; April, 7,416; May, 8,441; June, 8,533; August, 10,652; and September, 10,910. The amount spent up to date is £40,668. The borough treasurer thought that the undertaking was going to pay well. The charge for current is 6d. for the first 1½ hours and 3d. per hour afterwards.

Stock Exchange.—The Stock Exchange Committee has appointed Oct. 2 as a special settling day for Chelsea Electricity Supply Company's further issue of 10,436 ordinary shares of £5 each, fully paid, Nos. 40,501 to 50,936, and have also ordered the undermentioned securities to be quoted in the official list: Calcutta Tramways Company's further issue of £100,000 4½ per cent. first debenture stock; Chelsea Electricity Supply Company's further issue of 10,436 ordinary shares of £5 each, fully paid, Nos. 40,501 to 50,936. Applications have been made for the following securities to be quoted in the official list: London United Tramways, Limited, further issue of £100,000 4 per cent. first mortgage debenture stock; Willans and Robinson's further issue of 10,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 70,001 to 80,000.

Longton (Staffs.).—The Council's electricity works were successfully opened on Wednesday afternoon. The site of the works, which have been designed and carried out by Mr. W. Langford, the Corporation gas manager and electrical engineer, is included in the gasworks premises, and the cost of putting down the plant, etc., has amounted to about £21,000. The generating plant has been installed by the Electric Construction Company, Wolverhampton. The Mayor (Mr. Alderman Bennion), in calling upon Mr. Alderman Bakewell and Mr. Alderman Walters, chairman and vice-chairman respectively of the Gas and Electricity Committee, to start the generating machinery, emphasised the efficient condition in which they found the gasworks that day as compared with some years ago. He added that he believed the electric light would prove a great benefit to the town.

Epsom.—The Lighting Committee are investigating the advisability of purchasing penny in-the slot meters for electric lighting. All lamp-posts, etc., are being transferred to the electricity supply department. Their maintenance from the time they are connected with the

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cables will fall upon that department. Satisfactory progress is being made at the generating station. The larger engine has been delivered, and the boiler pumps and feed pipes have been fixed and connected up. The distributing mains for the private lighting have been started from West-hill, and from the Dorking-road near the union, and will be pushed forward within the compulsory area with as much haste as is consistent with proper work. The arc lamps are being erected and steps will now be taken to ascertain what number of intending consumers there was likely to be from outside the compulsory area.

Wiring Table.—We have received from Mr. R. H. Waite a copy of his "Electrical Engineer's Pocket Reference Table," which gives information which will be useful to those installing electric light. The list consists of various sizes of electric lighting tables from No. 20 S.W.G. up to a strand of 61 No. 16 S.W.G. wires. We notice that in every case the carrying capacity is worked out at 1,000 amperes per square inch, and we think Mr. Waite would do well to alter this and work to the Institution table of currents for the various sizes which provides for equal heating of the conductors. In consequence of this they are, of course, not worked at a uniform current density of 1,000 amperes per square inch. Mr. Waite also gives columns to show how many 16-c.p. lamps could be supplied at five different voltages by each of the conductors. Here, again, the figures are only correct if a certain number of watts per candle are required by the lamps in question.

New Cable.—The Commercial Pacific Cable Company, with a capital of 100,000dol., has been incorporated at Albany by Messrs. John W. Mackay, Clarence H. Mackay, Edward C. Platt, Albert Beck, George G. Ward, Albert B. Chandler, and William D. Cook for the purpose of laying a cable from California to the Philippines *viâ* Honolulu. The new cable will connect at the Philippines with the cables to Japan and China, and will thus reduce the cable rates from the United States not only to the Philippines, but also to China and Japan, from 30 to 60 per cent. The length of the cable will be about 8,500 miles. The first part will be laid from California to the Hawaiian Islands, 2,200 miles. It is expected that this portion will be completed and in operation in nine months." The entire line to the Philippines is supposed to be ready in two years. The new company are willing to construct and lay the cable without asking for any subsidy or guarantee.

Strabane.—At a recent meeting of the committee appointed to consider the best means of lighting the town of Strabane, Mr. S. B. Langlands, Coleraine, and Mr. Skinner, Londonderry, appeared to advise the committee regarding the lighting of the town with gas, and Mr. R. K. Steele, of the Westinghouse Company, was present to give his advice regarding electricity as an illuminant. Mr. Langlands expressed his approval of the estimate submitted by Mr. Skinner to provide new gasworks and plant for the sum of £15,000. Mr. Steele, on behalf of the Westinghouse Company, stated that, having regard to this estimate, he was prepared to send in another estimate to the committee to provide electric light for both public and private purposes, and also to supply gas for heating and cooking purposes, at a total cost of £17,000. After a very long discussion the committee asked the Westinghouse Company to send in the new estimate, and also decided to have plans and specifications for developing the present gasworks, and recommended that in the meantime the Urban Council proceed to take the necessary steps to obtain a provisional order to do these works.

Worthing.—The Marquis of Abergavenny, Lord-Lieutenant of Sussex, on Saturday formally opened the Corporation electric lighting works. The installation, which has cost the town £32,000, includes 110 arc lamps each of 1,000 c.p. for lighting the parade and chief streets. Applications equivalent to 3,000 8-c.p. lamps have been received from private consumers. In the erection of the generating station the old waterworks buildings have been made use of, and it is also proposed to utilise the water from the old well for the condensing apparatus and feeding the boilers. At the present time only two of the three steam dynamos with which the generating station is to be equipped have been placed in position. The system adopted, it may be added, is the low-pressure continuous current, with a voltage of 460 for the outer conductors and of 230 to the consumers' premises. The Mayor (Councillor F. E. Ovenden), in his introductory remarks, spoke in highly complimentary terms of the services rendered by the engineers, Messrs. Burstall and Monkhouse, and the contractors who had worked under them; the architect, Mr. Peach; and last, but not least, to Mr. Roberts, the borough surveyor, who had undertaken the work in the place of a contractor. The Marquis of Abergavenny then proceeded to start one of the dynamos bearing the name "Abergavenny," and to switch on the current to those consumers who were connected with the mains. Subsequently an adjournment was made to the town hall at the invitation of the Mayor and the chairman of the Electric Lighting Committee (Councillor J. H. Rafferty). Amongst those present were the Mayors of Brighton (Alderman E. Stafford, J.P.), Arundel (Councillor J. N. Hare, J.P.), Lewes (Councillor G. Holman, J.P.), and Rye (Alderman Frank Jarrett, J.P.). The formal ceremony of turning on the current to the street installation was performed by the Mayoress (Mrs. Ovenden) from the town hall in the evening. A conversazione followed, and an interesting exhibition of electric lighting fittings was also on view in the magistrates' room.

Southport Telephones.—We quote the following from the report of the Telephone Committee, which has been adopted by the General Purposes Committee and the Town Council: "In the event of the Council deciding to establish a municipal telephone exchange for the Southport area, we submit for consideration the following estimates of capital expenditure, annual revenue, and expenses as a basis of what is likely to occur in Southport, judging from the experience we have gained in other towns. Expenditure: 500 completed lines, at £17. 10s., £8,750; 250 partially completed lines for future subscribers, at £8, £2,000—total, £10,750. Revenue: 300 subscribers, at £6 per annum, £1,800; 200 subscribers on the toll system, average £4, £800; 10 public telephones, at a net average of £6, £60—total, £2,660. Working expenses: Manager, £180 per annum, £180; clerk, at 30s. per week, £78; office boy, at 10s. per week, £26; share of establishment charges, £30; chief operator, £1 per week, £52; 15 girl operators, at an average wage of 10s. per week, £390; rent and rates of central exchange, £60; three branch switchrooms, at £20 each, £60; local rates on wires, £35; insurance, lighting, printing, and sundries, £100; wayleaves, £50; Post Office royalty, 10 per cent. on £2,660, £266; repairs, 2 per cent. on £8,750, £175; depreciation on instruments and distributing wires, £3,000, at 5 per cent., £150; interest and sinking fund on £10,750 at 6 per cent., £645; contingencies, 10 per cent. on above, £233—total, £2,530. Estimated capital, £10,750; estimated revenue, £2,660; estimated expenditure, £2,530. The charges in Southport made by the company for an unlimited number of calls are £9 per annum, and on the toll system £3. 10s. per annum and 1d. per call where the subscriber is within a mile of the exchange; for longer distances a higher charge is made, the charge for the two instruments at the gas and electricity works being £11. 8s. each. An extra charge of 5s. per year is also made if a desk instrument is supplied instead of a wall instrument." It is specially recommended that early steps should be taken to place all wires underground wherever practicable.

Swansea.—Mr. Cawthra, who has for some time been chief electrical engineer under the Swansea Corporation, left on Saturday to take up his new appointment as chief engineer at South Shields. He is to be succeeded by Mr. Prusmann, and till that gentleman is able to come to Swansea the electrical works will be under the control of Mr. A. R. Bell, the assistant engineer. The work of street-lighting, which is in hand, will probably be completed before December. At the quarterly meeting last week the following statement showing the expenditure in connection with the electricity undertaking of the Corporation to Aug. 31, 1901, was submitted:—Capital account: D. Jenkins, building, £18,120; engineer's commission, £500; Yates and Thom, boilers, £9,300: Callender's Cable Company, mains, etc., £5,239. 3s. 10d.; British Schuckert Electric Company, engines and generators £6,640, switchboard and instruments £1,600; Tudor Accumulator Company, accumulators, £1,300; Venner and Co., meters, £682. 12s. 1d.; Henry Coles, wiring of station, £275; Crompton and Co., £750; B. Evans and Co., office furniture, £145. 5s.; all other payments, £1,810. 2s. 4d.—total, £46,362. 3s. 3d. Revenue account: generated electricity, £310. 14s. 7d.; rent, etc., £14. 8s.; interest and sinking fund, £538. 11s. 10d.; management expenses, £176. 10s. 11d.; miscellaneous, £20. 5s. 10d.; insurance, £3—total, £1,063. 11s. 2d. Grand total, £47,425. 14s. 5d. The acceptance of the tenders for Contract No. 9—motor-alternators—was deferred so that the remarks of Mr. Cawthra as to certain of the electrical plant in the station may be transmitted to Messrs. Kincaid, Waller, and Manville for their observations thereon. The Resident Engineer reported that to Aug. 31, 143 applications for current had been received, equivalent to a lamp demand of 16,875 8-c.p. lamps, including public arcs and incandescents. The total number of consumers now connected to the mains is 117; the maximum load is 218 kw., equivalent to a lamp demand of 6,811 lamps alight at one time. The recommendation that Mr. A. R. Bennett, the engineer to the Glasgow Corporation telephone department, be engaged to report generally upon the question of the establishment of a municipal telephone exchange at Swansea, was agreed to.

COMPANIES' MEETINGS AND REPORTS.

WILLANS AND ROBINSON.

Directors: Mark Robinson, Esq., M.I.C.E. (chairman); Sir Gilbert A. Clayton East, Bart. (deputy-chairman); Captain H. Riall Sankey, R.E. (ret.), M.I.C.E.; Lieut.-General Sir Richard H. Sankey, K.C.B., R.E.; Thomas O. Lazenby, Esq., J.P.

Fifteenth half-yearly report of the directors (with abstract of accounts) to be submitted at the ordinary general meeting of the Company to be held at the City Terminus Hotel, Cannon-street, E.C., on Wednesday, Oct. 2, 1901, at 2.45 p.m.:

After writing off as depreciation from plant, etc., the sum of £5,614. 4s. 3d., and paying interest upon debenture stock, the balance to the credit of profit and loss account at the end of the half-year, including £7,412. 6s. 6d. brought forward, is £34,089. 15s. 6d. Out of this the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares, and 10 per cent. per annum upon the ordinary shares, amounting in all to £18,682. 16s. 3d. The amount payable to the original directors, in accordance with the articles of association, is £3,449. 18s. 2d., leaving an available balance of £11,957. 1s. 1d. From this the directors propose to carry £2,000 to the debenture redemption fund and £3,500 to the reserve fund, leaving a balance of £6,457. 1s. 1d. to be carried forward. In accordance with the authority conferred upon the directors at the last general meeting, 16,666 preference shares of £5 each, and 16,666 ordinary shares of £5 each were offered to the shareholders, *pro rata*, in April last, at £6 and £8 per share respectively. The shares were placed without difficulty, those not taken up by the allottees being largely over-applied for by other shareholders in the Company. On Dec. 31, 1900, the balance of the premiums on shares account stood at £27,440. 2s. 4d. Further premiums to the extent of £43,968 have been received during the half-year, and the directors have availed themselves of the opportunity to write off, at one operation, the whole of the goodwill, which since the formation of the present company has stood at £37,879. 14s. 11d. They have also written off the whole of the patents account, standing

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at £3,335. 15s. 10d., a small balance in the Paris Exhibition account amounting to £171. 18s. 10d., and the expenses of the last issue of shares, £1,028. 17s. 11d., which includes £625 for stamp duty. They have also carried to the reserve fund the sum of £25,000, which has been favourably invested at the low prices recently prevailing, and there still remains a balance of £3,991. 14s. 10d. to carry forward to the next half-year. The directors are glad to say that the Admiralty has ordered another of the new armoured cruisers of 22,000 h.p. (the "Berwick") to be fitted with Niclausse boilers by the Company's licensees, and they look forward with confidence to the time, now fast approaching, when the Company will be able to undertake such work for itself. The use of the Niclausse boilers in foreign navies is rapidly extending, and the directors cannot but believe that its remarkable advantages will be recognised by the British Admiralty when the ships now ordered to be fitted have been tested at sea. The directors regret to announce the loss to the Company of the valuable services of their colleague Lieutenant-General Sir Richard Hieram Sankey, K.C.B., R.E., who resigns his directorship, owing to the pressure of other engagements. To fill the vacancy thus occasioned the directors strongly recommend the election of Mr. Arthur Lazenby, who has been in the service of the Company since 1890. Mr. A. Lazenby has for some years been charged with an important section of the administrative work, and in the opinion of the directors he combines in a marked degree technical and scientific knowledge with a thorough acquaintance with the business of the Company. He is the holder of 1,249 shares in the Company. The directors propose that an agreement be entered into with Mr. A. Lazenby binding him to give his exclusive services to the Company in the same manner as the present managing directors, and they suggest that his remuneration be a fixed salary of £800 per annum, increasing by periodical increments (subject to re-election) to £1,200, together with 3 per cent. of the profits remaining after 7 per cent. has been earned upon the ordinary shares, as set forth in Article 90 of the articles of association.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Rent, rates, and taxes	635	9	2
Interest on debenture stock	2,125	0	0
Salaries, including directors' remuneration	6,929	15	2
Contingent salaries to employés	1,541	17	10
Fire insurance	231	8	2
Fire insurance fund	400	0	0
Legal and professional charges	36	12	4
Advertising	758	9	8
Books, stationery, and printing	1,029	5	10
Postage and telegrams	315	5	3
Travelling, hotel, and general expenses	667	10	7
Auditors' fee and expenses	99	18	1
Company's subscription to sick club, etc.	337	14	0
Subscription to volunteer corps	350	0	0
Depreciation of property and plant and machinery	5,614	4	3
Allowances to reservists' families	44	7	10
Balance carried down	26,677	9	0
	£47,794	7	2
Contingent share of profits to directors	£3,449	18	2
Balance available for dividend or reserve	23,227	10	10
	£26,677	9	0

Cr.	£	s.	d.
Gross profit for the half-year	46,175	19	6
Royalties	400	0	0
Interest on investments, etc.	1,179	11	5
Transfer and registration fees	38	16	3
	£47,794	7	2
Balance, profit (half-year), brought down	£26,677	9	0
	£26,677	9	0

JOHNSON-LUNDELL ELECTRIC TRACTION.

In their first annual report the directors state that the revenue was insufficient to meet all expenses, there being a deficiency of £4,927. 0s. 1d. The cash in hand and at bank amounts to £15,081. 3s. 1d., and £448. 13s. 1d. was owing. The major portion of this sum has now been collected, and the balance is quite good. The calls in arrear amounted to £11,999, which amount has now been reduced, and steps are being taken to collect the residue. Nominally, the Company began its existence on April 17, 1900, but, as a matter of fact, it was not ready for business for many months after. This fact has a very direct bearing upon the apparent inactivity of the Company, hence some explanation becomes necessary. Owing to the development of unexpected complications and consequent delays in the transfer of the patents and the preparation of the numerous papers in connection therewith, and also because of the temporary default of some of the underwriting, several months elapsed before the directors felt themselves to be fully warranted in incurring any material expenditure. It will be recalled that whereas some of the Company's inventions had already been put in marketable form, others had as yet only been incorporated in such experimental form as would suffice to enable experts to pass judgment thereon. It was anticipated that immediate business could be done with the former while the latter was being commercially standardised. Had this foreeast been accurate the Company would long since have been engaged in the work of equipping tramways, etc. Unfortunately, it failed to take into account the difference between English and American engine speeds, and the consequent necessity for restandardising the whole line of generators to conform to English requirements. To facilitate this work of restandardising, Messrs. Holmes and Johnson went to America, and established in New York a drawing office under the personal supervision of Mr. Lundell. At the same time they arranged with the Sprague Electric Company for the manufacture of the several standardised units of apparatus as fast as Mr. Lundell and the drawing office could supply the data therefor. Incidentally an agreement was entered into with the Sprague Company for the temporary supply of apparatus to enable the Company to fulfil any contracts it might enter into, pending the establishment of its own works. The work of standardising having now been completed, the drawing office staff has been transferred to the offices of the Company in London, where it is now engaged on the engineering work essential to the proper and effective conduct of the business. The Company's inventions form three groups: (1) the dynamos, or electric generators; (2) the motors and controllers; (3) the tramway surface-contact system. As to the dynamos, the royalty account, as shown in the balance-sheet, will give evidence that, in spite of the delay caused by restandardising, a fair beginning has been made in the introduction of this apparatus. It is confidently anticipated that here, as in America, these pioneer installations will greatly develop the popularity of this apparatus. The work of standardising the motors and method of control, though much delayed by the unexpected dynamo work, is now practically complete. Sample equipments of two distinct types of motors are now in England and about ready for formal trial, which has been arranged to take place upon the tramways of the Blackburn Corporation in the presence of consulting engineers and tramway authorities. The third and highest development of the Company's type of railway motors is now in process of construction under the supervision of Mr. Lundell in America. The standardising of the numerous details of the surface-contact system was left to be dealt with last. It has, however, now been completed, in so far as it can be in the factory or laboratory, and a special engineer will shortly arrive in England to put the system in practical operation on a commercial scale. Under encouragement from the Continent, Messrs. Holmes and Johnson paid an early visit to France and Germany to determine whether to immediately negotiate for the sale of the Continental patents, or to postpone such negotiations until proof of value had been established by the Company's operations in England. As a result of this visit the Board was satisfied that better terms could be obtained when they were prepared to substantiate their claims by the English operations; subsequently, however, the chairman renewed the negotiations in both France and Germany as regards the dynamos only, effecting in each country an optional agreement determinable by the results obtained from a large dynamo, which each of the option holders are now manufacturing for the purpose of acquiring the essential information at first hand. Looking to the preservation and development of the Company's Continental patents, a comprehensive and systematic programme has just been approved by the Board, and is being put in force. The vacancy on the Board created by the lamented death of Mr. Arthur Laing has been filled by the appointment of Mr. Alexander MacKay. The directors to retire are Messrs. Webb, Johnson, and MacKay, who, being eligible, offer themselves for re-election. The retiring auditors, Messrs. Monkhouse, Stoneham, and Co., also offer themselves for re-election.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Directors' fees	1,526	12	5
Directors' travelling expenses	142	19	3
Salaries	2,419	11	6
Rent	285	10	0
Legal and professional charges	135	6	8
Travelling expenses of directors and agents in connection with sale of patents, manufacturing agreements, etc.	535	16	0
Patent fees	476	7	6
Stationery and books	166	2	0
Advertising	97	14	7
Postages, telegrams, and bank charges	98	3	8
Sundry expenses	178	3	3
	£6,062	6	10

Cr.	£	s.	d.
Royalties	596	16	0
Commission	24	7	6
Interest—balance of account	510	5	6
Transfer fees, etc.	3	17	9
Balance	4,927	0	1
	£6,062	6	10

BRITISH ALUMINIUM.

The report of the directors of this Company for 1900 states that the progress and development of the business has been maintained, and the uses of the metal are gradually extending, though the rate of progress is not such as the directors had anticipated. The factories are working well, and the sales are increasing, but not as yet on so large a scale as in foreign countries. The profits during the last financial year were £3,619 less than the profit made the previous year, the difference being accounted for mostly by the great increase in the price of coal and other materials used at the Larne and Greenock factories. Owing to a clerical error the profit made in 1899 was overstated by £4,620 in the accounts for that year, but this has been taken into consideration in the falling off mentioned above. It will be seen from the carbide account that an extraordinary expenditure of £3,143 has been incurred, arising chiefly from delay in the delivery, starting, and operating the requisite new machinery and furnaces. While the directors consider it would be in order to place a considerable portion of this sum to capital account, they recommend that it be provided for out of the profits of the year, and that the expenses in connection with

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the French Exhibition be treated in the same manner. The directors have also written off considerable sums by way of depreciation and otherwise from various accounts, particulars of which appear in the balance-sheet. Under these circumstances the directors regret that it is impossible to pay any further instalment this year towards the dividend on the 7 per cent. cumulative preference shares. The directors are glad to report that the negotiations which were initiated by this Company some time ago, with a view to bringing about an understanding between all the producers of aluminium in the world for the purpose of the better development of this new industry, have resulted in recent conferences between the parties, and promise a favourable issue. In order to further strengthen the position of the Company, the directors have decided to secure the bauxite deposits in the Var district in the South of France, from which at the present time all the producers of aluminium are being supplied with raw material. The directors have found it necessary to obtain parliamentary sanction for carrying out the water-power works at Loch Leven, and the Bill introduced for that purpose has been passed by both Houses of Parliament and received the Royal assent on the 17th ult. This gives the Company the control of the best and largest known water power in the United Kingdom. In order to meet the capital outlay requisite for the policy indicated above, the directors have decided to issue the remainder of the "A" 6 per cent. cumulative preference shares, and the issue has been already provided for.

PROVISIONAL PATENTS, 1901.

SEPT. 16.

18446. The protected electric wire insulator. William Sykes, Higher Whitehalgh Laugho, near Blackburn.

18483. Improvements in the manufacture of electrical accumulators. Carl Tunstill John Oppermann, 2, Wynyatt-street, Clerkenwell, London.

18502. Improvements in electric arc lamps. René Froment, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Feb. 16, 1901, being date of application in France.) (Complete specification.)

18505. Improvements in central-station apparatus of telephonic installations with parallel branched subscribers' jacks. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien - Gesellschaft, Germany.) (Complete specification.)

SEPT. 17.

18530. Improvements in electric dynamos and motors. Wilfred Robert Vernet Marshall, 121, West George-street, Glasgow.

18531. Improvements in electric dynamos and motors. Wilfred Robert Vernet Marshall, 121, West George-street, Glasgow.

18540. An improvement in enclosed arc lamps. Edward Henry Johnson and Edward Smith Southwell, Victoria Hotel, Wigan.

18545. Improved mode of attaching glass shades to electric light and the like fittings. James Armsby Ellis, 34, Castle-street, Liverpool.

18564. Improvements in manholes and covers used in connection with electric cables and mains. Thomas Henry Firth, 15, St. James's-row, Birmingham.

18569. Improvements in incandescence electric lamps. John Robert Quain, Royal Colonial Institute, Northumberland-avenue, London.

18576. An improved alternating-current electric motor. John Bush and Matthew Thomas Medway, 90, Lausanne-road, Peckham, London.

18577. An improved push-button-controlled electric lift. John Bush and Matthew Thomas Medway, 90, Lausanne-road, Peckham, London.

18578. An electric controlling governor for the prevention of marine engines racing in a storm or heavy sea. John Bush and Matthew Thomas Medway, 90, Lausanne-road, Peckham, London.

18579. An alternating-current brake for electric motors. John Bush and Matthew Thomas Medway, 90, Lausanne-road, Peckham, London.

18597. Improvements in electric regulating apparatus. The General Electric Company (of New York), Bush-lane House, Cannon-street, London. (James A. Foote, United States.) (Complete specification.)

18598. Improvements in alternating-current electric meters. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

18600. Improvements in the treatment or manufacture of paper applicable for use in electric insulation. John Bernard Tayler, 6, Lord-street, Liverpool.

18610. Improvements relating to electric telegraphy. Alexander Muirhead, 323, High Holborn, London.

SEPT. 18.

18622. Improvements in electric clocks. Alexander Eugen Conrady, 104, Park-street, Camden Town, London.

18626. Improvements in trolleys for electric cars and the like. James Linkleter, Tyneside Works, Tynemouth.

18645. Improvements in or applicable to pendants for incandescent electric lamps. William Royston Laidlaw and George Hamer Scholes, 70, Deansgate, Manchester.

18652. Improved means applicable for use in breaking electric arcs. Thorsten von Zweigbergk, Clun House, Surrey-street, Strand, London.

18658. Improved insulators for electric wires. John E. Sharpe, Fife House, Kingston-on-Thames. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 17, 1901, being date of application in United States.)

18682. An improved electromagnetic motor. David Perret, 40, Chancery-lane, London. (Complete specification.)

SEPT. 19.

18691. Improvements in and relating to electric switches. Arthur Denby Smith, Sunbridge-chambers, Bradford.

18732. Improvements in contacts for electric glow lamps. Electric Lighting Boards, Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Armand Lefebre, France.)

18739. Improvements in electric indicating apparatus for telephone and telegraph systems. Arthur Thomas Milnor Thomson and the Thomson-Davis Telephone System, Limited, 22, Southampton-buildings, Chancery-lane, London.

18743. Improvements in electric wires or conductors applicable for use in electric railway or tramway systems and in trolleys or like current collectors therefor. George Allan, 6, Lord-street, Liverpool.

SEPT. 20.

18787. A new or improved electrical hauling apparatus, applicable also to other purposes. Thomas Greensmith, Matthew Brown Wild, and Fred Kidd, 70, Market-street, Manchester. (Complete specification.)

18795. Improvements in electric lighting by low-frequency currents. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Walter C. Fish, United States.) (Complete specification.)

18797. Improvements in trolley-line switches and the methods of operating the same. Philip Henry Dawe, 4, Waldemar road, Wimbledon Park, London.

18830. Automatic electric fire-alarm. Willis J. Brewster, 40, Chancery-lane, London. (Complete specification.)

18831. Improvements in electric telegraphs for use on board ships and for other purposes. Evershed and Vignoles, Limited, and Sydney Evershed, 1, Queen Victoria-street, London.

SEPT. 21.

18879. Improvements in and relating to electric tramways and the like. Albert Neumann Connett, 322, High Holborn, London. (Complete specification.)

18895. Improvements in and relating to switches. Sebastian Ziana de Ferranti, 18, Southampton-buildings, Chancery lane, London.

18898. Improvements in electric current controllers. Thorsten von Zweigbergk, 18, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 12.

1900.

14633. System of electric lighting and apparatus or devices therefor. Lapertot, Villard, and Pignaud.

14841. Means and apparatus for telegraphing and controlling various mechanisms from a distance without wire or other like connections. Armstrong and Orling.

16705. Electromagnetic switches used for electric train control. British Thomson-Houston Company, Limited. (Barry.)

16901. Process and apparatus for the electrolytic decomposition of alkaline salt solutions. De Brito e Cunha.

18296. Electric couplings. Walker.

19058. Electric brake circuits and controllers on electric railway cars. Newell. (Date applied for under International Convention, March 28, 1900.)

19213. Dynamo-electric machines and motors and means for regulating the same. Atkinson.

19371. Switches for starting and stopping electric motors. Norris.

19509. Manufacture and production of solid ends on electrical conductors. McTighe.

19576. Electric switches or contact makers, applicable to order telegraphs, railway signalling apparatus, and the like. D'Arlincourt.

19847. Electric fuses. Peard.

20200. Electrolytic cells. Noble and Merry.

20383. Alternating-current induction motors. Lamme. (Date applied for under International Convention, April 14, 1900.)

20384. Systems of electrical distribution. Lamme. (Date applied for under International Convention, April 14, 1900.)

20576. Apparatus for signalling by wireless telegraphy. Fleming and Marconi's Wireless Telegraphy Company, Limited.

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21252. Means of eliminating and retarding certain electric and other rays for surgical, medical, and other purposes. Johnson.

1901.

14946. Electrolytic apparatus. Haas.

14997. Electric motors. Heany.

15522. System of wireless telegraphy. Feeny. (Allgemeine Electricitäts Gesellschaft.)

16566. Storage battery plates. Davies.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Sept. 14	821	742	+ 79	—	—
Birmingham Tramways	,, 21	4,916	4,632	+ 284	169,811	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 20	570	499	+ 71	18,953	17,100*b*
Blackpool Corporation	,, 19	1,573	1,358	+ 215	31,056	23,438
Blackpool-Fleetwood Tramways	,, 21	1,008	1,045	- 37	16,954	16,875
Bolton Corporation	,, 22	1,502	1,380	+ 122	54,801	44,992*b*
Bradford Corporation	—	—	—	—	—	— *b*
Bristol Tramways Company	,, 20	4,130	3,555	+ 575	—	—
Carlisle Tramways Company	,, 21	130	—	—	2,543*b*	2,461
Central London Railway	—	—	—	—	—	—
City and South London Railway	,, 22	2,040	1,519	+ 521	22,270	18,047
Cork E. T. and L. Company	,, 19	564	477	+ 87	17,849	15,723*b*
Darwen Corporation	,, 20	192	155	+ 37	7,069	5,763
Dover Corporation	,, 21	256	285	- 29	8,400	7,978*b*
Dublin & Lucan Electric Railway	,, 22	99	107	- 8	1,688	1,437
Dublin U. T., electric cars	,, 20	3,686	3,637	+ 49	—	—
Dublin S. District, Electric	,, 20	883	999	- 116	20,736	15,937
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 21	13,958	9,813	+ 4,145	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 21	1,658	1,306	+ 352	—	—
Liverpool Corporation	,, 14	9,649	9,047	+ 602	330,324	287,418*b*
Liverpool Overhead Railway	,, 22	1,565	1,789	- 224	20,531	20,995
Oldham-Ashton-Hyde Tramways	—	—	—	—	—	— *b*
Portsmouth Corporation	,, 21	982	—	—	—	—
Potteries Tramways	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 22	3,687	—	—	—	—
Southampton Corporation	,, 18	999	764	+ 355	—	—
Southport Corporation	—	—	—	—	— *d*	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. *b* From Jan. 1. *d* From April 1. 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £157 decrease.
Barcelona Ensanche y Gracia, £51 decrease. Barcelona, £154 increase.
Brisbane, £419 decrease.
Buenos Ayres and Belgrano Electric, £603 increase.
Calcutta, £134 increase.
Cape Town (month of Aug.), receipts, £14,799; expenditure, £7,009.
Manchester Corporation (Sept. 21), £2,127.
Mexico Electric (month of Aug.), receipts, £17,900; expenditure, £10,800.
Perth Electric, £229 increase.
Port Elizabeth (month of Aug.), receipts, £3,151; expenditure, £1,844.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅝-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	9 16-11/16
—— Ordinary, 1-125,000	1 ..	⅜-½
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6¾
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4¾-5½
Brush Electrical Engineering, Ordinary	2 ..	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2½
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	110-114
—— Ordinary	5 ..	15-16
—— 5 per cent. Pref.	5 ..	5¾-6½
Crompton and Co.	3 ..	3½-3¾
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	1-1½
—— 5 per cent. Debentures	5 ..	1½-2½
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	85-90
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10½
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16½-17½
—— 4½ per cent. Preference	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10 ..	22-23
—— 4 per cent. Debentures	100 ..	101-104
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref.	5 ..	5¾-6¼
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-100
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	7⅞-8½
—— 7 per cent. Preference	5 ..	8½-8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7¼-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10½ xd
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5½-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105
Chelsea Electricity Supply	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	11½-12½
—— 5 per cent. Debenture Stock	100 ..	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-103
County of London and Brush Provincial, Ordinary	10 ..	8-9
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	103-106
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¾-6¼
—— 6 per cent. Cum. Pref.	5 ..	5½-6
—— 4½ per cent. First Mort. Deb.	100 ..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7¼-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1½
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-114
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15¼-16½
Oriental, 1879	1 ..	1¼-1½
—— £5 Shares	5 ..	7½-8¼
—— £4½ Shares, New	4½ ..	7-7½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5¼-5½
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	8¼-9½
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	12-13
Electric Railways.—		
Central London, Ordinary	100 ..	102-105
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	98-101
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	51-54
—— Ordinary	10 ..	5-5¼
—— 4 per cent. Debenture Stock	100 ..	113-118
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4¼-4¾
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-128
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6-6¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	101-103 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14-15
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11¾-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	123-126
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¾-2
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5¾
—— 5 per cent. Deb. Stock, Red.	100 ..	104-107
—— Prov. Cert., all paid	100 ..	98-101
Cape Electric Tramways, Nos. 1-400,000	1 ..	1¾-2¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5¼-5¾
—— 4 per cent. 1st Mortgage Debentures	100 ..	103-106
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	105-107
New General Traction, Ordinary	5 ..	3-3½
—— 6 per cent. Cum. Pref.	10 ..	4½-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11½-12¼
Potteries Electric Traction, Ordinary, 25,667-40,000	10 ..	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-10¼
—— 4½ per cent. Debenture Stock	100 ..	105-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8a. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	3¾-4
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅜-4½
—— 4 per cent. Deb. Stock, Red.	100 ..	95-98
—— 3½ per cent. Deb. Stock, Red.	100 ..	95-98
Oriental Telephone and Electric Company	1 ..	¾-1

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NOTES.

Special Lectures at Finsbury.—We beg to draw attention to the short special course of lectures, of which a notice appears in our advertising columns, on "Insulation and Insulating Materials," which will be delivered by Mr. Mervyn O'Gorman, M.I.E.E., at the Technical College, Finsbury, on Thursday evenings. The first of the six lectures will be given on Oct. 10.

British Fire Prevention Committee.—A large silver portrait medal accorded by her Majesty the German Empress in connection with the Fire Congress of June last has been presented to the Executive of the British Fire Prevention Committee as a mark of appreciation for the services rendered by that body in the demonstration of scientific and economic aspects of fire protection.

Post Office Telephone Delay.—We understand that the inauguration of the new Post Office telephone service in London is likely to be delayed. It was promised that the City exchange would be in operation early this month, but it is now reported that another month at least must elapse before this is possible. As regards rates of subscription, these also are not likely to be announced before the end of the present month.

Yorkshire College.—Several extensions and improvements have been effected at this college since last session, the most important of which is a new building to provide additional accommodation for the electrical engineering department. This has been necessitated by the large increase in the number of students in electrical engineering; and in order that the work of the department might continue as successful as ever, a one-storey building consisting of an electro-motor room, an electrical cable-jointing room and, a workshop has been erected and brought into use. A large amount of electrical engineering plant of the latest design has also been added to the equipment of the department. The college was reopened on Wednesday last for its twenty-eighth session.

Theory of Electrolytic Dissociation.—In a recent paper under this title, Mr. Louis Kahlenberg adversely criticised Arrhenius' electrolytic dissociation theory and its applications. We take the following short abstract of the paper from the current number of the *Journal* of the Chemical Society: "Cryoscopic and ebullioscopic determinations have been made with a large number of salts in aqueous solution over a wide range of concentration; further, conductivity determinations have been made with the same solutions at 0deg. and 95deg. On the basis of this experimental material, it is maintained that there is no such connection between the freezing points and boiling points of solutions on the one hand, and their electrical conductivity on the other, as is claimed by Arrhenius' theory; in numerous cases, there is not even a qualitative agreement. The author examines a number of problems on which the theory has been brought to bear, and contends that, whilst it has stimulated research on many lines, it is quite inadequate as a key to the phenomena of solution"

Electrochemical Behaviour of Acetylene.—A paper by Mr. Alfred Coehn on this subject is abstracted in the current number of the *Journal* of the Chemical Society, as follows: "The discharge potential of oxygen from a solution of potassium hydroxide is depressed, when acetylene is passed through the solution, from about 1·7 to 1·2 volts. The chemical reaction of which this depression is an indication is the oxidation of acetylene to formic acid, which takes place quantitatively when the E.M.F. employed lies between the above limits. In solutions of sulphuric acid, the presence of acetylene diminishes the anodic polarisation by about 0·19 volt. The chemical change in this case is the oxidation of acetaldehyde (formed by the action of acetylene on sulphuric acid) to acetic acid. The current efficiency is 100 per cent. when the E.M.F used is less than that required for the liberation of oxygen. In acid solutions acetylene does not act as a depolariser for the halogens except in the presence of a carrier, such as phosphorous tribromide, when a considerable depolarisation occurs."

Electro-Harmonic Society.—The sixteenth session of this popular society opens on Friday night, the 11th inst., with a smoking concert at St. James's Hall. We are pleased to hear that during the past few weeks the secretary (Mr. W. E. Lane) has received some 35 nominations for new members, and the society now numbers over 350 members. The programme of the opening concert next Friday, which, by the way, will be given in the banqueting hall, is an exceptionally good one, and some very enjoyable instrumental music may be expected from the orchestra, which has heretofore proved always very popular at these concerts. As at present arranged the following items will be included in the programme: Vocal—Mr. Harry Stubbs, "Nirvana" (S. Adams), "The Bay of Biscay" (Davy); Mr. Bantock Pierpoint, "Gazing Around" ("Tannhauser") (Wagner), "Jess Macfarlane" (old Scotch). Instrumental—T. E. Gatehouse (violin) "Elegie" (Ernst), "Scenes de la Czarda" (Hubay); the orchestra will play selections at intervals. Miscellaneous — Mr. Alexander Watson (recitations), "Gunga Din" (Kipling), "An Irish Cricket Match" (Anon.); Mr. John Warren, prestidigitateur and ventriloquist; Mr. Tom Clare, humorous sketches. Five other concerts will be given this season, including two ladies' nights. Notwithstanding the increase in the membership of the society since last season, it is hoped that the numbers may be considerably augmented in the next month or so.

Luminous and Vibrating Electrical Effects.—Mr. M. D. Legreans, of Paris, recently conducted a series of experiments relating to the vibrations and luminous effects produced in metallic wires by a Wimshurst machine. His results are interesting. If one pole of the machine is connected to a wire stretched, insulated, and contained in a tube, the other pole of the machine being connected to earth, the wire is seen to make transverse vibrations. If the vibrating wire is observed in the dark, alternately luminous and obscure portions are seen. When the wire is attached to the positive pole of the machine, the phenomenon takes the form of brilliant and equidistant lines, which are wider at the middle of the wire and thinner at the ends. In the case of the negative pole, a series of equidistant luminous points is seen all along the wire. The experiment was made with a glass tube 8ft. long and 2·4in. in diameter, and a wire gauging 0·1in. If two wires of the same length are stretched parallel and connected with the two poles of the machine (the outer ends being electrically free), the wires enter into vibration. In the dark a series of equidistant luminous points are seen on the negative wire, while on the positive is a series of luminous lines whose centres correspond to the luminous points of the first wire. The experiment is very brilliant if the two wires are fused in the ends of a glass tube, and the luminous lines and points appear very regular. If the wires are close enough together, only one of them need be attached to the machine, the second being connected to earth, thus giving a condenser effect.

Transmission of Heat Through Water Vapour.—In the discussion which was elicited at the recent convention of the British Association by the paper of Messrs. Chas. F. Brush and Edward W. Morley, on a new gas

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whose power of transmitting heat is vastly greater than that of hydrogen, Sir William Crookes suggested that the observed phenomena might perhaps be due to water vapour, and described experiments which seemed to show that, at high vacua, water-gas is a better conductor of heat than either air or hydrogen at similar pressures. Being able now to measure small pressures directly, he said we have determined the rate of transmission of heat through water vapour at pressures from that of saturation at 0deg. to less than a millionth of an atmosphere. The three gauges described before have been used in three series of experiments with three different apparatus. At low pressures water vapour transmits heat more rapidly than air, but not so rapidly as hydrogen. The superiority over air is a maximum at 20 or 30 millionths of an atmosphere, and is not far from 30 per cent. At 60 or 80 millionths, air and water vapour transmit heat at the same rate; at higher pressures water vapour transmits heat less rapidly than air at the same pressures. Statements more precise than these cannot now be made, because the form and dimensions of the apparatus used modify slightly the curves which represent the relations between pressure and rate of transmitting heat, and the place of intersection of the curves is therefore uncertain.

Inductor Furnace.—Mr. Fredrik Adolf Kjellin, the Swedish engineer, has been granted a patent in the United States for an electric furnace in which the various materials may be melted by currents of electricity induced within them. From a note in the *Electrical World* of New York we gather that the construction of the furnace is extremely simple, the charge (which must be a conductor of electricity) being so packed within an annular groove in a body of refractory material as to form a closed circuit, which constitutes the secondary of a step-down transformer whose primary—a cored coil of insulated wire—is placed within the annulus and connected to a source of alternating current. In operation the current induced in the charge is found sufficient for such metallurgical operations as admit of a closed metallic circuit within the annular furnace chamber. The furnace would seem to be especially adapted for the melting of platinum and other metals which, particularly at high temperatures, possess such power of occluding hydrogen and other gases as to render it extremely difficult to obtain perfect castings by the use of the oxyhydrogen flame or similar combustion methods. A furnace of the same general type has been heretofore patented in America and abroad by Edward A. Colby, and in this country by De Ferranti. Kjellin's construction differs from these in that compactness and an increased efficiency are gained by placing the primary within the secondary, and thus, for a furnace of given size, very materially reducing the space between these elements.

Chambly-Montreal Transmission.—We notice in the New York *Electrical Review* for the 14th ult. a lengthy illustrated description of the Chambly-Montreal transmission power-plant, which supplies a considerable portion of the light and motive power used in Montreal, from the falls on the Richelieu river at Chambly, Quebec. It is, however, the transmission line itself which calls for attention, as possessing some exceedingly novel features. Notwithstanding that the large total of 6,000-h.p. in motors is operated upon the secondary distributing system in Montreal, the power factor of the load has been held so nearly unity as practically to cause no trouble of any kind, and the full output of the plant has been made available without extra cost. This has been accomplished by the use of synchronous motors at the substation operated directly by the incoming line current. These machines are used to drive street lighting plant and for working other machinery during the day. Running light with over-excited fields, they compound out the induction factor of the line, and bring up the power factor of the system to almost unity. The power factor, in fact, is kept normally as high as 96 per cent., the men at the switchboard having become very expert in regulating the field excitation of the balancing machines in order to bring about the desired result In the daytime one 750-kw. synchronous motor is ordinarily used for this purpose. In its protection from lightning the transmission line is of particular interest. For two summers now barbed wire has been the only protection which the line has possessed, all other forms of lightning protection having been discarded in its favour. It has gone through severe thunderstorms without the slightest trouble, whereas the lightning arrester as ordinarily constructed had failed to give anything like such satisfactory results. The point is of considerable interest to those who have to maintain long-distance high-tension transmission lines, although, of course, the lightning arrester has its field The experience of the Chambly-Montreal line, however, would seem to show that the barbed wire protection is perhaps the best against lightning yet discovered for a cross-country line.

Electrolytic Generator.—Having regard to the growing demand for an electric generator of relatively low voltage but of large current output, a short description of a new generator which has been designed with these objects in view will not be out of place in these columns. We find in the *Electrical World* of New York for the 21st ult. an illustration of one of a pair of electric generators built especially for refining purposes for use at the copper mines of the Imperial Ore Reduction Company, of Boston. The machine in question has a capacity of 3,000 amperes at an E.M.F. of from four to eight volts. The first problem to be solved in designing machines of this nature is to prevent abnormal losses due to the heating effect of the current, while a second is the commutation of the enormous quantity of current. By careful attention to ventilation and generous allowances in point of copper and iron, the first difficulty mentioned is claimed to have been solved in the machine illustrated. The second problem has been overcome by the use of a double armature winding with two commutators and a special conformation of field. The field ring is of cast iron, and the poles, eight in number, are of wrought iron, cast-welded into the ring, making an excellent form of magnetic joint. The poles are fitted with a special form of shoe of cast iron selected on account of its low permeability. It is saturated at the normal induction of the field, and so helps to prevent the field flux from becoming distorted by cross-magnetisation in the armature. The armature core is relatively of quite a large diameter, and is built up of thin discs of soft steel, painted on either side to break up eddy currents. Air ducts are provided in the core, and the air being drawn into the body of the core and thrown centrifugally through the ducts and windings serves to keep the armature cool, notwithstanding the great quantity of current flowing. The cylindrical form of winding is used, making the armature resistance low, and permitting of the replacing of a damaged coil without much difficulty. The machine is separately excited at 110 volts, and owing to the special shape of the pole-shoes is able to deliver any load from 0 to 3,000 amperes without its being necessary to change the position of the brushes, the diameter of commutation remaining practically fixed for these ranges of load. The two machines which have been constructed especially for copper refining purposes will be connected in such a way that they may work separately or in multiple, giving

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a total output of 6,000 amperes at an E.M.F. of from four to eight volts.

Electricity in New Zealand.—Electricity is literally forging ahead in New Zealand. There is every likelihood that within the next three or four years a sum of probably over a million sterling will be expended upon or in connection with electrical schemes. To mention only a few places—Auckland, Napier, Wellington, Christchurch, and Dunedin are all committed to expensive works, either of electric lighting or electric traction, or both. From what we read in the *New Zealand Mining and Engineering Journal*, we gather that the question at present being debated in the Colony is as to the advisability of co-operating in the expense of getting expert advice upon electric traction and lighting. It is urged that local advice has disqualifications, which, however, do not apply to a highly-qualified visiting expert, who, with the facts placed before him, would be able to advise on the several schemes in contemplation. With regard to individual schemes, we find that the people of Dunedin are not yet convinced that the water scheme is the best and cheapest for providing the city with electric power. In this particular case there must be a very considerable initial expenditure owing to the nature of the water power it is proposed to harness. Again, 15 miles of line would have to be erected and maintained, and under these circumstances it is a question at Dunedin whether or not it would be cheaper to put down a steam plant for generating electrical energy. In the town of Lawrence the relative advantages of gas and electricity as an illuminant are being considered. A short while ago a proposal was brought before the Borough Council for the establishment of a water gas installation in the town. Very wisely, the Council refused to adopt any such scheme, it being pointed out that it had been decided to adopt a system of electric lighting for the borough, and that all the initial steps had been taken. At Waiha, also, a similar state of things exists, except that the corporation are not, as yet, committed to an electric lighting scheme. It is, however, on the *tapis*, and in view of the marked preference which the burgesses have shown for electric lighting, a proposal to erect gasworks and light the town by gas has fallen through. We have referred from time to time in these columns to other electric lighting and traction schemes in several of the more important towns of New Zealand, and these we are pleased to note, though still in their initial stages, are progressing rapidly.

Foreign Experience.—It is always exceedingly difficult to correctly judge of the real state of progress of any industry in two rival countries. Owing to the great difference in local conditions, it is sometimes very easy to draw erroneous conclusions. For instance, many people suppose in this country that we are greatly behind the United States in the matter of electric lighting. Our special correspondent, who has recently been to America in order to attend the congress organised by the American Institute of Electrical Engineers, informed our readers in an article last week that this was far from being the case. From other independent sources we have the same story, that while our American cousins are extremely eager to get large schemes through, the actual state of the electrical lighting works in the bulk of the American towns is such as would be considered disgraceful in this country. A perusal of the editorial columns of our contemporary, the *Electrical World* for Sept. 21, also discloses evidence of this, and of the difficulty of correctly judging between two rival countries. The first editorial note we refer to is on switchboard manufacture in England, and we are told that because the switchboard for the new Manchester electric lighting station is being constructed by a German firm, English manufacturers of switchboards must be in a bad way. Our verdict on the matter is that it is because the German electrical manufacturers are in such a bad way that the Manchester switchboard is being supplied by them. In fact, the German firms are now taking work greatly under cost price in order to keep their manufactories going and in order to, if possible, build up export departments. We are quite sure that the same thing would be found in the States were it not for the fact that the heavy protective duties render the American manufacturers practically safe from foreign competition. To paraphrase our contemporary, "The United States with their 3,000 central stations and 1,000 electric railways would find English manufacturers and also firms on the Continent supplying them with more economical plant than they are using at present were it not for the fact that the United States Government still treats the electrical industries of its country as infants in arms." The other note to which we refer deals with 200-volt incandescent lamps, and we find that the editor of the leading electrical paper in the States is still debating as to whether or no these should be introduced, although the question has been thrashed out and settled in this country for years. If the incandescent lamp manufacturers in the United States had been forced to supply high-voltage lamps, as our manufacturers have been there need not have been such a long delay in turning out these accessories, which so greatly extend the range of direct current lighting by means of the three-wire system.

The Economic Effect of the Tramway Act.—Mr. E. F. Vesey Knox, M.A., who has gained large experience at the Parliamentary bar in the working of the Tramways Act of 1870, contributed a most interesting paper to this year's meeting of the British Association at Glasgow on the "Economic Effect" of the Act. It has now been in operation for 31 years, and Mr. Knox describes it as a "disastrous legislative experiment." This view is not the result of opposition to municipal trading, nor based on any idea that municipal ownership of tramways is an economic mistake. The object of the Act was to facilitate tramways by substituting provisional order for Bill. It was, however, hedged round with restrictions. The essence of the departmental method is that the inspector who holds the local enquiry (if any) has no authority to decide. The Board of Trade have failed to obtain any respect for decisions in really contested cases. In such cases the practice of promoters is now to go to Parliament direct. As regards the want of compulsory powers for the taking of land, English roads are seldom suited for tramways without alteration, yet the tramway order may not authorise the taking of land for road widening. The frontagers' veto, by which frontagers in narrow places can prevent tramways by a mere mechanical veto, has led to single lines and other bad tramway practice. The veto of the local authorities has sometimes been abused, and has tended to discourage the best schemes and the soundest promoters. It is not, however, likely that an objection by a local authority based on reasonable grounds would ever be overruled. Referring to the purchase clause, the really debatable matters now are the period and the method of valuation, it being hopeless at this time to contend that there should be no power of purchase. What the promoters have done, however, is "to try to take their profit through inflating the capital and clear out"; hence abortive schemes and disappointed investors, and the ultimate result that the best class of investors have been discouraged by the Tramways Act, and the cost of capital for tramway enterprise has consequently been increased. The great discovery of the application of electricity to tramways came just when the purchase periods in England were running out. There was

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consequently a long delay in adopting the new invention, and though England ought, but for Parliament, to have led the world, as it did in railway construction, it has been kept behind other countries, and has suffered social, economic, and industrial loss. There is no other country which had so great a need for electric tramways as England. One reason for our present position is that the corporations have been slow to try experiments owing to their careful trusteeship of the ratepayers' money. The method of valuation is more important than the period of purchase. If goodwill is not to be paid for there is no adequate motive for developing a business. It pays the company better, when the purchase period is approaching, to retain an obsolete equipment, which ought to be scrapped, so as to make the corporation buy it. The author's conclusion is that while practically no tramways are now made by companies on Tramways Act terms without modification, the retention of the Act on the statute-book still does a great deal of injury to tramway enterprise.

Coherer Effects.—Among the many instructive contributions to the list of papers read in Section A of the recent convention of the British Association was one by Prof. Jagadis C. Bose, M.A., D.Sc., on the change of conductivity of metallic particles under cyclic electromotive variation. The following abstract of Prof. Bose's paper will doubtless be read with interest: "Under the action of electric radiation, the conductivity of metallic particles exhibits variation. In the positive class, like iron, there is an increase, and in the negative, like K, etc., a diminution, of conductivity. Each class again falls into two sub-classes (*a*) sensitive substances which undergo self-recovery, and (*b*) sensitive substances which do not. In the case of self-recovering substances, the conductivity distortion varies with the intensity of radiation. Under the continued action of radiation, the distortion attains a maximum, balanced by force of restitution, and on the cessation of radiation there is an elastic self-recovery. The three classes of substances—positive, negative, and neutral—may be distinguished by their peculiar characteristic curves. The change produced in the sensitive substance by the action of radiation is not, normally speaking, chemical. The conductivity change is produced, not only by very rapid, but also by comparatively slow electric variation. Generally speaking, all the conductivity variation effects produced by electric radiation can be reproduced by comparatively slow cyclic electromotive variation. These conductivity changes under cyclic electromotive variation may be continuously recorded by means of the conductivity curvograph. Electric conduction in metallic particles sensitive to electric radiation does not obey Ohm's law. The conductivity is not constant and independent of the E.M.F., but varies with it. In the positive class the characteristic curve—in which the ordinates represent the currents and the abscissæ the E.M.F.—is concave to the axis of the current. The conductivity increases *continuously* with increasing E.M.F. The variation of conductivity in the lower portion of the curve is small, but increases with great rapidity in the upper portion. The curve obtained with strong is steeper than that with feeble initial current. There is found, especially when the initial current is feeble, a critical E.M.F., at which the conductivity change becomes so rapid as to produce an almost abrupt bend in the curve. Stronger initial current appears not only to lower the critical point, but also to mitigate the abruptness of this change The effect of E.M.F. in modifying the conductivity of the conducting layer is well seen in self-recovering substances. There is a definite conductivity corresponding to a definite E.M.F. As the E.M.F. is increased, the sensitive molecular layer is strained, and a definite increase of conductivity produced. When the increased stress is removed, the corresponding strain also disappears, and there is an elastic recovery to its former molecular and conductive state. Hence, when it is carried through a complete cycle of electromotive variation, with moderate speed, the forward and return curves coincide, and the substance remains, at the end of the cycle, in its original molecular condition. This is the case where there is complete recovery on the removal of the stress. With non-recovering substances we find an outstanding residual effect. In a curve taken with cyclic electromotive variation, the forward and return curves do not coincide, but enclose an area. There is a hysteresis. The larger the range of the electromotive variation the greater is the area enclosed. There is a residual conductivity variation at the end of the cycle, which may be dissipated by variation."

Mr. Yerkes and the Metropolitan Railway.—The directors of the Metropolitan Railway Company, through the medium of the daily Press, indignantly repudiate the action attributed to them by Mr. Yerkes of delaying the plans for the electrical equipment of the Inner Circle. Speaking on behalf of his Board, the secretary, in his communication to the Press, emphatically states that "there are no grounds whatever for the charge," and gives as the chief reason for the delay in the promised reference to the Board of Trade the recent visit of Mr. Yerkes to Budapest to see the Ganz system in actual operation. It is asserted that Mr. Yerkes at this time quite misled Messrs. Ganz, and delayed them in their preparations for the enquiry. It was not until the first week in September that he definitely stated to them that he would not have anything to do with the Ganz system. The Metropolitan Company, however, think that "reasonable time" should be allowed to Messrs. Ganz to present a complete case to the tribunal which will be appointed by the Board of Trade to settle the question. After stating that the Metropolitan Company are already at work with the preparations for their power station, the secretary writes: "There was not the least necessity for Mr. Yerkes to rush into print in the way he has done, with the object apparently of seeking to prejudice the case of the Metropolitan Company in a purely judicial proceeding whilst the case is *sub judice*. My Board are of the opinion that these tactics will not commend themselves to fair-minded people"; and again, "Had not Mr. Yerkes appeared on the scene the work of substituting electricity for steam traction upon the Underground railways would by this time have made considerable progress." The secretary closes with a eulogy of the action of his Board, who "have no other object than to obtain the most efficient and ecomical system which recent advances in electrical science have placed at their command, and immediately the decision of the Board of Trade is announced they will carry out the work with all possible dispatch." Mr. Yerkes has replied on the several points raised in the above communication in a letter to the *Times*, reiterating his declaration that the Metropolitan Company are delaying the plans for electrifying the Underground railways. After his return from Budapest the Board of Trade appointed an arbitrator, but, says Mr. Yerkes, "this was no sooner done than the Metropolitan Company sent a communication in which they ask that the matter be further postponed, stating that Ganz and Co. could not have their witnesses ready until Nov. 15." Further on Mr. Yerkes pertinently points out that when Messrs. Ganz made their tender many months ago they must certainly have been aware of what they were going to furnish. He proceeds: "Taking a business view of it, there is no reason why the Ganz people should not have been ready to go ahead immediately and at that time, and

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I defy the Metropolitan people to show one instance of where they have, by their acts, displayed a desire to get to work at the electrification of the road, or to make any progress." Mr. Yerkes also denies that he ever expressed himself as being satisfied with the Ganz system. He adds in conclusion that "if the Metropolitan people really mean what they say, that they are quite desirous to have the arbitration committee decide this matter at once, all they have to do is to join with the District people in an earnest desire to have this done." We agree with Mr. Yerkes that quarrelling over the matter will not build railways, and it is to be sincerely hoped that instead of writing letters to the Press and wasting valuable time the two companies will see their way to proceed with the arbitration with the utmost dispatch. It is announced that Mr. Alfred Lyttleton, M.P., a barrister of the Inner Temple, has been appointed by the Board of Trade to be arbitrator in the above dispute. The first meeting before the arbitrator will, we understand, take place on Monday next, when it is more than probable that the inquiry will be adjourned for at least a month.

Induction Motors for Electric Railways.—In continuation of our note under this head last week, we have now before us an abstract of Mr. Ernst J. Berg's paper on "Electric Railway Apparatus," to which we referred as having been read this year before the Buffalo Convention organised by the American Institute of Electrical Engineers. Mr. Berg, we find, brings out some very interesting points in regard to the latest practice in the design and operation of apparatus employed in electric railway work. The greater part of the paper, however, deals with the induction motor. Alternating-current railway motors are of the polyphase induction type, and therefore their characteristics are essentially those of direct-current shunt motors—that is, they run efficiently only at one speed, whereas the direct-current series motor will operate at high efficiency over a considerable range of speed. With the same mechanical clearance in the two types of motors, the amount of wattless current taken by the induction motor would be quite prohibitive, and therefore these must be made with decidedly smaller air-gap than direct-current motors. With the known methods of insulation, and with the limited space available for railway motors, it seems that it is almost out of the question to consider a design at higher potential than 3,000 volts. Even with the smallest safe air-gap, this will give a power factor of at the most 85 or 88 per cent. at full load under the best conditions, which with an efficiency of, say, 86 per cent., including gear loss, gives an apparent efficiency of at the most 77 per cent. This means that the volt-ampere output of the motor would be about 30 per cent. greater than that corresponding to the work done, whereas with the direct-current motor the power input would probably not be more than 12 or 15 per cent. greater than that corresponding to the work done. It follows, therefore, that the copper losses in an alternating-current motor will be decidedly greater than in a direct-current motor. Another source of increased heating of the induction motor is the core loss in the field, which is greater than the core loss in the armature of the direct-current motor at maximum speed. This increased heating involves the use of a much larger machine than the direct-current motor, which increases the cost and weight of the equipment. To illustrate this somewhat more concisely, consider the losses occurring in a couple of motors of direct and alternating current type while accelerating from standstill up to full speed. The core loss and eddy losses in the direct-current motor are zero at standstill, and increase to a certain maximum at full speed. In the alternating-current motor at standstill even under favourable conditions, the core loss in the field is the same as the maximum core loss in the armature of the direct-current machine, and the core loss in the armature at standstill about the same as in the field. At full speed the core loss in the field still remains the same, but the core loss in the armature is zero, and therefore, roughly speaking, the core loss of the direct-current motor is in the neighbourhood of half of the core loss at maximum speed while accelerating, and is 1½ times as much in the alternating-current motor. Adding to this core loss the greater copper loss due to the larger power input of the motor, it is shown from actual calculations that the alternating-current motors of good design will have in the neighbourhood of four times as much loss as the direct-current motors when operating over relatively short lines as would be the case in rapid-transit systems. The author gives further examples illustrating more fully the characteristics of the two types of motors. But to sum up his results: It is found from the various methods of running trains, first, that under apparently the most favourable as well as average conditions, the most economical alternating-current system will take 26 per cent. more power, and 2·2 times as many volt-amperes as the direct-current system. Second, that the concatenated control takes 26 per cent. less power, but only 10 per cent. more apparent power than the alternating-current system with rheostatic control. It must, however, be borne in mind that these values refer to power input at the motors, not the relations at the sub-stations and power-house as will be seen later. Mr. Berg's comparative figures as to expenses of installation and amount of power required are worthy of special note, and we give them in full as follows: "A" represents continuous-currrent motors with series-parallel control; "B" alternating-current motors with rheostatic current; and "C" alternating-current motors with concatenated control. The conditions are the same in all three cases, and need therefore not be detailed.

	A.	B.	C.
Power-house steam equipment.	£96,000	£120,000	£105,000
„ electrical „	33,200	46,800	52,000
Rotary converter station	62,400	—	—
Transformers	—	10,100	11,500
17 locomotives, complete	45,000	64,400	64,400
68 passenger coaches	61,200	61,200	61,200
Cables, duplicate	31,400	34,400	73,200
Trolley and feeder copper ...	9,800	6,200	6,200
Track construction	21,800	21,800	21,800
Trolley construction.....	4,680	6,240	6,240
Total cost	£365,480	£204,340	£244,540
Average kw. power requred ...	3,650	5,600	4,170
Average kw. loss.....	600	440	380
Per cent. loss	16·4	7·8	9·1
Percentage of d.-c. power	100	153	114
Percentage loss of d.-c. installation	100	100	107

It is thus apparent in this particular instance, which is fairly representative for heavy urban work, that the direct current system offers decided advantages in economy if installed at the same price as the alternating-current system, and that the same economy cannot be obtained with alternating current, no matter at what cost: furthermore, that the alternating-current system with concatenated control is preferable to that with rheostatic control. In conclusion, Mr. Berg considers that owing to the favorable characteristics of the direct-current railway motor and the rotary converters, compared with the alternating-current motor for this class of work, very few propositions warrant the use of the alternating current throughout. While there is undoubtedly a field for alternating-current motors, it is strictly limited to long distance schemes with very few stops, or to mountain railways.

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CROYDON ELECTRIC TRAMWAYS.

On Thursday of last week the electric tramways of Croydon were officially opened in the presence of a distinguished gathering, among the guests being the Right Hon. C. T. Ritchie, M.P. The Croydon tramways have not had a happy past, perhaps because they have not been able to earn sufficient profit to keep the company controlling them in a position to make the required improvements from time to time. There have also been certain proceedings of the company and its officials which have resulted in legal actions being taken against them.

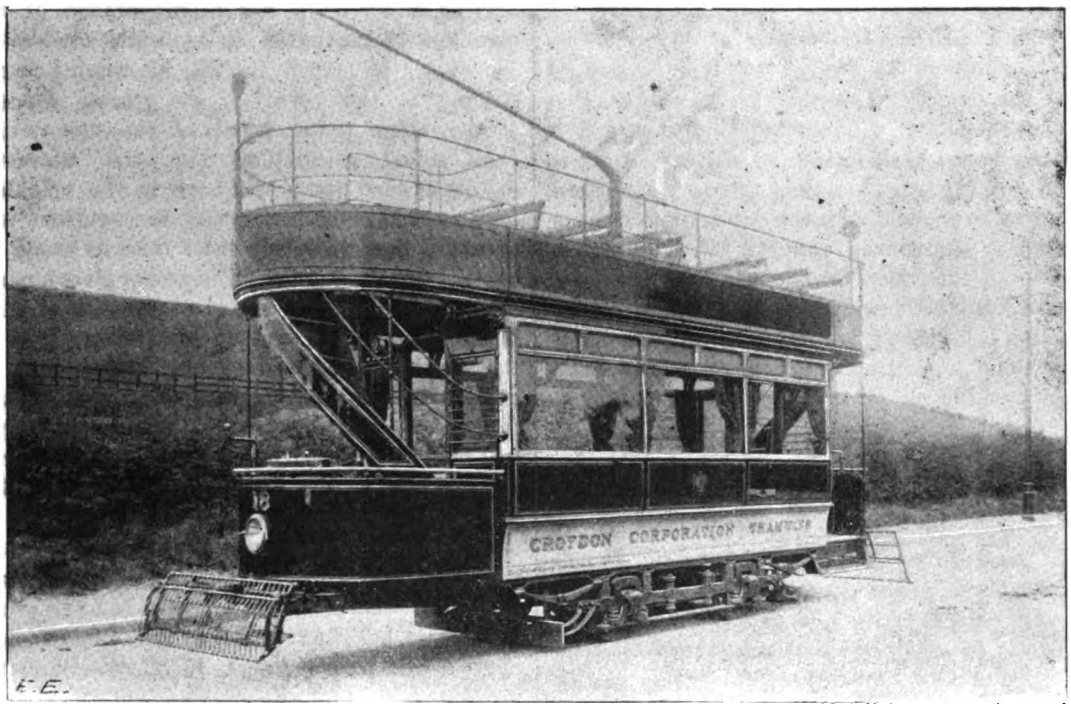

FIG. 1.—A Croydon Tramcar, showing Life Guards.

It would not, however, serve any useful purpose to go into the stormy past beyond recording the outcome that in January of last year the whole of the undertaking of the Croydon Tramway Company was transferred to the Corporation. It was then decided to equip the line electrically, and Mr. E. W. Monkhouse, of the firm of Burstall and Monkhouse, was retained to advise the Corporation as to the best system of electric traction, and also to supervise the carrying out of the scheme selected. The overhead trolley system was eventually decided upon, most of the work being carried out with the side pole construction. The estimated cost of the work without generating plant was in round figures £175,000, but we do not know what the actual expenditure has been. The Corporation of Croydon also obtained from Parliament in 1899 a Bill which enabled them to reconstruct the tramways, and also gave them the requisite authority to work the same when reconstructed. This latter provision is not being put in force at the present time. The Corporation have instead leased the tramways for a period of 21 years to the British Electric Traction Company. The lease would seem to be an exceedingly favourable one to the Corporation. Under it the British Electric Traction Company have to pay the Corporation

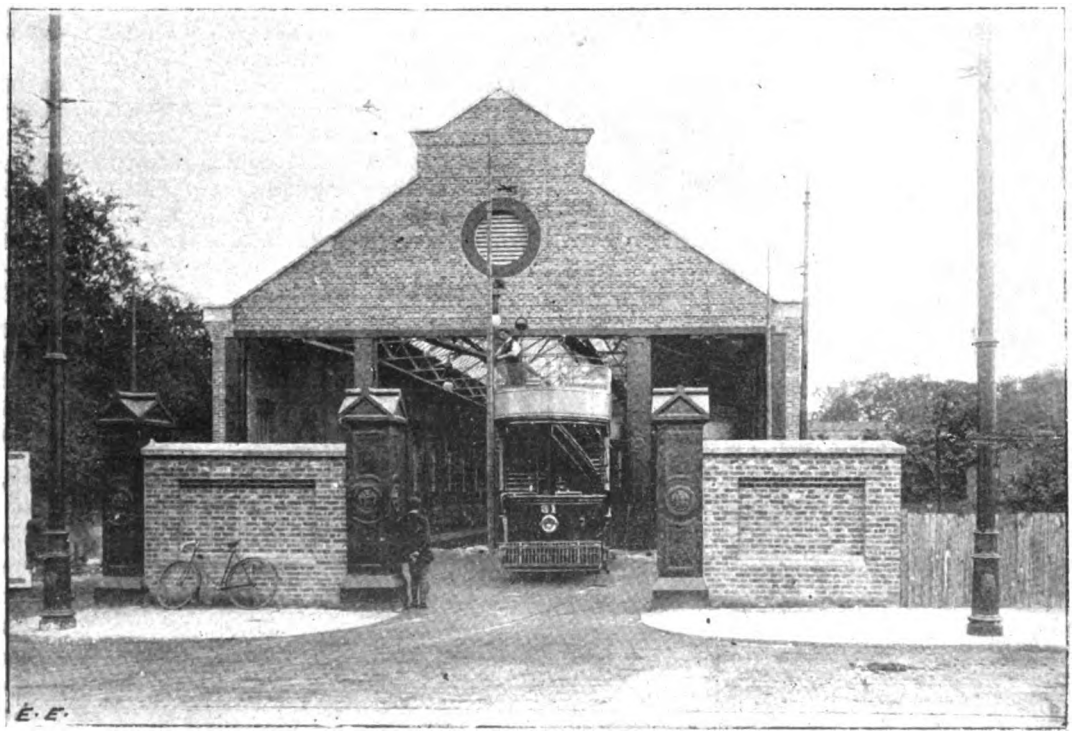

FIG. 2.—The Car Shed on the Purley Road.

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6 per cent. per annum on the total capital expenditure on the electric tramways. They have also to pay £100 per annum for every mile of track for upkeep. Besides this, the company has to take all the electrical energy required for the tramways from the Corporation, paying at the rate of 2½d. per unit The Corporation under the lease has the right to take over the working of the tramways at the expiration of any period of five years without giving any compensation to the company.

We do not propose at the present time to give a full detailed description of the equipment of these tramways It will interest our readers, however, to have a brief *résumé* of the essential points of the system. The following are the routes which are now open for electric traction. The main line is from Norbury railway station on the north to the southern boundary of the borough at Purley, about 5¾ miles. The branch lines are respectively from Thornton Heath pond to Thornton Heath, about a mile and a quarter; from the junction of Oakfield-road with London-road, *viâ* Oakfield-road, St. James'-road, Whitehorse-road, Northcote-road, Selhurst-road, to South Norwood, about two miles and an eighth; from the junction of George-street and High-street, *viâ* George-street, Cherry Orchard-road, and Addiscombe-road, to Addiscombe, about a mile and a half. The total length of route is about 10½ miles, of which five miles are equipped with double track. Unfortunately the narrow streets in the centre of the town preclude the use of double track where it is most required. In these narrow streets a frequent use of turnouts is made, in order to avoid as far as possible a congestion in the traffic due to the overlapping of a number of tramway routes at a point where only a single line can be provided. The rails used in the reconstruction work are of the 7in. girder type, weighing 95½lb. per yard. These rails and the fishplates for jointing the same were supplied by Messrs. Walter Scott, Limited, of Leeds, while the points and crossings were supplied by

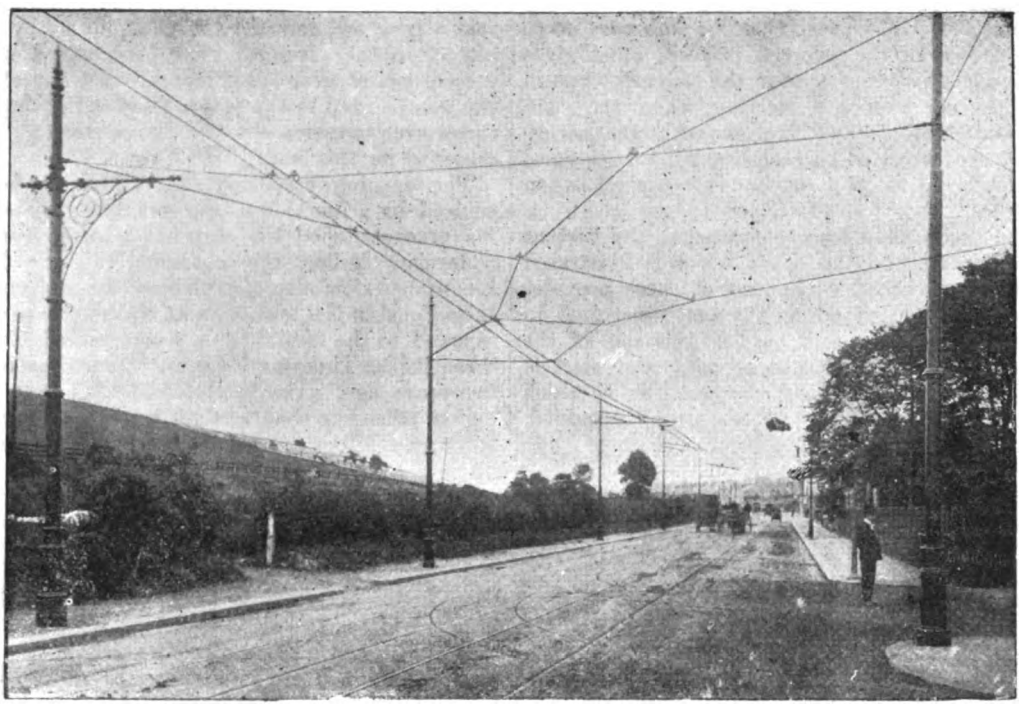

FIG. 3.—Overhead Work at Croydon.

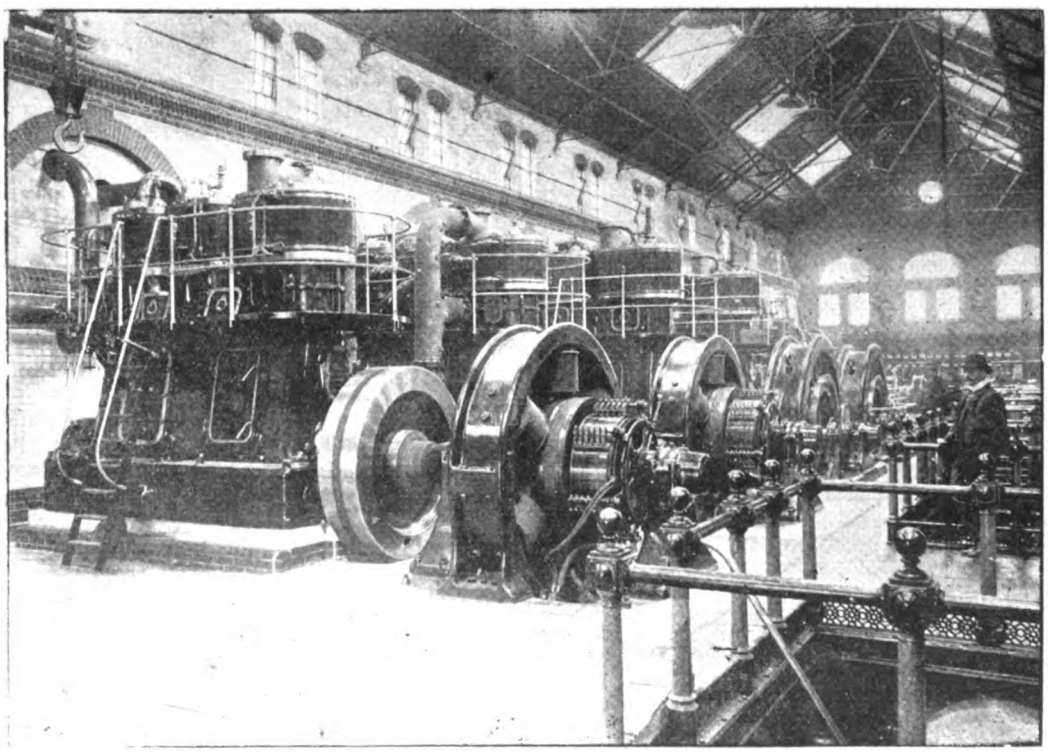

FIG. 4.—The Direct-Current Generating Plant in the Croydon Municipal Station.

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Messrs. Askham Bros. and Wilson, of Sheffield. The whole contract for the equipment was placed with the British Thomson-Houston Company, who have utilised throughout their standard types of electric traction apparatus. Thus the electric cars (Fig. 1), supplied by their sub-contractors, Messrs. G. F. Milnes and Co., are of the double-decked type, providing seating accommodation for 52 passengers. It will be seen that the staircases up to the top of the car are of the reversed pattern, which gives greater safety to the passengers than the ordinary type in the event of the car suddenly starting when they are ascending the staircase. Two motors with the series-parallel control are provided on each car, while both hand and electric brakes give the driver full control when descending grades.

Two new car-sheds have been constructed, the first at Thornton Heath pond, and the other, which is illustrated in Fig. 2, on the Purley-road. The first of these provides accommodation for 19 cars, while the one illustrated in Fig. 2 will contain 16 cars, and besides this one of the older sheds has been reconstructed to take the electric trams. In all these sheds pits have been constructed which enable the machinery under the tramcars to be examined. The overhead work can be seen in Fig. 3. which is made from a photograph taken just outside the Purley-road car-shed. This illustration shows the span-wire construction at a point where it merges into the side-pole construction. The latter way of supporting the trolley wires is used over practically all the tracks, the span wire being employed at the crossings. The tramway feeders and conductors were supplied by the Callender Cable and Construction Company, as sub-contractors to the British Thomson-Houston Company. The cables are all of the Callender type, and are laid on the system which has been advocated by this company for so many years.

Coming now to the generating station, which belongs to the Croydon Corporation, and will be worked by them, it will be remembered that the electric lighting of Croydon is carried out on the single-phase, alternate-current system. In order, therefore, to supply the tramways, the Corporation, under the advice of their electrical engineer, Mr. T. H. Minshall, have put down three direct-current sets. Two of these consist of 600-h.p. triple-expansion Belliss engines, coupled to British Thomson-Houston traction generators. The other set consists of a 1,200-h,p. Belliss engine, connected to a dynamo of the Electrical Construction Company, of Wolverhampton. This new plant can be seen in Fig. 4, while the alternate-current plant lies behind it farther up the station. Fig. 5 shows the traction switchboard which was manufactured and supplied by the British Thomson-Houston Company. Two negative boosters underneath the switchboard gallery are provided in order to keep the drop in the uninsulated rail return in accordance with the Board of Trade regulations. We understand that it is proposed in the near future to supply the centre of the town with electric light on the three-wire, direct-current system, and that a new switchboard for controlling the same will be placed on the platform near to the traction board. The present switch gear is so arranged that any of the tramway sets can be used in the future for this lighting work. The throw-over switches seen in the centre of the panels are provided for this end.

The opening ceremony, on Thursday, Sept. 26, commenced by a function in the generating station, where the Mayoress switched the current on to the traction feeders. Alderman Miller, the chairman of the Lighting and Electricity Committee, explained the objects of the new extensions in the station, and, in the course of his speech, referred to the fact that they had recently overhauled the three Belliss Thomson-Houston steam alternators, installed five years ago. They had found after test a 4 per cent. higher efficiency than was got when they were taken over. Alderman Miller mentioned this fact to show that their plant was not deteriorating. The company then adjourned to luncheon in the Town Hall, where more speech-making ensued.

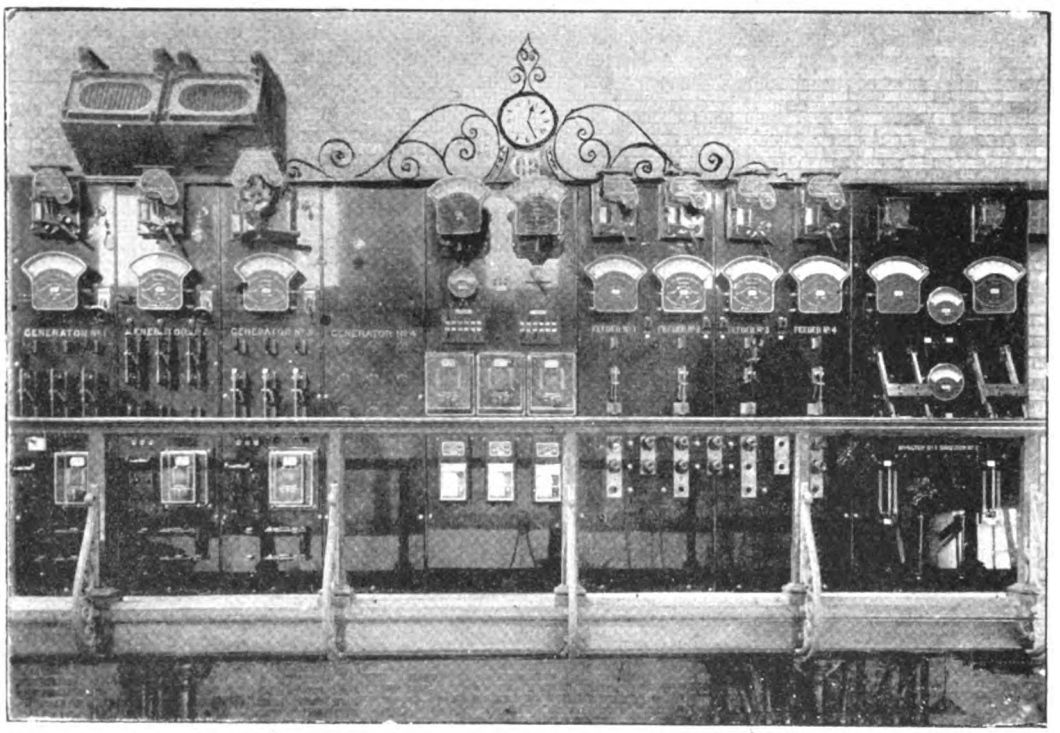

Fig. 5.—The Traction Switchboard.

Sir CHARLES RIVERS WILSON, replying on behalf of the British Electric Traction Company, said he hoped soon to have communication by electric trams completed to Mitcham with an extension to the Crystal Palace. The officers of his company were also, he believed, in friendly negotiation with the local authorities of Sutton, Carshalton, Wallington, and possibly with other places.

Mr. RITCHIE'S speech contains the following expressions of opinion, which are of great interest to tramway engineers. He said it was difficult to exaggerate the great importance to the inhabitants of a town of providing such cheap, rapid, and frequent means of communication. He had noticed the other day that the London County Council [? the London United Tramways Company] having provided a system of tramways reaching out as far as Southall, so great had been the application for building plots in Southall that the very catalogue of a public sale ran through half a dozen editions, showing how willing people were to avail themselves of the enormous advantages which must accrue to everybody to get out of a crowded city into the fresh air of the suburbs. Electric traction was an enormous step in the direction of providing the solution of the great

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difficulty of the housing of the people. There was, perhaps, no subject which was more before the public mind at the present moment than the subject of the housing of the working-classes. He had been responsible for more than one Act of Parliament in connection with the matter, and he expressed satisfaction that most of those who spoke on that subject now recognised that it was not so much the want of legislation as it was the want of carrying out existing legislation which caused the evil which they all recognised and desired to ameliorate. He hoped before long to see the Housing of the Working Classes Act of 1890 and the Public Health Act of 1891, for both of which he was responsible, put more into operation for the great benefit and advantage of the working people. He was satisfied that, so far as their crowded cities were concerned, the main solution of that great difficulty was to enable people to get outside the area of the crowded towns and crowded cities. It was not possible to provide for the required accommodation within the area of nine or ten of their crowded towns, and it was not possible that the outside area could be availed of unless rapid, frequent, and cheap means of communication were available. That rapid, cheap, and easy means of communication was to be provided he believed mainly, if not wholly, by the spread of electric tramways. There had been a great deal said and written in connection with municipal enterprise in that matter *versus* private enterprise in the matter of providing tramways. He thought it had come now, at any rate, to be generally recognised that the provision of tramways was an important part of the powers and duties of municipal authorities. If those communications were in the interest of the people of the localities, if they tended in the direction of providing healthful conditions under which their working people could dwell, he could conceive nothing more worthy of the attention of municipalities than the provision of those means. He, for his part, recognised it as an important part of the duty of a municipality to deal with matters of this kind. The Croydon Corporation, while recognising their duty in that matter, had, he thought, wisely determined to take others into partnership with them in the matter, and, contenting themselves with the provision of the tramways and with the provision of the energy for those tramways, they had taken into partnership the British Electric Traction Company on terms which he could not but think were highly favourable to the Corporation. He was sure that they all desired not only that the people of Croydon should reap advantage and benefit by those tramways, but also that the British Electric Traction Company should make a profit, because, they could rely upon it, if they desired those things to be done, they must desire that it should be profitable to the people on whom they had mainly to rely to do it. They had done wisely, in his opinion, in adopting the course they had done, and he was sure all present desired both success to the Corporation and success to the company. Mr. Ritchie then proposed the toast of "Success to the Croydon Electric Tramways."

ST. ANNES-ON-THE-SEA ELECTRICITY WORKS.

The electricity works of St. Annes-on-the-Sea have now been in full swing since March in this year, just two years from the time that the engineer was engaged to design and carry out a scheme for the electric lighting of the town. The works site (the nearest that could be obtained to the town after most protracted negotiations) is at any rate healthily situated on the sandhills, very nearly a mile from the town. The system adopted is the three-wire, with the neutral earthed at the station, and a pressure of 480 volts between the outers, consumers being supplied at 240 volts pressure. The mains, which were put down by the British Insulated Wire Company, Limited, are laid on the solid system in wooden troughs. The feeders are triple-concentric plain lead-covered, and laid solid, with a three-cored $^{7}/_{22}$ pilot wire in the same trough. The distributors are three singles, laid in the same manner as the feeders. Disconnecting boxes are placed at every street corner, dividing the mains up into a number of sections for convenience in testing and so on. About five miles of distributors are laid at present.

The streets are lighted with 30 6½-ampere Crompton enclosed arc lamps, arranged five in series across the 480 volts on the outer conductors. The service for the arcs which is single $^{7}/_{18}$, and is plain lead covered, is drawn into a ¾in. gas barrel. This not only forms a mechanical protection, but on account of the complete magnetic circuit round the conductor for some 300 yards on every circuit, a great steadying effect is produced, which quite checks any inclination to pumping on the lamps. There are also

Arc Lamp Column with Crompton Lamps at St. Annes-on-the-Sea.

over 100 small standards, with tubular lamps of 32 or 50-c.p., in 8in. prism globes on the tops of the posts. These each have a switch of their own, just under the lamp fitting, and they are switched on by the ordinary gas-lamp lighters with a stick. The switches are the Reason Manufacturing Company's excellent double-break, single-pole, water-tight pattern.

The worksare built of red brick with freestone facings, and contain boiler-house, fan-house, engine-room, battery-room, stores, workshop and offices. The first thing that

Incandescent Street Lamp with Prism Globe at St. Annes-on-the-Sea.

strikes anyone in looking at the works is the absence of a chimney of any height, the one employed being less than 40ft. high. In consideration of the fact that the subsoil was only soft sand and water to an unknown depth, it was thought better to abandon the idea of a chimney—which would have cost at least £1,000—and put in an induced draught plant, at a saving of over 60 per cent. in the prime cost.

The boiler-house contains two 250-h.p. multitubular dryback marine boilers, 8ft. diameter and 13ft. long, each capable of evaporating 5,000lb. of water an hour at a working pressure of 140lb. to the square inch. They

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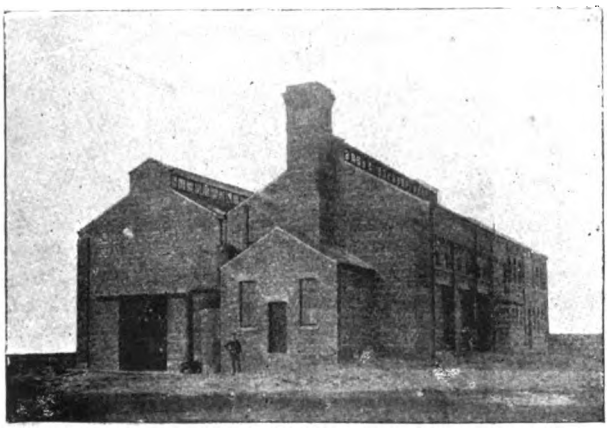
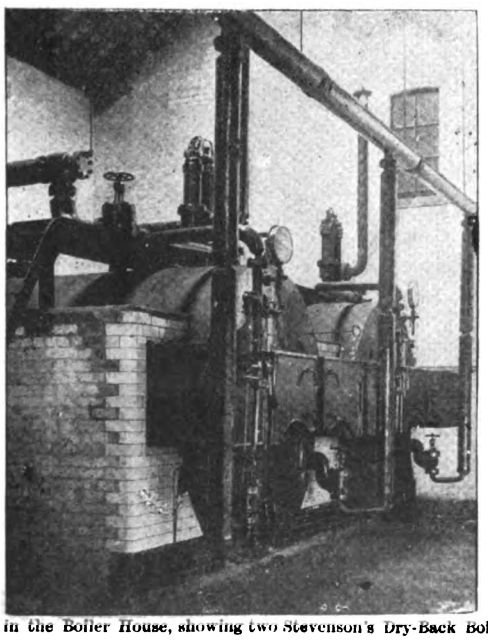
are by Stevenson and Co., of Preston. The water used is from the mains of the Fylde Water Board, and comes from Garstang. It is beautifully pure and soft, the use of boiler fluid or composition of any sort being unnecessary, and there is absolutely no scale. A Worthington double-acting duplex pump is used to supply the boilers, and a White's injector is ready as a standby. All the feed water is passed through a Jefferies feed-water heater, where it is heated by the exhaust from the engines to over 200deg. F. before reaching the boilers. In the fanhouse are two 42in. Sturtevant centrifugal fans, each



External View of the Electricity Works, St. Annes-on-the-Sea, showing the Induced Draught Fan House and Short Chimney.

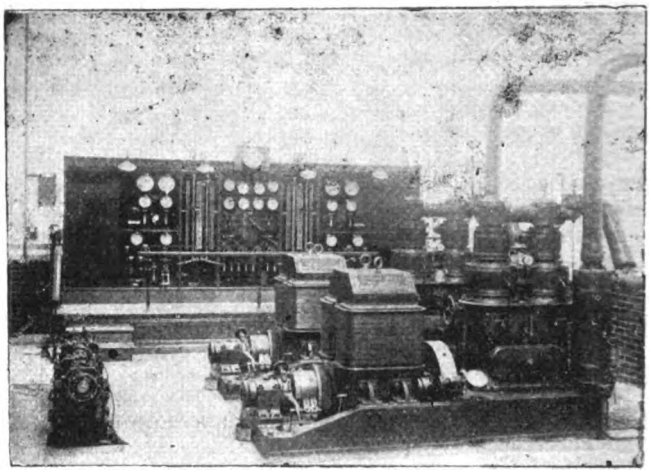
large enough to induce the draught for 750-h.p. boiler power, so that more than one is never running at the same time at present, the other being in reserve. They are each direct-coupled to an 8½-h.p. Sturtevant electric motor. Water-jacketted bearings are used between the fan and the motor. No trouble whatever has been experienced with this plant, and it has been the very greatest convenience possible when a sudden demand has arisen. It runs absolutely without attention for hours together, and has given the greatest satisfaction from the beginning. One of its chief charms



View in the Boiler House, showing two Stevenson's Dry-Back Boilers.

is that any degree of draught can be instantly obtained up to about 2½in. or even 3in.

The engine-house contains two compound Willans engines of 125 h.p. each, coupled direct to two Parker shunt-wound dynamos of 70 kw. capacity, each arranged to give a pressure of 500 volts for plugging on to the 'bus bars, or 620 volts for charging the whole battery. The balancer is by Crompton and Co., and is arranged to transmit 5 kw. from one side of the system to the other. On to the same shaft are coupled the two boosters for charging the regulating cells of the battery, which are on the two outside conductors. The switchboard is by Crompton and Co., and contains their patent dead-beat instruments and shunted ampere-meters. The regulating switches are their rectangular pattern, and work very well. The battery consists of 260 cells by the Tudor Accumulator Company in glass boxes, 11 plates per cell, the capacity being 350 ampere-hours. The coupling of the regulating cells to the switchboard is all done with bare copper rods. A small workshop is provided and equipped for repairs and fitting. Stores, test-room, and offices take up the rest of the space at present occupied. The present engine-room



The Engine Room, showing the Willans-Parker Steam Dynamos.

and boiler-house are sufficient to contain 1,000 h.p. before the building will require extending. Another engine and dynamo of 200 kw. is at present on order to meet the demand that is expected next winter. Private consumers are charged on the Brighton system for the electrical energy they take. The rates are 1d. and 4d. respectively. The street lighting load is supplied at a flat rate of 4d. per unit as are also the various places of worship.

The whole of the above works were designed by Mr. P. J. S. Tiddeman, and carried out under his supervision. The arrangement shows that careful forethought and provision for the future which is not often found in new stations in our smaller towns. The past experience of Mr. Tiddeman is briefly as follows. He commenced his electrical career in May, 1889, by entering the School of Electrical Engineering, Hanover-square, Mr. Lant Carpenter being the principal at that time. He obtained the certificate in December, 1890, and then entered the

P. J. S. TIDDEMAN, ELECTRICAL ENGINEER.

works, at Chelmsford, of Messrs. Crompton and Co., in March, 1891, and while there also served some time in the central station of the Chelmsford Electric Light Company. In March, 1893, he was employed by Messrs. Crompton on various installation work, including the Liverpool-street railway station, Southampton Docks, and many other public buildings and private houses till January, 1895, when he was appointed resident engineer at the Pontypool central station. This position he held till January, 1899, when he was appointed electrical engineer to the St. Annes Urban District Council to design and carry out the scheme for the electric lighting of the town.

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RECENT TRAMWAY PRACTICE.*

BY JAMES MORE, JUN., M.I.C.E., F.R.S.E.

(Continued from page 446.)

Fig. 25 is a diagrammatic view of a switch box suitable for fixing on a tramway pole. It contains two ordinary quick-break knife switches in the upper part with a Garton-Daniels lightning arrester, which I have already explained in connection with the description of the feeder pillar. The box is fixed to the pole by four set screws, and the fittings in the box are insulated from it by prepared slate bases. Fig. 26 is somewhat similar to the previous drawing. This consists solely of plug switches in place of knife switches, and no lightning arrester is included in the box. The lightning arrester in this case would be located in a box of its own, and fixed separately on to the pole. It is necessary to attach this arrangement in positions where only a small size of box may be used. The first method of combining the apparatus in one box is, of course, preferable, the only drawback being that the box has to be of some considerable size to hold the apparatus.

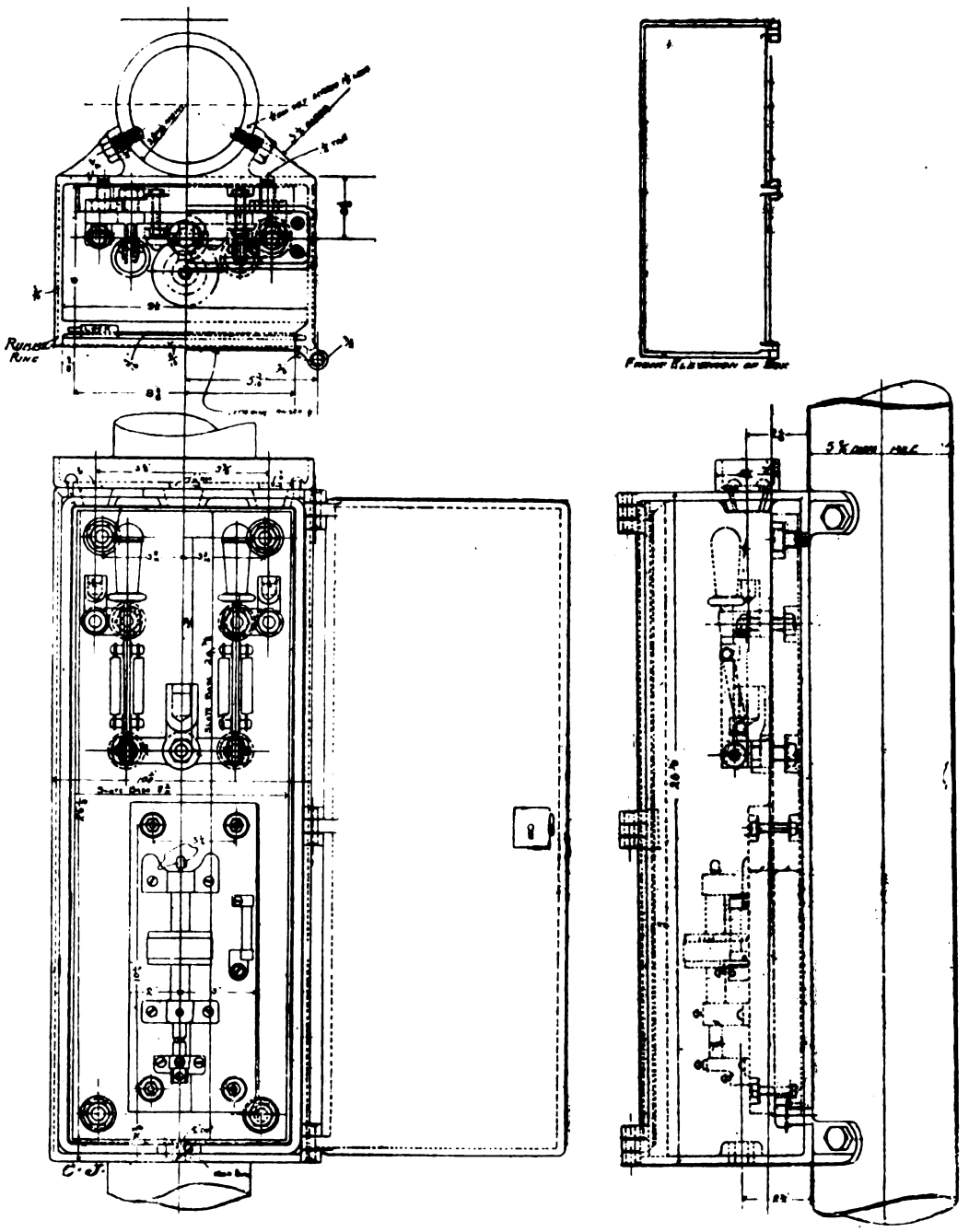

FIG. 25.—Cover Box and Cut-Out.

ROLLING-STOCK.

Cars.—Cars for use in a large town should seat from 50 to 55 passengers. The question as to whether they should be four-wheeled or eight-wheeled bogie cars depends upon the physical features of the routes. There is no doubt that a bogie car is preferable in respect of smooth running at high speeds for working small curves and for durability in itself. It is also much easier on the rails, the wear and tear on the rails on curves being considerably less than with a four-wheeled car. It has, however, two disadvantages. It takes considerably more power to run it; on some roads as much as 50 per cent. more than is necessary for a four-wheeled car. This is not entirely due to the extra weight, but to the extra friction. It is also at a disadvantage on lines with steep gradients on account of the weight being distributed over eight instead of four wheels. This is a serious objection, as the coefficient of friction on a tramway rail is low unless the rail is absolutely clean and dry. This condition is not by any means usual in this country. On most days there is a greasy film of mud on the rail head. To overcome this deficiency of adhesion, Messrs. Brill, of Philadelphia, have introduced the maximum traction truck or bogie for eight-wheel cars. In this truck the perch bolt is moved forward, so that 80 per cent. of the weight is carried on the driving wheels of each bogie. This, certainly, reduces the objection of adhesion. It has, however, other disadvantages, such as the pilot wheel lifting when starting. It is likely in future that where bogie cars are to be used on roads with stiff gradients that ordinary bogies will be used with a motor

* Paper read in Section VII. of the Glasgow International Engineering Congress.

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to each axle—that is, four motors on the car. This will make a most useful car, although somewhat heavy, expensive, and greedy of current. The four-wheeled car, however, is more suitable for all-round work, especially in towns where the speed is never very great. It is lighter, and, therefore, can be controlled more quickly. It takes gradients that a bogie car could not do, and it absorbs less power in friction. The Liverpool type of car which Mr. Bellamy has adopted is a particularly fine roomy car, and the reversed staircase is an improvement as regards the safety of passengers This type of car was introduced in Edinburgh in 1887, and at that time the Board of Trade, although passing the car, suggested that the driver had his angle of view restricted by the staircase on his left. In the Liverpool car the controller is further forward than the gripper in Edinburgh, so that this objection does not apply so forcibly. The staircase is caged in with wire netting, thus making it safer for passengers even than the Edinburgh type. Fig. 27 shows the Liverpool single-deck car, with maximum traction bogie.

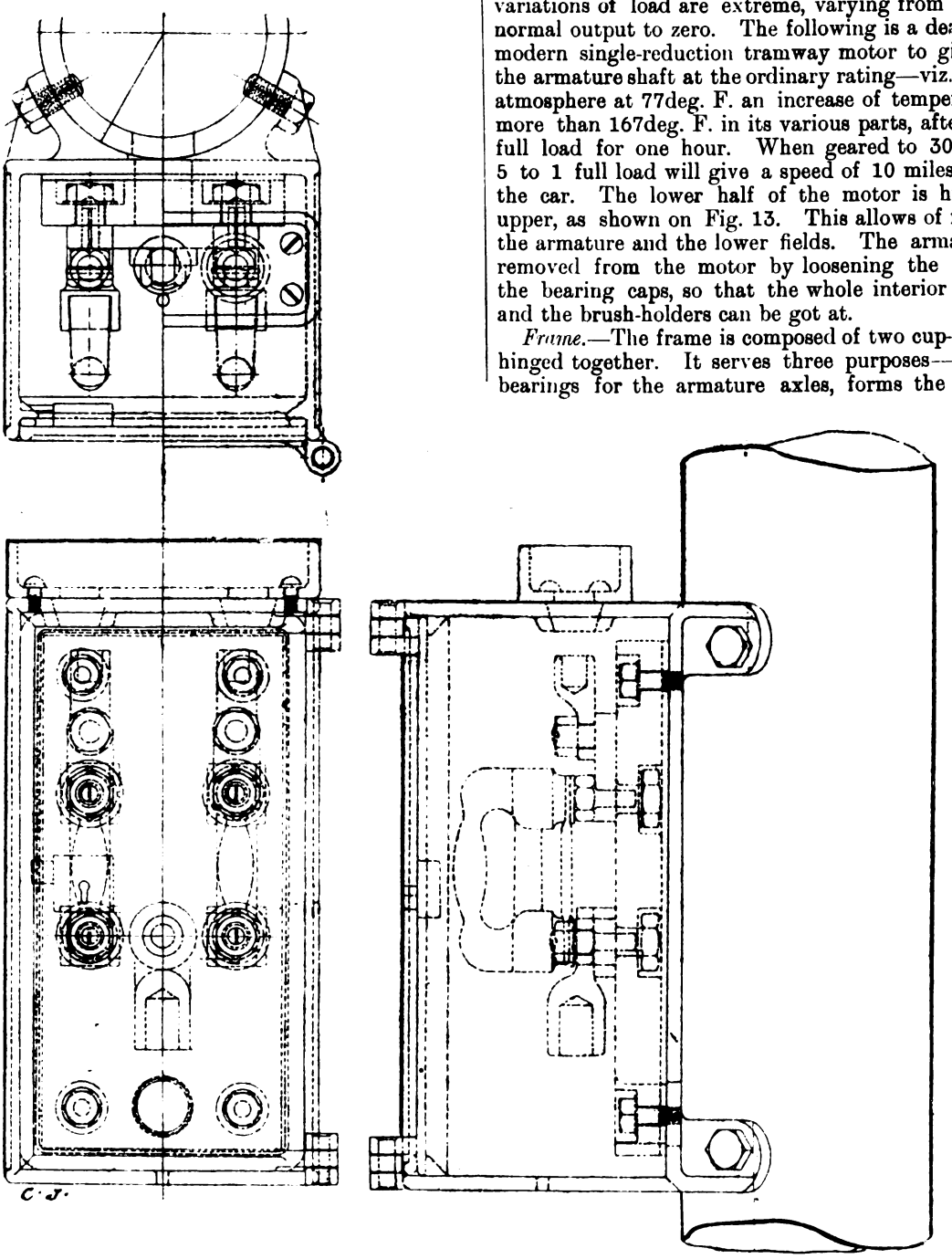

FIG. 26.—Cover Box for Fuse Cut-Out.

Motors.—For tramway purposes the modern motor is almost always single-reduction. They are made as light as possible, and completely closed in. In all cases it is well to leave them of a full margin of capacity, so as to have ample power at the curves and gradients. The difference of efficiency is not great at ordinary loads between a 25-h.p. and 35-h.p. motor. The starting torque must be high, and the motor capable of being run at least one hour at its rated capacity without heating more than, say, 120deg. F., and at 50 per cent. over its capacity for short intervals without serious sparking. This test is a severe one, and it is surprising that it has been possible to get a motor capable of standing it in so small a bulk and weight as is required in a tramway machine. The conditions under which a tramway motor works are most disadvantageous. They are necessarily close to the ground, and subject to the mechanical interference of mud and dust, and the conditions as to variations of load are extreme, varying from double their normal output to zero. The following is a description of a modern single-reduction tramway motor to give 25 h.p. at the armature shaft at the ordinary rating—viz., to give with atmosphere at 77deg. F. an increase of temperature of not more than 167deg. F. in its various parts, after running at full load for one hour. When geared to 30in. wheels at 5 to 1 full load will give a speed of 10 miles per hour to the car. The lower half of the motor is hinged to the upper, as shown on Fig. 13. This allows of free access to the armature and the lower fields. The armature may be removed from the motor by loosening the bolts holding the bearing caps, so that the whole interior of the frame and the brush-holders can be got at.

Frame.—The frame is composed of two cup-shaped pieces hinged together. It serves three purposes—viz., provides bearings for the armature axles, forms the yoke of the multipolar field magnet, and provides an entire casing for the machine, making it mud and dust proof. There is an opening made in the frame for the purpose of getting access to the commutator and brushes. The inner surface of the frame has four equally spaced rectangular surfaces, to which are bolted the four laminated pole-pieces, round which are wound the exciting coils of the field magnets. Two ventilating spaces are left in the pole-pieces to allow air to pass to the cool surface of the outer shell.

Feed Coils.—The feed coils should be of the best copper wire, well insulated with asbestos paper and linen. They are generally wound on moulds the exact form of the pole-pieces, and after being removed from the moulds are dipped

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in insulating compound, thus making them thoroughly waterproof. The ends of the wires are terminated in bronze castings, which are connected after fitting in the motor frame.

Armature.—The armature is of the iron-clad type, and weighs about 484lb. The core is built up of thin discs of sheet steel, strung on to the armature shaft. Ventilating holes are made in the discs themselves, and they are spaced on the shaft to allow of ventilation at intervals. The discs are slotted parallel to the shaft for the purpose of receiving the coils.

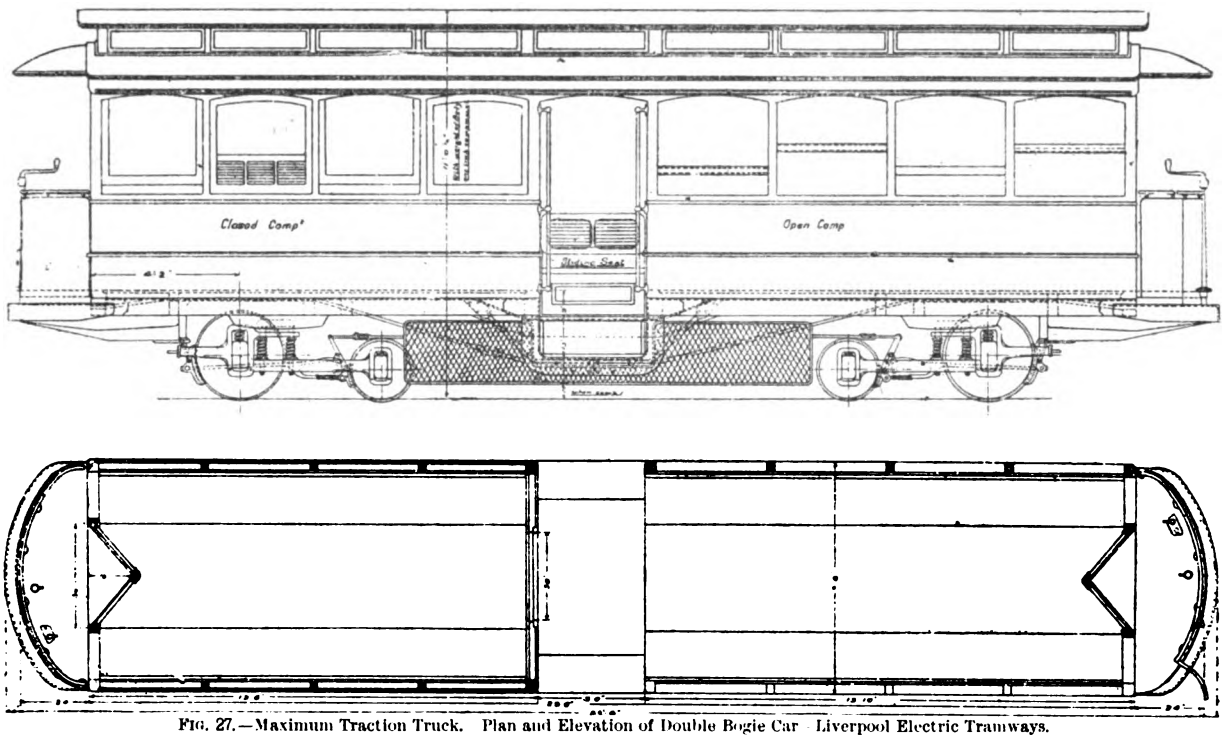

FIG. 27.—Maximum Traction Truck. Plan and Elevation of Double Bogie Car—Liverpool Electric Tramways.

Commutator.—The commutator of the motor in question is 11in. in diameter, contains 123 hard-drawn copper segments with a wearing depth of 1in., and a wearing face of 3in. for the carbon brushes. These dimensions are particularly large, and give long wear and cool running. The hub has openings for ventilation between it and the core.

Armature Coils.—These are of copper wire of 100 per cent. conductivity, thoroughly insulated individually with cotton, and collectively with insulating compound afterwards, and taped three together. There are 41 triple coils for the armature, and six terminals to each coil, having thus two wires to connect to each commutator bar.

Winding.—This consists, after cleaning out the slots in the armature core, of placing the 41 coils into the 41 slots. The terminals of the coils are carefully soldered to the commutator bars, and the windings carefully and tightly bound together by bands of tinned steel wire, to counteract the centrifugal force set up by the rotation of the armature. The brushes are of carbon, and placed so that they can be conveniently reached from the commutator cover.

(To be continued.)

MODERN COMMUTATING DYNAMO MACHINERY, WITH SPECIAL REFERENCE TO THE COMMUTATING LIMITS.*

BY H. M. HOBART, M.I.E.E.

(Continued from page 455.)

Considerable emphasis has been laid upon the importance of low reactance voltage. This quantity not being conveniently measurable under the precise conditions in which it affects the commutation, each designer estimates it on the basis of whichever method his experience has led him to consider least unreliable. The writer proposes to describe the method which he prefers for this purpose. Prof. Perry gives the following approximate formula for the inductance, L, of a cylindrical spool free in air of N turns, whose width, w, mean radius, r, and height of winding, h, are of such dimensions that $\frac{w}{r}$ and $\frac{h}{r}$ are very small:

$$L = \frac{N^2 r^2}{\cdot 0184 r + \cdot 031 h + \cdot 035 w}$$

Solving this for a coil of a cross-section of one square centimetre for various diameters, we derive the curve given in Fig. 2. The curves of Fig. 3 give the corresponding values for square cross-sections of coil for diameters of 50cm., 100cm., and 200cm. A few experiments have been made with a view to ascertaining in how far the values given by these curves—in which the results are given in terms of the flux per centimetre of length of coil—may, for rough practical purposes, be used for other than circular coils. Five coils were prepared, of the shapes and dimensions shown in Fig. 4. The inductance of these were measured on a 50-cycle circuit supplied from a uni-slot alternator. It was afterwards found in another set of inductance tests, that this alternator gave results 23 per cent. higher than when the circuit was supplied by an alternator giving a more ordinary wave-form. The particular machine giving the lower results with which comparison was made had three slots per pole. Besides the values observed on the circuit of the uni-slot machine, there are given in Table XIV., where the results of the test are set forth, also a set of values corrected

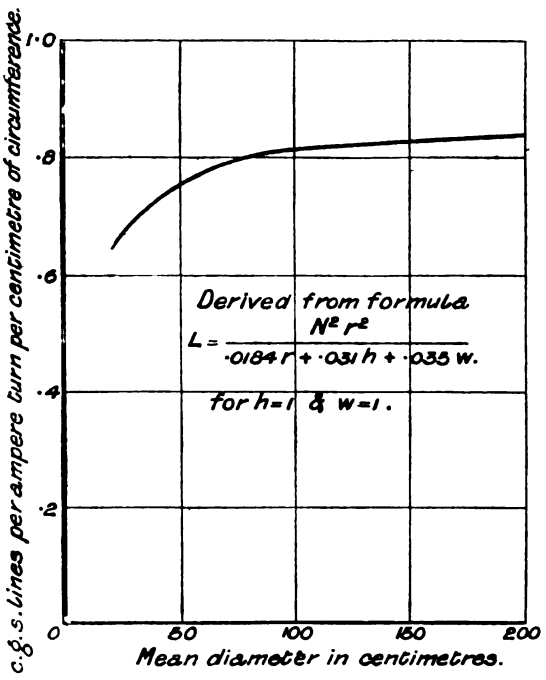

FIG. 2

* Paper read in Section IX. of the International Engineering Congress, Glasgow, 1901.

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by 15 per cent. for the purpose of arriving at more representative results.

TABLE XIV.

Coil.	Mean length per turn centimetre.	Diameter of circular coil of same periphery.	Value for circular coil from Fig. 3.	Value observed in uni-slot alternator with abnormal wave shape.	15 per cent. lower value to correspond more nearly to average wave shapes.
I.	177	56	·73	1·0	·87
II.	105	33	·65	1·0	·87
III.	147	47	·70	1·1	·95
IV.	189	60	·75	1·2	1·05
V.	234	74	·70	1·2	1·05

This shows the experimental values, although higher, to be not altogether different from those which one obtains by this rather free use of the formula:

$$L = \frac{N^2 r^2}{\cdot 0184\, r + \cdot 031\, h + \cdot 035\, w}.$$

Only the tests on these five coils were available, and, partly on account of the meagreness of this data, but more because the results thereby obtained correspond better with the final average results in practice, the writer has preferred to work from the basis of the formula, as arranged in the curves of Fig. 3. Furthermore, in this matter of the reactance voltage, it is the *relative* values for different machines which possess the chief importance. Justification for this course will be more evident later.

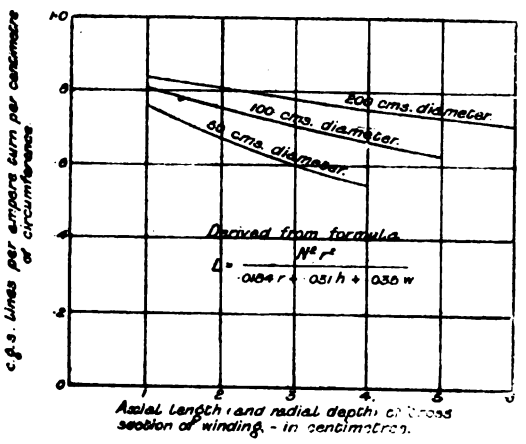
c.g.s. lines per ampere turn per centimetre of circumference
200 cms. diameter
100 cms. diameter
50 cms. diameter
Derived from formula
Axial length and radial depth of cross section of winding - in centimetres.

FIG. 3.

The customary shape of the coil of a continuous-current dynamo is as shown in Fig. 5, and the portions lying outside of the slots will be treated as having values for the inductance per centimetre of length of some such amounts as are given by the curves of Fig. 3. It must, however, be observed that several coils are simultaneously short-circuited under the brushes, and hence the turns making up the short-circuited group are considerably spread out. As three to five segments are generally at the same time under the brush, two to four coils per brush come into consideration. Hence the complete coil on which we

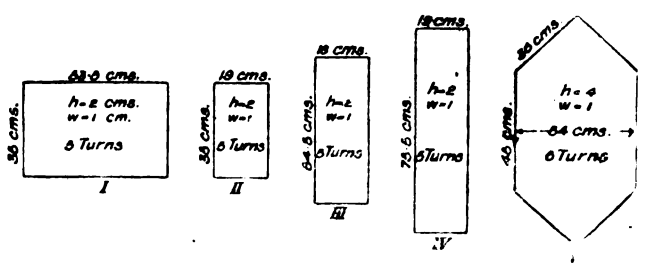

FIG. 4.

must reckon is much as shown in Fig. 6—*i.e.*, rather spread out. A representative cross-section may, for a rough basis, be taken as having (considering the equivalent circular loop) an axial length of 1cm. and a radial depth of 2cm., and we might take from 40cm. to 80cm. as the customary range of diameters. It will be seen from the curve that, on this basis, there will be about ·7 C.G.S. lines per ampere-turn per centimetre of length for the free part of the coil. For the portion lying embedded in the slots, various observations lead to a representative value of about four lines per centimetre of effective length. But one important difference between the exposed end connections and the embedded portion must be pointed out—namely, in the embedded portion, or more exactly, that portion of the face conductors parallel to the shaft, the conductors short-circuited under the positive brush lie over or near (according to the nature of the winding, and also according to whether the pitch is so chosed as to yield a short or long chord winding) those simultaneously short-circuited at the negative brush, whereas the two groups of corresponding *end-connections* are located entirely separately, as in Fig. 7. Hence the magnetomotive force, acting in the short-circuited coil, is twice as intense for the effective length as for the end connections. It has seemed best to designate by "embedded lengths" and "free lengths" respectively the slot-enclosed portion and the end-connections, including with the latter that portion of the conductors parallel to the shaft, not strictly ironclad—*i.e.*, that portion corresponding to the ventilating ducts and the insulation

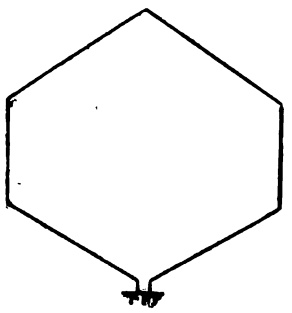

FIG. 5.

between the laminations. In the writer's design this makes quite a difference, the "effective lengths of laminations" often constituting less than 70 per cent. of the length of armaturecore over all. In this free portion, where the conductors are parallel to the shaft, the magnetomotive force is also twice as intense per centimetre of length as for the end connections. But rather than complicate the necessarily

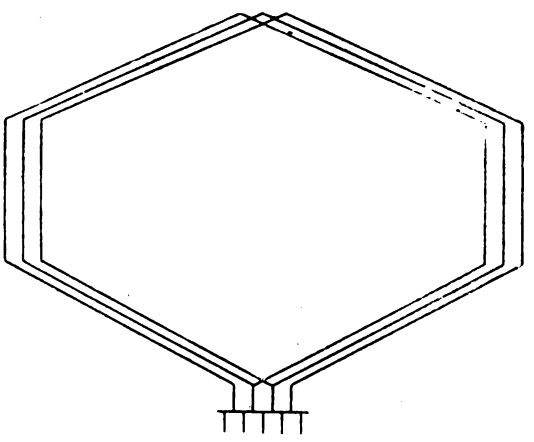

FIG. 6.

only approximate calculations, it is preferable to take a slightly higher value—namely,

·8 C.G.S. lines per centimetre of "free length."

This, together with the approximate value of four C.G.S. lines per centimetre of embedded length, suffices to yield reliable approximate relative estimations of the total flux.

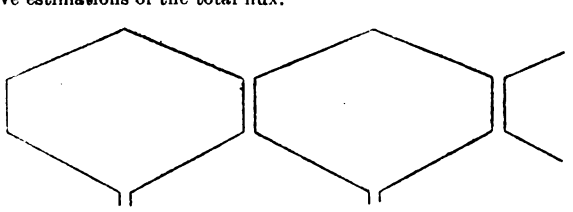

FIG. 7.

It is desirable here to illustrate the method of applying these constants. Take a case where three turns are short-circuited under the positive and three under the negative brush:

The mean length of one turn	100cm.
The effective length of arm laminations	10cm.
"Free length" per turn	80cm.
"Embedded length" per turn	20cm.
Lines per ampere-turn for "free length"	= ·8 × 80 = 64
Ditto "embedded length"	= 4 × 20 = 80
Lines per *ampere* for "free length"	= 3 × 64 = 192
Ditto "embedded length"	= 6 × 80 = 480
Total lines linked with short-circuit turn	= 672

The inductance of one turn, in henrys, with relation to all the turns simultaneously short-circuited

$$= 672 \times 10^{-8} = \cdot 00000672 \text{ henry.}$$

If the periodicity of reversal (twice the reciprocal of the time, in seconds, during which a given turn is short-circuited under the brush) equals 500, then the reactance equals

$$2\pi \times 500 \times \cdot 00000672 = \cdot 0212 \text{ ohm;}$$

and if 100 amperes is the current to be reversed per set of brushes, then the reactance voltage per segment equals

$$100 \times \cdot 0212 = 2 \cdot 12 \text{ volts.}$$

The writer believes that here, for the first time, attention is called

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to two very interesting facts: (1) that in the majority of modern machines the inductance of the "free length" is a very considerable percentage, say 25 to 40 per cent., of the total inductance; (2) that with the ordinary open slots with parallel sides of the proportions generally found in modern continuous-current generators, the induct-

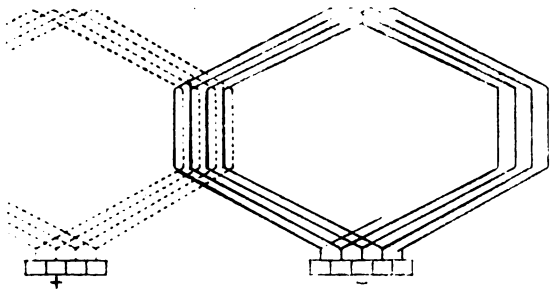

FIG. 8.

ance per centimetre of "embedded length" is generally only some four to six times greater than the inductance per centimetre of "free length." These two considerations lead to another of still greater interest and importance—namely, that the inductance of a coil laid upon the surface of the armature—*i.e.*, on the lines formerly so frequently employed, and sometimes nowadays termed "smooth-core" construction—is, with customary proportions, rarely much less than

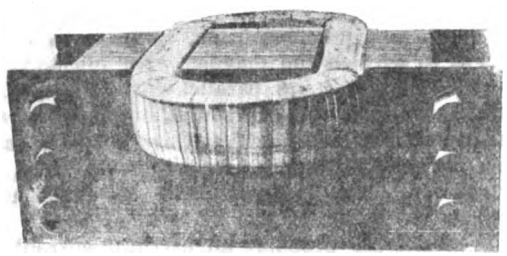

FIG. 9.

one-third and often one-half or more as great as in the case of the same coil laid in a slot. This is readily seen from the case already illustrated. Thus, had the entire 100cm. of mean length of one turn been "free length," the flux would have been

$$\cdot 8 \times 80 \times 3 + \cdot 8 \times 20 \times 6 = 192 + 96 = 288,$$

about 43 per cent. of the value (672) obtained when 20 per cent. of the winding was embedded. Of course, in the old-fashioned types

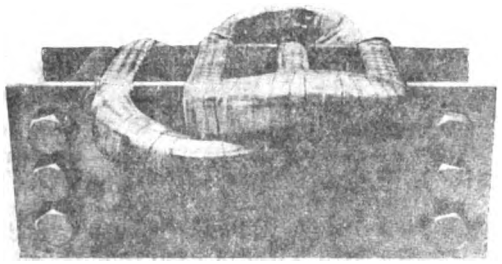

FIG. 10.

with but two, or at most but very few poles, the armature was very long, and the end connections but a relatively very small percentage of the mean length of a turn; but in most of the modern machines, such as the latest multipolar generators built by Mather and Platt, Westinghouse, General Electric Company, Schuckert, and many others, the general tendency is toward narrow armatures of large diameters, and the proportions of end connections will be found to be not widely dissimilar from those represented by the case taken.

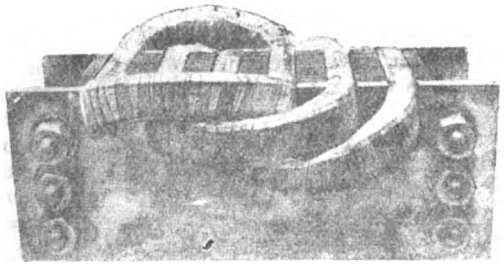

FIG. 11.

In connection with some investigations which Mr. Parshall and the writer are making in the subject of "Alternating-Current Design," some tests were made for the purpose of arriving at rough practical constants for determining the decrease in the inductance, accomplished by the subdivision of a given number of turns in many slots. Some of the results for the position of minimum inductance have considerable bearing upon this question of the reactance voltage in commutating dynamos, and hence it is proposed to briefly explain sufficient portions of the investigation to enable these results to be described. Five sets of punchings were prepared, of the same external size, but with different numbers of slots—namely, with 2, 4, 6, 8, and 12 slots, this corresponding to 1, 2, 3, 4, and 6 slots per pole-piece. The slots were

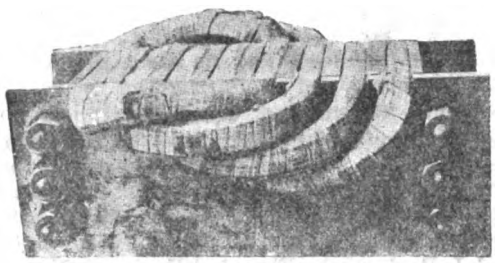

FIG. 12.

so proportioned that the ratio of width to depth was the same for al five models. The punchings were cut from annealed transformer iron about 0·38mm. thick, and built up to a depth of 63mm. Each lamination was japanned on one side only, and the japanning may be taken as corresponding to some 10 per cent. of the total depth. The laminations were held together by end-plates of manganese stee

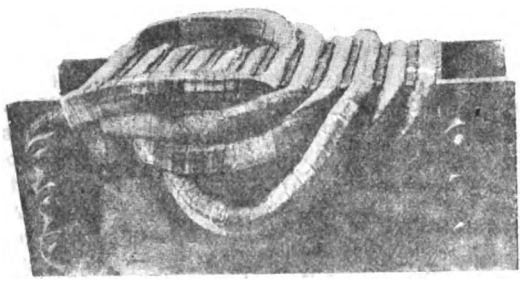

FIG. 13.

6·4mm. thick, bolted together by means of insulated brass bolts. Th coils were wound on formers, taped up and forced into the slots. The wire used was No. 14 S.W.G. (2·04mm. bare diameter), and 144 turns were wound on each set, the total units being evenly distributed among the slots. Photographs of the five sets are shown in Figs. 9, 10, 11, 12, and 13. The data contained in Table XV. relates to these five models.

TABLE XV.

Size of slot in mm.	Number of slots.	Number of coils.	Turns per coil.	Total turns.	Measured resistance (ohms at 20deg. C.).	Corres. mean length of turns (cm.)
36·8 · 24·2	2	1	144	144	·33	43
26·2 · 17·2	4	2	72	144	·31	41
21·4 · 14·0	6	3	48	144	·29	38
18·4 · 12·1	8	4	36	144	·31	41
15·0 · 9·9	12	6	24	144	31	41

While fundamental *quantitative* results were not the purpose of these tests, the models being so small, it may be pointed out that the approximate equivalent diameter is 13cm., and the approximate equivalent cross-section of coil for the first model is about 3cm. square. For such dimensions Prof. Perry's formula would not apply. One would, however, infer from the shape of the curves of Figs. 2 and 3 that there would be probably not over 0·3 C.G.S. lines per centimetre of free length for the uni-slot model, and still less for the other models, hence the magnetomotive force of the "free length" would not affect the results by more than some 10 to 20 per cent. at the most.

(To be continued.)

Affidavit by Telephone.—A recent judgment of the Circuit Court at Baltimore, U.S.A., is of considerable interest as deciding the oft-discussed question of whether or not an affidavit by telephone, taken by a justice or notary, is legal and *bonâ fide*. In this particular case, Judge Burke held that an affidavit sworn by a Mr. Cross in the petition of the Manor Humber Company asking for an order appointing a receiver for the concern by telephone was good in law. It must be noted, however, that Justice Thomas Butler, who is said to know Mr. Cross very well, was at the receiving end of the telephone, and took his affidavit to the bill; otherwise we think it would not always be a simple matter to establish the identity of the person purporting to take the oath.

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ELECTRICAL ENGINEERS DECORATED.

We desire to add our voice to the numerous and sincere expressions of congratulation which have gone out to Lieut.-Colonel R. E. Crompton on his appointment to the Companionship of the Order of the Bath. To say the least of it, his decoration has been well earned, and it must be most gratifying alike to himself and his late comrades-in-arms to find that his many and useful services rendered to his country while in command of the Electrical Engineers Volunteers in South Africa have received such timely and suitable recognition. It must no less be a matter for hearty congratulation for the corps as a whole that the distinguished conduct medal has been bestowed on Quartermaster-Sergeant W. S. Entwhistle, Sapper R. W. Holliday and Second Corporal J. Rook, of the Electrical Engineers Volunteers.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

417. What is the usual procedure in changing over the network of an electric station from 230 to 460 volts?—R. S.

418. A 700-ampere 110-volt compound six-polar dynamo, fitted with carbon brushes, is continually flashing round the commutator from brush to brush. What is the cause of this and the remedy? The commutator is freely cleaned with emery paper. Also a smaller dynamo, shunt-wound, used for battery charging, 150-volt 60-ampere, fitted with carbon brushes, frequently takes half-an-hour to generate. How can this be remedied? Different makes of carbon brushes have been tried.—W. A.

ANSWERS.

Question No. 411.—Six steel-armoured concentric feeders are drawn into iron pipes; they have no exterior distinguishing marks of any kind, and cannot be traced. Their inners carry an alternating current at 5,000 volts, their outers being earthed at the station as usual. A "short" develops in one and it is rendered dead. What is the best way to identify the faulty cable at any draw-box along its route? Telephone methods have been tried and found useless.

Best Answer to No. 411 (*awarded* 10*s.*).—This inability to distinguish individual mains in draw-boxes is a very serious matter, and does not reflect credit upon the mains superintendent in this case. All cables running from a central station should be marked at draw-boxes, and more particularly does this apply where duplicate high-tension feeders run. There is no particular way of immediately identifying faulty cables at draw-boxes along the route unless the cables are properly labelled. This should have been done as the cables were laid and jointed, but as it evidently has been shirked, there should be no time lost in getting metal labels stamped distinctively and bound with wire to the right cables in each draw-box.

To identify the faulty cable in question (and in due course its companions) use the inner and outer of the cables *unitedly* as the lead, and use earth as the return; and by passing a fairly heavy continuous current through this the cable under treatment can be distinguished by its effect upon a compass needle, which will incline in one direction when held on one side of the cable and in the other direction when placed at the other side. The armour will, of course, take up a fair amount of the stray magnetic lines, but is unlikely to act as a perfect shield. If, however, it does destroy all the external field, it will be best to divide the armour of the suspected cable with cable cutters, and after unwinding a few inches try the compass against the exposed jute serving, afterwards rewinding the armour and binding in place with wire. If each cable is drawn into a separate pipe it should be an easy matter to distinguish, for marking, any particular cable by noting the position of the pipe through which it runs to the next drawbox, and so on into the next one to that; but this should not be carried to too great a distance without again proving by means of the compass. And above all, this work of tracing should be given to a careful and competent man, with the knowledge that an error in marking may at some future time cost human life. The writer has had painful experience of this non-marking in connection with the high-tension and low-tension cables of deceptively similar size.—B. C. H. J.

Answer to No. 411 (*awarded* 5*s.*).—A plan which has been found most successful in cases of the above kind is to send a continuous current of, say, from 10 to 20 amperes down the faulty cable to the station, and working from the station test at the draw-boxes by means of a small, light, delicately-suspended magnet contained preferably in a small brass box with glass lid. The magnet will be very decidedly deflected when the box is placed immediately under or over the faulty cable. One precaution, however, is necessary, and that is, to see that the magnet, when affected only by the earth's magnetism, lies parallel with the cable. If it does not, it must be brought round by means of a small bar magnet, or magnetised pocket-knife. This plan, moreover, has the merit of roughly localising the fault, for the faulty cable will cease to deflect after the fault has been passed.

As the feeders are probably all carrying current having the same frequency, the faulty cable could be detected by sending a moderate current down at a different periodicity to that in the others. A telephone, with one wire connected to earth and the other to an insulated searching wire wound several times round the cable under test, will then certainly indicate the faulty one, as the "alive" cables will all produce one note, while the "dead" one will cause induction, notwithstanding a different sound altogether.—GRAFTON.

Question No. 412.—What is the best way of cleaning and polishing switchboards? (1) White or grey marble panels; (2) enamelled slate panels; (3) instrument cases and glasses; (4) 'bus bars, switch contacts, and arms; (5) keeping the "back" clean.

Best Answer to No 412 (*awarded* 10*s.*).—The essential of a clean switchboard is "elbow-grease," and plenty of it. However, we will endeavour to answer "P. T. K.'s" questions in detail, and take them in the order given. The following tools should be kept in a box in a handy place: a pair of rubber gloves, a pair of hand bellows (with a good leather stomach), two painter's dust brushes, three large pieces of chamois leather, quantity of fine waste and cleaning cloth, and a good stock of metal polishing paste.

1. *White or Grey Marble Panels.*—Undoubtedly the best way to clean marble is to wash the surface well with warm water in which has been dissolved a quantity of good dry soap (Hudson's is recommended). This method, unfortunately, cannot always be used on live boards, for obvious reasons. If it is possible to make portions of the board "dead," much time can certainly be saved by adopting the above method. A damp flannel may sometimes be used in places where the switch gear is cramped, but, of course, it all depends on the care exercised by the individual who is cleaning down. If this way is risky, then a dry cloth and plenty of "elbow grease" must be used. The gloves will prove useful in places where there is any risk of receiving a shock. Paraffin oil or benzine is not recommended for cleaning marble, as it gives the board a dirty yellow appearance. If grease and dust has not been allowed to accumulate, the board will present a bright appearance if it is given a good dusting and dry wiping all over every day.

2. *Enamelled Slate Panels.*—Black enamelled slate is much better to clean than marble, and if done regularly, it looks exceedingly well. Give the enamelled surface a good rubbing all over with a piece of waste moistened in paraffin oil, and polish off with a soft dry cloth.

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3. *Instrument cases (a) and glasses.*—All lacquered and enamelled surfaces can be kept very bright by cleaning in the same way as enamelled slate. The best way to clean instrument windows is with a piece of chamois leather, slightly moistened with water, and polish off with a dry piece. Another, but rather messy way is to use a mixture of whiting and paraffin, made in a soft paste. Apply, on a piece of waste, and polish off with a clean cloth.

4. *'Bus bars, switch contacts, and arms.*—All lacquered work will look well if cleaned in the same way as in Nos. 2 and 3 (a). All contact surfaces and plain polished metal work can be kept up to the mark by using a good metal-polishing paste, applied on a piece of flannel, and given a finish off with a dry cloth on which a little dry whiting has been sprinkled. Emery cloth should never be used. For silver-plated surfaces a mixture of whiting and water made in a stiff paste is recommended. Apply, on a piece of flannel, and polish off with a dry chamois leather. If there is any vulcanite about the board it can be kept in good order by washing with a solution of ammonia, afterwards wiping over with a piece of flannel moistened in paraffin oil.

5. *Keeping the "back clean."*—This "out of sight (and sometimes) out of mind" part of the board often receives scant attention, and when it is necessary to spend a few minutes on a job here, one comes out looking more like a "coaler" than a dignified member of the "voltchasing" profession. The "back" should be the first item in the daily cleaning operations, owing to the large amount of dust which is generally allowed to accumulate here. The dust brush should be used here carefully, so as to raise as little dust as possible. The bellows come in very handy for cleaning out corners which cannot be reached safely by hand. Do as much wiping as possible with a cloth, and afterwards give the whole board a final blow over with the bellows. It is advisable to tape round the bellows nozzle (if made of metal) with a couple of layers of adhesive tape, as "accidents will occur even in ——."—S. L.

Answer to No. 412 (*awarded* 5*s.*).—Before commencing to clean a switchboard, the switches, instruments, and mounting, whether slate or marble, should be dusted with a camel hair brush. Next wash the slate with milk or methylated spirit on a soft cloth and polish with a washleather or piece of velvet; a little furniture cream will help to remove any grease left by the milk. In cleaning marble milk may be used but not furniture cream. A good way of cleaning marble, however, is to make a paste with water of American potash and whitening in about equal proportions, and rub on with a cloth. This should be allowed to dry, and must then be rubbed off. By this means the colour of the marble is greatly improved. Switches are usually laquered, so no polishing paste must be used, unless it be on the contacts, where care must be taken to remove all traces of paste in polishing. A switch is best cleaned with a brush, while for the contacts a vaseline rag is usually sufficient. The vaseline should be rubbed off with a dry cloth, but just a trace, if left, will not greatly injure the contact and will lubricate same. Where sparking has occurred a little fine emery should be used. Steel parts, if rusty, should be polished with fine emery and then polishing paste. A little powdered charcoal rubbed over will remove damp and grease, and will improve the polish. Ebonite handles should be polished with linseed oil. 'Bus bars should be rubbed with oil, and then rubbed dry. The plug holes should be blown through with bellows, while the plug handles if of ebonite should be rubbed with linseed oil. Instrument glasses should be cleaned with whitening or paraffin, while the cases should be dusted with a brush and polished with a washleather. The painted iron framework of a board, where exposed, will be improved by rubbing with linseed oil. A board should be thoroughly cleaned in the above way once a week, and every day should be dusted with a brush (camel-hair or feather) or a pair of bellows with a rather small nozzle, care being taken that no dust remains in small corners. The back of a board should be cleaned in the same way with bellows or a brush and should be kept very clean. All nuts and connections should be gone over once a fortnight and tightened up if loose. All rubber cables would be improved by varnishing occasionally, while the iron framework, if painted with brunswick black, will not hold much dust.—T. W. B.

Answer to No. 412 (*awarded* 5*s.*).—Taking the questions in their respective order, there are various ways by which marble may be cleaned. Though not all well adapted for switchboard use, the following two receipts may be used with advantage: First, take finely-powdered pumice stone and vinegar, wash the surface with the mixture, and leave it for several hours; then brush it hard and wash it clean. When dry, rub it with whiting and washleather.

Second method: Mix up a quantity of the strongest soap-lees with quicklime to the consistency of milk, and lay it on the panel for 24 hours; clean it afterwards, and it will appear as new. This may be improved by rubbing afterwards with fine putty powder and olive oil. If the polish is off in places, they can be repolished with oxide of tin and water applied with a cloth.

To clean enamelled slate the following are three good receipts: (1) Yellow wax, 4oz.; yellow soap, 2oz.; water, 50oz. Boil, with constant stirring and add boiled oil and oil of turpentine, each 5oz. (2) Soft water, one gallon; soap, 4oz.; white wax, in shavings, 1lb. Boil together, and add 2oz. of pearlash. To be diluted with water, laid on with a paint-brush, and polished off with a hard brush or cloth. (3) Wax, 3oz.; pearlash, 2oz.; water, 6oz. Heat together and add 4oz. of boiled oil and 5oz. of spirits of turpentine. The above mixtures for marble and slate would not need to be used very frequently, say once a month, the panels in the meantime being kept clean by a good rubbing with washleather or "Selvyt" cloth.

Instrument cases are generally either lacquered or enamelled. In the first case, all that is necessary to keep them clean is to rub them lightly with a washleather or soft cloth to remove the dust. If, as in the "Weston" instruments, the cases are enamelled, they may be cleaned by the same preparation that is used for enamelled slate. The glasses may be cleaned by rubbing on a strong solution of soda, or whiting mixed with water to the consistency of cream, afterwards polishing off with a washleather.

To Clean and Polish 'Bus Bars, Switch Contacts, and Arms.—'Bus bars, as a rule, are fitted behind the board, and do not require to be polished, dusting being all that is necessary. If, however, it is desired to polish them, providing they are in the "rough," they must first of all be rubbed down with fairly rough emery cloth wrapped round a wooden block, care being taken to get all the marks made by the emery in a straight line, and to get all the cross marks out. Different grades of emery cloth may now be used, gradually getting smoother until the bars assume a glossy appearance and all the scratches are out. Finish off with metal polish—"Needham's" or "Matchless"—applied with a rag, and burnish with a soft cloth and a little powdered whiting. For switch contacts and arms, and in all cases where the fittings have been "finished" before leaving the shop, no emery cloth must be used, the only things necessary being some good metal polish and "elbow grease," taking care that all the paste is thoroughly cleaned off. When a switch contact has become "blobbed" through breaking excessive current, it may be touched up with a smooth file and finished off with emery cloth and polish. A little tallow used sparingly on the contacts will make switches work freer.

It is a somewhat difficult matter to keep the back of a board clean, owing to the numerous cables, connections, and wires of various sorts generally to be found there. Much can be done to facilitate cleaning by tieing cables and "leads" into bundles wherever possible, and using flat copper strip for connectors. A loose wooden flooring raised up, say, 4in. to 6in. from the ordinary floor ought to be provided, under which the cables can be run, and which can be lifted up when necessary; a space of about 9in. must be left between the flooring and the switchboard for bringing the "leads" down, and a "beading" or "edging" ought to be fixed on to prevent dust, etc., from being swept on the cables.

The back of the board ought to be enclosed as far as possible to prevent dust and foreign substances from entering. When this is done, and care is taken in arranging the different cables and "leads," there ought not to be much difficulty in keeping it clean, a pair of bellows with a wooden nozzle, a dust brush, duster, and sweeping brush being all that is required.—C. J. S.

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TO CORRESPONDENTS.

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MUNICIPAL MUDDLING.

The Corporation of Croydon, with its enormous municipal buildings, its municipal electric light undertakings, and its so-called municipal electric trams, congratulated itself on Thursday of last week on its own enterprise. As these congratulations were echoed by no smaller a personage than the Hon. C. T. Ritchie at the banquet in connection with the opening ceremony of the electric trams, it may seem presumptuous on our part to differ from the conclusions then arrived at. In matters electrical, the Corporation of Croydon has not shown the enterprise which it was called upon to do. To go back to the earlier days when electric lighting was first inaugurated in Croydon, we then find the Corporation entering into a contract with a single manufacturing firm for the equipment and working of an electric lighting undertaking within the borough. Under the working agreement the contractors had to maintain and run the plant and they received the revenue, but the company had to pay the Corporation about 6 per cent. on the contract price per annum as interest and sinking fund on the loan which the Corporation obtained to pay for the plant. The Corporation were advised that the undertaking would pay before this contract was entered into, and the prediction was so verified in practice that after a year's working they determined the contract at the cost of £1,000 to the ratepayers. One would have thought that from the experience obtained the history of the tramway undertaking would have been free from any similar fault. We find, however, that this is not the case and that a similar or worse policy has been followed. Again we find the lump sum contract with one firm, which, as every one knows, is not the most reasonable way of getting large contracts carried out at the present time. Having decided to equip the tramways electrically, and having good advice as to the probable financial result, the Corporation determined to ensure themselves against loss as far as the tramway expenditure was concerned, by granting a lease of the lines to a third party. That this party happens to be the British Electric Traction Company does not concern the case much, although the lease will be of great service to that company in obtaining other tramway concessions of a more permanent nature in the surrounding districts. The only excuse we can see the Corporation can bring forward for granting the lease is the supposition that the undertaking will not pay. It is interesting, then, on this supposition to review the conditions of the lease. Under it the company has to pay 6 per cent. on the capital outlay, which is about 1 per cent. more than the Corporation will have to pay for interest in sinking fund on the tramway loan. In addition to this the company has to keep the line in repair, making good any depreciation which may occur. They have also to hand over to the Corporation each year £100 per mile towards the maintenance of the track and the street surface. Again, not content with the profit in the 6 per cent. above mentioned, the lessees are made to buy all the electricity required from the Corporation, and to pay for the same at the rate of 2½d. per unit. The actual profit on this transaction is at least 20 per cent., and will be considerably more if the system of allocating standing charges within the central station be a just one. In fact, the company running the Croydon tramways have to pay as much per unit for their supply as do consumers in the City of London who require, say, a 5-h.p. motor to work a printing machine. We presume that if the members of the Corporation of Croydon were questioned they would think that the above conditions are a token of the shrewd way in which the interests of the ratepayers of Croydon are guarded. Mr. Ritchie at the banquet had much to say about the increased

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facilities which the Croydon Corporation were providing in their electric tramways. Our opinion is that he was incompletely informed as to the conditions of the case. It would have been more correct to say that the Croydon Corporation have so burdened their tramway undertaking with indirect profits that they have done harm to their district. All these indirect profits have to be paid, not by the British Electric Traction Company, but by the users of the tramways. The result will be one of two alternatives. Owing to the narrow streets in the central parts of Croydon, it is difficult to run a rapid service of trams in both directions. This hampers the tramway undertaking, and the first alternative seems to be that with the additional burdens imposed by the Corporation, the tramway company will make little or no profit in Croydon. In consequence of this there will come a need to cut down expenses, which will be done either by an infrequent service or by neglecting to keep the tramway plant in proper repair. In view of the high cost of power, it would seem likely that the company would economise by running only a few trams, except at morning and evening, when the rush takes place. The other alternative is that the tramways will just pay the company, then we presume the Corporation will rush to take them over, as they did the electric lighting undertaking. It will be seen, however, that provided the company get a good number of concessions for tramways in the districts around, it will be to their interest to work the Croydon tramways in such a way as to make a loss rather than to allow the running of these trams to get into other hands. In conclusion, the Corporation of Croydon can only be considered as a businesslike municipality when it forsakes its present muddling policy of shirking the responsibility of its municipal undertakings. At the present time it resembles more nearly a parcel of schoolboys playing into the hands of skilful company promoters.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

JERRY WIRING.

SIR,—Considering the importance of the above subject, it is little short of marvellous that so little up to the present has been said or written about it. Taking the average price of electric lighting at from 18s. to £1 per point, one is prepared to put the best material and employ good workmen upon all one's installations; but where lights are installed by some so-called wiring contractors at 12s. 6d., and I even know of cases where it has gone so low as 10s. 6d. per point, I absolutely fail to see how anyone can make a living out of it. They not only bite their own fingers, but spoil the chance of a decent firm getting work, and fairly ruin the trade. Of course, in shop lighting and offices, where the lights are numerous and close together, one can reasonably expect to do the work at a considerable reduction; but I want to draw attention to the fact that the same likewise applies to private house wiring.

Now as the average number of points is one per room (except drawing and dining rooms, where it is usual to fix up a three-light fitting in each), one cannot but wonder, considering the amount of wire and time taken on the job, how the contractor makes a living profit. Of course, needless to say, there is some sacrifice somewhere, and this can generally be found under floors, etc. Quite recently I was called in to report upon an installation which was continually at fault and causing considerable trouble and annoyance. Upon examination I found that the wires under the floors were destitute of any protection, the wires lying in any position they could adopt. Some of the joints were just covered with a layer of waterproof tape. It is nothing short of scandalous that such things are allowed, and I think the supply companies are somewhat to blame in this matter, for although upon first testing the installation, it might answer their requirements, still I think if they made a general survey of the work, much of the jerry wiring would be exposed. I think the names of the contractors responsible for the work should be sent to the trade journals, so that they might be fully exposed. You cannot possibly blame the customer, his work is open for anyone who cares to estimate, and as he naturally thinks of his pocket, and all the estimates read much about the same, he naturally choosest the lowest, but if he could only be shown in the first instance the dangers he is incurring, he might look before he leaps.

No doubt the employment of boys to a certain extent solves the question, but no decent firm would entertain the idea of such labour. Yet we must all compete with the above. "How can trade unions expect employers to pay high wages with the present market prices?" Let them first look to the question of standardising the trade, and then enquire into the labour question. No employer with a spark of manhood in him would cut his employés down to the last penny, if he had proper scope, but one cannot expect wages to go up if prices go down. Undoubtedly plumbers, ironmongers, and small builders cause a lot of mischief, as they are the ones usually connected with jerry wiring. They not only work at their own trades, but generally combine lighting and bells. Of course they can take the work at a much lower rate, as the combination of jobs yields them a very fair profit. I have frequently noticed that the plumbers who do bell-work are very inferior workmen at their own trade, and so rely upon the little that bell installation brings in. Small wonder that electric bells are voted a great nuisance, for when once they become faulty they give no end of trouble, for although our plumber may be able to instal them, when it comes to the question of locating the fault he has not the necessary knowledge how to proceed, and after pulling the house to pieces, he is generally forced in the end to seek competent assistance, and then, of course, the customer, too late, finds to his cost how easily he has been duped, and will have nothing more to do with it, and thus the trade is spoilt by the interfering of people totally unfit to compete in it. The same applies to builders, who generally get their carpenters to run both casing and wire with equally disastrous results. This is no fancy picture, but one I am continually coming across. I trust some of the large firms will give their experience, as they, too, must certainly suffer in consequence of the above. Anyway, I shall be pleased if this letter becomes the means of some practical scheme being adopted whereby contractors may estimate against each other in fair competition without actually cutting one anothers' throats. NE SUTOR ULTRA CREPIDAM.

ELECTRIC FITTINGS.

The General Electric Company, of Queen Victoria-street, have just issued a new edition of their fixture catalogue, to which they wish the attention of electrical engineers and architects drawn. We have taken the opportunity afforded us instead of looking through the catalogue itself, to inspect in the showrooms of the company the new productions which necessitated the issue of this new list. We were fortunate in having the head designer of the firm to go round with us in order that we might quickly identify the most recent productions of his skill. Until comparatively recent times there has been much too great a similarity between electric light fittings and those designed for the use of gas. While this is not an objection from one point of view, in that the good designs of gasaliers were quite suitable for electric lighting, it has prevented the designer from making use of the way in which the small conductors required for electric lamps, can be made to harmonise with the fixture supporting the same. It is in this that the new designs of the above Company stand pre-eminent. They are not florid, or richly engraved, but the work throughout is such as lends itself to excellence of finish. At the same time the new fittings are so arranged (as will be seen from the illustrations on the adjoining pages) that the lines of the electric conductors form in a number of instances an integral part of the fixture

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NEW TYPES OF ELECTRIC FITTINGS OF

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from an artistic point of view. The bulk of the new types are characterised by an extreme simplicity, which we, as non-experts, think must conduce to ease of manufacture, while at the same time the lines are such as make the fixtures most chaste and an ornament to any room. Another feature is that the glass used as a shade to the lamps is made to harmonise in shape with the curves on the fixture itself. In drawing-room lighting it is not the object of the electrical engineer to produce the most brilliant illumination with the fewest possible number of lamps, but rather to so surround the lamps with fancy shades as not to make them unduly obtrusive, while harmonising with the general decoration. This end is attained by the designs we had the pleasure of inspecting the other day, and samples of which are illustrated in this issue. These fixtures are all manufactured in the firms own workshops, where over 300 hands are employed for this branch alone. The fittings are as a rule to be obtained in various materials, such as polished brass or copper, natural bronze, oxidised silver, and hammered ironwork. This ironwork can either be left in the black state or artistically finished after the steel armour style. To those who have not the opportunity of inspecting these designs either in Queen Victoria-street, or in the showrooms of the company at Glasgow, Newcastle, Manchester, Birmingham, Cardiff, or Dublin, we would recommend a perusal of the new fixtures list. To those who have the opportunity, an inspection of the actual articles will repay the time so spent.

OPENING OF THE BATTERSEA ELECTRIC LIGHTING STATION.

The Borough Council's generating station in Lombard-road was opened on Saturday afternoon in the presence of a vast concourse of ratepayers, their wives, and children, many hundreds of whom found room in the spacious building, which with its white glazed brick walls looked very spruce and tidy. Punctually to programme time—five o'clock; the invitations said 4.30, but that is a detail—the chairman of the Electric Lighting Committee, Councillor J. E. Livsey, took the chair on the switchboard gallery, welcomed the audience and gave a few details of what had been done and what was going to be done. He eulogised the staff for their untiring efforts and excellent workmanship and appealed to the ratepayers to support the undertaking by becoming consumers. These two points were the main gist of all the speeches, which were both numerous and long. Mr. Livsey specially mentioned the architect, Mr. C. Stanley Peach, F.R.I.B.A.; the borough surveyor, Mr. J. T. Pilditch; Messrs. Kennedy and Jenkin, or more especially Dr. A. B. W. Kennedy, F.R.S., the consulting electrical engineer; and Mr. F. I. Thomas, who had represented the firm on the spot; Mr. R. R. Forbes Mackay, the electrical engineer; and Mr. L. J. Howell, the foreman of the central-station buildings. The agitation for the light had commenced eight years ago, while the actual work was begun three years ago.

A most important point in this undertaking, which represents an outlay of £153,000, and which at present has a plant actually providing for 240 arc lamps for public street-lighting, and capable of supplying current to 45,000 8-c.p. lamps, is the concession obtained with regard to repayment of loan. This is the first time that a public authority is being granted the privilege of postponing the repayment of instalments for three years, and the concession is especially valuable in the present case, where practically only current for street-lighting is supplied at the start. The Council have thus only to provide interest for the first three years, without being hampered by payments for amortisation of capital. We believe that the success thus obtained is specially due to the individual efforts of the town clerk (Mr. W. Marcus Wilkins), supported by some of the members of the Borough Council.

One of the speakers, Mr. JOHN BURNS, M.P., L.C.C., laid great stress upon the fact that this was the first undertaking of its kind which had been erected by direct employment of labour, and had much to say about the company promoter and the contractor, both of which he appears to regard as a species of noxious animal, upon whose disappearance from Battersea the inhabitants ought, in his idea, to be highly congratulated. He then launched out on his usual diatribe on municipal trading, deplored the ignorance of the local Press, and delighted the audience with some specimens of his own learning by waxing eloquent upon historical points, as, for instance, when he described how Julius Cæsar 2,000 (?) years ago marched over this very spot to fight a rearguard action on Wimbledon Common, etc. He had, however to admit, in the face of the high rates charged in the borough, that it was possible for the present generation to do too much for posterity.

Mr. T. VENN GASKELL, L.C.C., who followed, was not so sure that it would not be better to let a company take the risks attendant upon such undertakings.

Here the audience became very noisy, and were informed by Mr. Livsey that the committee had made a mistake in the time of sunset—they had probably mislaid their office calendar—and that the speeches would have to be spun out in order to fill in another two hours which had to elapse before the lamps could be switched on so as to produce the highest possible dramatic effect.

Mr. A. M. Torrance, J.P., chairman of the L.C.C., finally switched on the current and declared the station open, and after the usual votes of thanks the company proceeded in drags through the street to view the illuminations.

HAMPSTEAD ELECTRICITY ACCOUNTS.

The accounts of the Vestry of St. John, Hampstead, electricity department, have just been issued, from which it appears that the total expenditure on capital account up to March 31, 1901, amounted to £236,544. 8s. 11d. Abstracts of revenue account, general balance sheet, and statement of electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation.						
Coal	£11,451	17	2			
Oil, waste, water and stores	931	0	10			
Wages at generating station	2,541	7	7			
Repairs, etc., of buildings and plant...	680	0	6			
General charges	4	11	6			
				15,613	17	7
Distribution.						
Repairs and maintenance of mains ...	809	11	1			
Transformers, meters, etc.	235	4	10			
Apparatus at distributing stations ...	185	18	10			
				1,230	14	9
Repairs and renewals of public lamps				537	0	9
Rates and taxes				406	9	6
Management expenses				2,270	8	3
Insurance				88	19	8
Testing and certification of meters and indicators				365	6	3
Investment expenses				14	15	2
Miscellaneous				10	10	6
				20,538	2	5
Balance carried to net revenue account				11,540	15	1
				£32.078	17	6

Cr.	£	s	d
Sale of current per meter at 6d. and 2½d. per B.T.U...	26,720	14	5
Ditto at 4d. ditto	1,393	11	11
Public lighting (sale of current and all charges)	2,552	8	7
	30.666	14	11
Rental of meters	1,402	4	9
Sundry receipts	9	17	10
	£32,078	17	6

BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	222,121	0	0
Sundry creditors	5,431	12	3
Reserve fund account	18,603	9	3
Depreciation fund account	3,205	2	7
Balance due to treasurer	24,795	3	4
	£274,156	7	5

Cr. Assets.	£	s	d.
Capital account—amount expended for works	236,544	8	11
Stores on hand at March 31	8,295	9	2
Sundry debtors for current and meter rents	13,185	9	4
Securities held (at cost price)	16,221	0	0
	£274,156	7	5

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STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		2,252,280
Quantity sold { Public lamps	179,562	1,759,147
Quantity sold { Private consumers	1,579,585	
Quantity used on works		34,508
Total quantity accounted for		1,793,655
Quantity not accounted for		458,625
Total maximum supply demanded (kilowatts)		1,506

Number of public lamps, 89 arc, 37 incandescent.

GLASGOW ELECTRICITY ACCOUNTS.

We give herewith abstracts of the revenue account, general balance sheet, and statement of electricity generated, sold, etc., for the year ended May 31, 1901, in connection with the Glasgow Corporation electricity works:

REVENUE ACCOUNT.

Dr.		£ s. d.
Generation of Electricity.		
Coal or other fuel	£19,657 4 5	
Oil, waste, water, and stores	1,559 7 0	
Salaries of superintendents at works	306 1 7	
Wages at generating stations	6,331 4 3	
Carting account	840 1 11	
Repairs, etc., of buildings, etc.	2,139 1 2	
		30,843 0 4
Distribution of Electricity.		
Repairs, etc., of mains, cables, etc.	3,327 0 11	
Repairs, etc., of meters, etc.	873 15 8	
Salaries of surveyors	817 1 9	
		5,017 18 4
Attending and repairing public lamps		1,542 11 11
Rents, Rates, and Taxes.		
Rents and feu duties	1,450 1 7	
Rates, taxes, and assessments	3,630 4 7	
		5,080 6 2
Management Expenses.		
Salaries—engineer's department	1,444 12 9	
Treasurer's department	1,000 10 0	
General establishment charges	1,296 3 6	
Stationery, printing, etc.	422 1 11	
		4,163 8 2
		46,647 4 11
Special charges		4,109 13 4
		50,756 18 3
Balance carried to profit and loss account		28,692 16 8
		79,449 14 11
Cr.		£ s. d.
Sale of current per meter		74,524 9 0
Public lighting		4,925 5 11
		£79,449 14 11

GENERAL BALANCE-SHEET.

Dr.	£ s. d.
Capital account—amount received	885,000 0 0
Sinking fund	27,366 8 7
Accounts due to sundry tradesmen and others	13,604 9 1
Balance due bank	5,694 5 11
	£931,665 3 7
Cr.	£ s. d.
Capital account—amount expended for works	836,146 11 8
Outstanding revenue assets	17,277 10 11
Stocks on hand	41,136 16 6
Sinking fund, invested	27,366 8 7
Suspense account	9,737 15 11
	£931,665 3 7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated, B.T. units.	Waterloo-street	2,665,773	8,254,146
	Port Dundas	5.282,158	
	Pollokshaws-road	228,643	
	Kelvinside	77,572	
Quantity sold	Private consumers	6,290,819	6,813,991
	Public lamps	523,172	
Quantity used on works			626.151
Total quantity accounted for			7.440,142
Quantity not accounted for			814.004
Number of consumers			4,031
Number of public lamps			348
Total maximum supply demanded (kilowatts)			11,787

COMPANIES' MEETINGS AND REPORTS.

CHLORIDE ELECTRICAL STORAGE SYNDICATE.

The ordinary general meeting of this Company was held at the offices, Clifton Junction, near Manchester, on the 27th ult., Dr. F. C. Bowman (the chairman of the Company) presiding.

The directors, in their report for the year ending June 30, 1901, state that the output of the works has been maintained during the year. Although somewhat better prices have been obtained the profits have increased to but a small extent owing to the high price of raw materials. These are, however, now showing a tendency to fall. The negotiations referred to in the last report respecting additional land adjoining the syndicate's property have been concluded and land has been acquired on long lease, running concurrently with the syndicate's old lease, sufficient to provide for any further extensions that may be neeessary for some considerable time to come. The syndicate's exhibit of their battery at the Paris Exhibition, 1900, was awarded the gold medal, the highest class of award made to any storage battery. An agreement has recently been entered into with an eminent firm for the supply of batteries for special purposes, which the directors anticipate will lead to a considerable increase in the syndicate's business. The directors have also secured control of the patent rights protecting an improved method of using storage batteries in connection with central stations for the supply of electrical energy for power and lighting, which will greatly increase the efficiency and utility of the batteries so used. The balance-sheet shows a profit for the year of £9,660. 17s. 1d. After providing £853. 6s. 4d. for debenture interest and writing off from several accounts £4,555 17s. 8d. (an amount which the directors think necessary), there remains a balance of £4,251. 13s. 1d., to which must be added £10,429. 4s. 9d., the amount brought forward from last account, less directors' fees, income tax, and audit fee, amounting to £855. 19s., making for disposal a balance of £14,680. 17s. 10d. The directors recommend that this balance be carried forward, as the money is needed for the conduct of the business. Further capital is required for the extension of the syndicate's operations and for the release of the profits earned for the payment of dividends, but the directors have not concluded any arrangements, as circumstances have not been favourable for raising additional capital on satisfactory terms. The retiring director is Mr. Edward Hopkinson, D.Sc., who being eligible offers himself for re-election. The auditors, Messrs. Parkinson, Mather, and Co., chartered accountants, also offer themselves for re-election.

The **Chairman**, in proposing the adoption of the report as above, referred to the fact that the works had been fully employed during the year. Had they been larger they could have been kept fully going, and seeing that it was necessary to meet the demand for storage batteries, which had really only just begun and was rapidly increasing, additional adjoining land had been obtained on a 999 years' lease at a very small outlay, so that the works could be increased as might be necessary for years to come. Although the Company was making good profits year after year, dividends could not be paid, because it was impossible for the directors to deplete the capital that was necessary for keeping the concern in its full efficiency, and the fall in value in industrial concerns, and even the best securities, such as consols, had not made it desirable for the moment to endeavour to raise fresh capital. He foreshadowed a coming reconstruction of the Company.

This was more fully gone into by **Dr. Edward Hopkinson** in seconding the resolution. Dr. Hopkinson went thoroughly into the accounts before the meeting, and explained that before the present board took over the Company a large sum had been paid for patents which had proved to be not of the value they were supposed to have been when the Company was formed, which value was represented on the credit side of the balance sheet by upwards of £170,000, and on the other side by paper shares. He thought it would be of great benefit to the Company that the items referred to on both sides should be wiped out one against the other, and some fresh capital introduced, so that the balance sheet could be put upon a businesslike basis and the annual amounts earned be paid to the shareholders, instead of being, as now, used to wipe off the old incubus and to provide the necessary working capital. Looking at the year under consideration as a normal one, he thought they could look forward to the continuance of the profits which had been realised in the past, and that they should be in a position to pay a reasonable dividend upon the cash capital of the business, seeing that they had solid assets and a flourishing business.

A **Shareholder** remarked that it was rather hard on them that when enough money had been earned to pay an 18 per cent. dividend on the actual cash capital of the Company they should go empty away.

Mr. Bannister, a director, pointed out that, holding as he did something like 10,000 shares, it would pay him very well indeed to get a dividend. At the same time, as a trustee of the Company representing the interest of the shareholders, he would not be faithful to that trust if he were a party to paying away that money in dividends. Their faithful businesslike conserving of the profits had been its salvation, there not having been more cash paid actually to the Company on which to work than £53,000.

The motion was ultimately carried. Dr. Edward Hopkinson, the retiring director, was re-elected, and the meeting closed with a vote of thanks to the chairman, directors, and staff.

WILLANS AND ROBINSON.

The half-yearly meeting of the proprietors of this Company was held at the Cannon-street Hotel on Wednesday, Mr. Mark Robinson in the chair.

In moving the adoption of the report and accounts, which appeared in our last issue, the **Chairman** first referred to the fact that on this occasion it had been decided to hold the meeting in London instead of in Rugby, as was customary. The reason of this was that they were much more likely to get a better attendance of shareholders in the Metropolis, and as an election to the Board would be proposed, the directors thought there ought to be as large a meeting as possible. Turning to the report and accounts, he thought they were able to congratulate themselves again upon a successful half-year. The profit was not quite so large as for the previous half-year, though a little greater than for the corresponding half-year of 1900. But it had often been pointed out that their system of balancing the accounts half-yearly instead of yearly, as in so many companies, though an excellent system, had the drawback that each set of accounts covered too short a period for the law of averages to take effect—one was liable to fluctuations from merely accidental causes. For some reason,

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the second half of each year was usually better than the first, and they hoped it would be so this year. The fluctuation was hardly great enough to call for detailed consideration, but one obvious cause, it need hardly be said, was the recent high price of materials. Apart from the profitableness or otherwise of their work, they were of necessity passing through a relatively lean time. The extensions at Rugby were coming gradually into use, but the capital they represented did nothing towards earning the dividend which it now received. They blamed themselves sometimes for the apparent slowness with which the extensions had progressed, but after all they had beaten the toolmakers; the buildings were ready first, and had they been ready earlier the money paid for them would have drawn still more deeply from the dividend account. At the Queensferry boilerworks they had £82.141 invested in buildings, plant, etc., at the end of June, and he need not say that this was wholly unproductive and must be so for some time to come. So, under the circumstances, they might congratulate themselves that they had a 10 per cent. dividend, with the usual large amounts carried to reserve. With reference to the boilerworks at Queensferry he knew the great interest the shareholders took in this enterprise, and that news of its progress was axiously waited for. The buildings were practically complete except one—the powerhouse—which he must admit was an important one as it was to produce the electrical and hydraulic power required for working the machinery. The hydraulic presses were for the most part there, and fixed, but they still waited for a good deal of other machinery. One department, however, was complete—viz., the steel-making plant—and they were glad to say that the gas-producers were actually at work, though at present they were only "baking" the furnaces—that was, bringing them into condition for practical work. They hoped to start steel-making in a week or two. As the object of having their own steel works was to secure high and special quality of steel, as well as certainty of delivery, they did not intend to push on too fast, and there was no reason to doubt that the tube works would be ready to make tubes as soon as a supply of the right material was available. He was sometimes asked if they had orders in hand for boilers to ensure business for the new works. Certainly not, nor did they seek them. The orders would come fast enough when they could show the world that they could execute them within a short time. All they had ever said of the Niclausse boiler and its prospects they would repeat now with added force, and they said further that the works would be worthy of the boiler. Of the prospects of the latter in the navy they had spoken in the report. It was useless to say more on the subject at present; it must work out its own conclusion. But let him repeat as emphatically as ever that even if the Admiralty failed in the end to acknowledge the enormous advantages of the Niclausse boiler, even if the fanatics who were trying to put back the clock and restore the old shell boilers in the navy were to succeed, the success of their boiler-making business would still, in the directors' opinion, be assured. They had never even taken the navy work into account in their calculations, but land work only, for on land the best boiler would win, with little reference to prejudice, and with none at all to politics. Of the general progress of the Company it was unnecessary to say much. The shops were full of work, and there seemed to be plenty more before them. The authorised issue of capital was carried out with complete success in the spring, though it could not be denied that the time was, and is, an unfavourable one for financial operations. As regarded writing off the value of patents, that was definitely proposed to the shareholders two years ago, and was approved by them. The amount (£3,335) almost wholly represented the Niclausse boiler license, and as it could not be doubted that the possession of that license, and the prospects of the trade to be built upon it, had proved an element in their success in issuing shares at a premium, it seemed reasonable that a small part of the premiums should be applied to getting rid of the patent account from their books. They had still to receive about £36,000 in premiums on the late issues, so there would be no difficulty in making the invested reserve fund up to an amount beyond the £100,000 of which they had spoken on former occasions—independent of the debenture redemption fund. This was a result of which a company but eight years old might well be proud. Having referred to several items in the accounts, the Chairman said a few words about the retirement of Lieut.-General Sir Richard Sankey, K.C.B., R.E., owing to the pressure of other engagements. General Sankey had brought to the counsels of the Board the support not only of a distinguished name, but of a ripe wisdom and experience gained in high administrative positions both at home and abroad. Sir Richard had been responsible for great engineering works, and though these were rather in the domain of civil than of mechanical engineering, this fact had but added weight to his views as an independent critic of the work carried on by the Company. The regret of parting was as strong upon the one side as upon the other. The work of the Board was growing, and they desired to take the present opportunity to strengthen the Board, not in the sense of replacing Sir Richard by a better man, which would be impossible, but by a man who could give his whole time to the business and allow his whole future to be dependent upon its success. They wanted a third managing director who would especially help them on the commercial side. He limited the term managing directors to Captain Sankey and himself, and would roughly describe the Board as now consisting of two working managers and three independent advisers and critics, who not being always present were not available for dealing with the many knotty points of daily administrative work. With a third working manager they would be strengthened where strength was wanting, and they would still have two directors whose special function would be to watch over the interests of their sleeping partners, the shareholders at large, and the latter would not, he thought, need stronger representatives, nor could any Board need more vigilant critics than Sir Gilbert Clayton East and and Mr. T. O. Lazenby. Such being the object in view, it was natural to recommend for election a member of the Company's staff, and the selection of Mr. Arthur Lazenby was based upon the fullest consideration. Mr. Lazenby had now for some years had charge of the foreign branch of the business, and he (the chairman) could assure them, for all his colleagues, that they could not have one more acceptable to them on the ground of character, of ability, or of devotion to the Company's interests, nor one to whom he personally could more confidently depute those portions of his work from which he was seeking relief. The Chairman then formally moved the adoption of the report and accounts.

Mr. A. Holland seconded the motion.

In reply to shareholders, the **Chairman** announced that it was hoped to begin turning out boilers from the Queensferry works in 12 months' time. As regarded the relations between the Company and their workmen, they were of the most friendly nature.

The motion was carried *nem. con.*, and the dividends recommended were declared.

Sir Richard Sankey then formally resigned his seat on the Board, and in an appropriate speech explained that he was forced to take his present action, much to his regret, through the pressure of other engagements.

The **Chairman** afterwards submitted a resolution in favour of the appointment of Mr. Arthur Lazenby as a director of the Company, and that he be remunerated by a salary of £800 per annum, increasing by periodical increments to £1,200 per annum, and further by a contingent share of profits—3 per cent. on the net profits remaining after payment of 7 per cent. on the ordinary shares.

Having been seconded the motion was ultimately adopted. The meeting concluded with a vote of thanks to the chairman.

BRITISH ALUMINIUM.

At the general meeting of this Company, held at Winchester House on the 26th ult., **Mr. R. W. Wallace, K.C.**, who presided, stated that the Company's business was rather scattered, there being no fewer than seven different branches. An important matter which had engaged the directors' attention was the obtaining of the Var deposits of bauxite, upon which the chief makers of aluminium throughout the world drew for their raw product. The question of the Highland water-power works had subsequently to be dealt with. Their petition for an extension of the patent referred to in the report was not obtained, and the directors had therefore had to pay considerable attention to the combination of producers of aluminium throughout the world. In connection with that matter there was a conference at Basel, at which there were representatives of the Swiss and German companies and of two French companies. At their request he proceeded to America to carry on negotiations with the American company, which was the largest producer of aluminium in the world. At Larne, Greenock, and Foyers, in so far as they used coke for the production of carbide of calcium, the abnormally high price of coal had greatly affected the profit shown; and it was a matter of great congratulation that the bulk of the Company's heat was obtained from water power. The accounts relating to the carbide of calcium showed a loss of £3,142 for the 8½ months to Dec. 31 last. Another matter which had materially affected the dividend-earning capacity of the company was that they had a large amount of money invested in things which were at present unremunerative. A certain sum had been written off for depreciation, and the amount set aside for repairs and maintenance had been increased. He had seen works put up in America both as regarded water and the utilisation of that power, and their own works were far more permanent and required much less to be expended on them for maintenance and repairs than the works he had seen anywhere else. He had heard it remarked that it was a pity that the company embarked on the manufacture of carbide of calcium, but he explained how this step had been rendered necessary. They were certainly at present losing on this investment, but as soon as this matter was put right the company's accounts would be in a very different position. If the sales of aluminium had been greater they would have been able to use their water power, and they need not have gone into other matters. In the end, however, he believed that they would be thoroughly successful, and their knowledge of electrical furnaces helped them to be in a position to take advantage of new things that were coming on. He was thankful to say that after a great fight in both Houses of Parliament the directors were enabled to obtain for the Company the water-power works at Loch Leven. They had taken what they considered to be the only remunerative portion of this scheme, and the Company had got what would give them about 18,000 h.p.—it was the best water-power in the United Kingdom—which would be developed within the course of the next three or four years. He had just returned from America, and he had seen what was being done at Niagara, which, when he visited it only six years ago, was a small village, whereas there were now immense works all along the banks, and a great deal of energy was being developed, which was being utilised in various ways. In these new power companies in America only the bond interest was at present being paid, and a certain amount of patience had to be exercised by shareholders in developing such industries. Their late colleague, Dr. A. A. Common, had had to retire owing to ill-health, and Mr. J. D. Bonner had been elected to the seat thus vacated at the Board. Mr. Bonner, who represented Mr. Charles Morrison, who owned over £100,000 in the Company's capital, had been devoting his time and energy to the business, especially in connection with getting aluminium adopted as an article of domestic use. Mr. Wolfenden had also undertaken to join the Board and to assist Mr. Ristori, the managing director. In obtaining the additional capital required, assistance was rendered by Lord Rothschild, Mr. Charles Morrison, and Messrs. Werner, Beit, and Co. He was quite certain that the demand for aluminium would continue to increase. The Government were at last waking up to the necessity of ordering it, and had sent the Company a large number of things. The United States Mint were now experimenting with aluminium as coinage; and all the cables and wires which conducted the current throughout the

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Glasgow Exhibition were made of aluminium. In conclusion he moved the adoption of the report.

Mr. Robert Heath seconded the motion, which was carried unanimously.

JOHNSON-LUNDELL ELECTRIC TRACTION.

Mr. Leonard W. Holmes, presided at the second general meeting of the shareholders of this Company at the Holborn Restaurant on Wednesday, and in moving the adoption of the report, stated that the revenue showed a deficiency of £4,927, being insufficient to meet all expenses.

Mr. G. B. Hunter, in seconding the motion, expressed great disappointment at the result of the year's working. It was hoped, however, to make greater progress in placing the company's apparatus and inventions before the public at home and abroad than had been done during the year under review, and the directors were hopeful when they next met to present a report which would be satisfactory to the shareholders.

A **Shareholder** could not see any prospect for the Company because the works were quite inadequate to carry on a large business. He advocated the winding-up of the company.

In reply to another shareholder, who desired to know why calls amounting to £12,000 were in arrears, the chairman said the directors did not like to unduly press the underwriters for their calls; but they thought they had given them sufficient latitude, and they had decided now to press them for those calls. Although the directors had put a great amount of work into the Company, they had decided to forego their fees for the year under review. The Board had had a great many difficulties to contend against, and that had been the cause of the unsatisfactory result of the year's working. They, however, were convinced that for some time to come they could carry on the business without making further calls, because they anticipated in a very short time to be able to conclude the sale of the German patents for a considerable sum. He had no reason to doubt the ultimate success of the Company.

Eventually the motion for the adoption of the report was carried.

ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS.

Presiding at the third ordinary general meeting of this Company held at Preston, **Mr. G. Richardson** said the profit for the year was £21,200, and to this had to be added £3,900 brought forward from last year, making a sum of £25,100 to be dealt with. The directors recommended that they should write off the whole of the expenses referred to in the previous report—£7,342. The payment of a dividend of 8 per cent., less income tax, meant £12,000, and there was £3,778 left to carry forward. It was true the Company had worked on rather short capital, but that had been simply on account of the increase of their business, and on account of delays in getting payments from corporations. In coming for fresh capital, they proposed issuing debentures to the amount of £50,000 at 5 per cent., shareholders having the preference in subscribing. All the money would be employed practically as working capital, and they would be able to clear off their liabilities to the bankers. He then formally moved the adoption of the report and accounts.

Mr. Prestwich seconded the motion, which was carried *nem. con.*

CAPE ELECTRIC TRAMWAYS.

In their report for the year ended June 30 last the directors state that the profit and loss account on the 12 months' working, after provision for debenture interest, shows a net balance to credit of £75,922, which, added to the balance of £11,319 (brought forward from last year), makes a gross total profit of £87,241. From this sum the directors have paid to the shareholders 12 per cent. upon their capital, represented by two interim dividends. The first of these at the rate of 6 per cent. was paid on Feb. 1, and amounted to £24,000, and the second at the rate of 6 per cent. was paid on Aug. 2, and amounted to £26,400. The directors have also placed to the credit of the reserve fund the sum of £8,000, and to the special reserve fund the sum of £12,000, making a total of £20,000 passed to reserve for the year under review. These several sums aggregate a gross total of £70,400, and leave a balance of profit of £16,841, which has been carried forward to next year's account. From this amount, however, provision has to be made for the remuneration of the directors, which shareholders will be asked to vote at the meeting. During the 12 months' working the Cape Town system has carried 13,056,965 passengers, as against 11,332,627 passengers in the preceding year. The Port Elizabeth system has carried 3,253,656 passengers, as against 2,967,420 passengers in the preceding year The grand total of passengers carried on both systems for the preceding year was 14,300,047. For the year under review the total number is 16,310,621, which shows a satisfactory increase of 2,010,574. After negotiations extending for some years with the Harbour Board, the Cape Government Railway, and the Municipality of Cape Town, the directors are pleased to announce that at length a joint agreement has been arrived at for the extension of the Company's tramway system from the bottom of Adderley-street to the dock gates. A further addition to the Hanover-street line has been constructed during the year under review with most satisfactory results, the traffic on this particular portion of the system having doubled since its completion. The directors, having purchased the suburban railway from Adderley-street to Sea Point (called the "Sea Point Railway"), are now applying for an Act of Parliament to electrify it with a view to establishing an express service to that important suburb. It is hoped that the assent of the Legislature will be obtained at its next session, as the directors anticipate that this line would be an important and profitable adjunct to the Cape Town system. The extension from Port Elizabeth to Humewood has been delayed pending the conclusion of a joint arrangement with the Harbour Board of Port Elizabeth and the Municipal Town Council. The directors are now pleased to report that all difficulties have been overcome, and that an agreement has been concluded, as the result of which the construction of this extension will be proceeded with at once.

DIRECT WEST INDIA CABLE.

The directors' report for the year ended June 30 last states that the net result of the year's working was a profit of £5,236, as compared with £5,456 for the previous year. An interim dividend of 3 per cent. has already been paid, and it is proposed (after providing £591 for depreciation of spare cable and other stores) to make a further equal payment, which would leave £2,796 to be carried forward. This will increase the amount to the credit of revenue account to £27,943. The Company's cables continue to work with complete efficiency. Offers for the sale of debentures to the trustees were invited in December and June last, and £6,695 was paid for £6,700 of debentures, which has been written off capital expenditure.

ANGUS ELECTRIC LIGHT AND POWER.

On the 26th ult. the second annual meeting of the shareholders in this company was held at Montrose, ex-Provost Scott Brechin in the chair.

The directors, in their report, which was submitted and ultimately adopted, state that as the works are scarcely completed, and have been running for a short time only, it is not possible to present any accounts to the present meeting. The number of shares taken up by the public is very small, and practically the whole of the capital so far required has been subscribed by Edmundson's Electricity Corporation. The supply of electricity was commenced in Montrose on June 29, 1901, and in Brechin on July 2, 1901. The applications for lamps received up to date are in Montrose equivalent to 2,385 8-c.p. lamps, together with street lamps, equivalent to 60 of 8-c.p., and in Brechin equivalent to 1,790 8-c.p. lamps, together with street lamps equivalent to 219 8 c.p. The directors consider that this is a very satisfactory commencement considering the short time the Company has been in a position to supply electricity. Arrangements have been made for lighting the principal streets in Montrose and Brechin by electricity, and the new lights will be in full operation in a few weeks. A number of incandescent lamps are already in operation.

The retiring directors, Messrs. Vallentine and Gripper, having been re-elected, the meeting closed.

ELECTROLYTIC ALKALI.

In submitting their first report from the incorporation of the Company to Aug. 31 last, the directors consider that they were fortunate in securing through the parent company the property at Middlewich, consisting of upwards of 73 acres, at a cost of less than £15,000, which was the amount actually paid by the parent company for it. As compared with other salt land in the district, this must be considered a very valuable asset to the Company. Boring operations were started in February, 1900, and brine of excellent quality was found. Subsequent operations have convinced the directors that the supply is practically inexhaustible. The anticipated results of working have been realised, taking into account the extent of the plant laid down and the short period of working. The products command a ready market—in fact, the demand for them is greatly in excess of the capacity of the present plant. The existing plant is, so far, only applied to the production of bleaching powder and soda crystals. The cost of production will be reduced in proportion as the working plant is increased, and the directors are so satisfied with the results that they strongly recommend the immediate extension of the plant. For this the directors proposed to provide the necessary capital by making a further issue of shares in the Company. The directors consider that the profit—£1,241—earned by the working of an average of 36 cells during about 4½ months, although under the serious disadvantages of stoppages for adjustment of machinery, etc., incidental to the starting of all new works, is satisfactory, and they recommend that the amount be carried forward.

APPOINTMENTS VACANT.

Trolley Linesmen, Manchester Corporation tramways, 9d. per hour. Full particulars in our advertisement columns.

Resident Electrical Engineer, Bootle Corporation, £350 per annum, Oct. 14. Full particulars in our advertisement columns.

Draughtsman, for large switchboard and motor work. Full particulars in our advertisement columns.

Electrician, with experience in resistances, to assist in completing new invention. Full particulars in our advertisement columns.

Head Foreman, for works manufacturing switchgear and central-station equipment. Full particulars in our advertisement columns.

Engineer, to take charge of electric light and power department. Full particulars in our advertisement columns.

Partner, to buy out certain interests and form a new company. Full particulars in our advertisement columns.

Electrical Engineer, in Public Works Department, Jamaica, three years' engagement. £500 per annum, Oct. 7. Full particulars from Messrs. Preece and Cardew, 13, Queen Anne's-gate, S.W.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

East London.—Tenders are invited for the supply of a 50-kw. alternator and engine. Tenders by Nov. 26. Details in our advertisement columns.

Stepney.—The Electrical Committee invite tenders for arc lamp columns, lamps, fittings, switchboard, etc., by Oct. 17. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of main switchboard. Tenders by Oct. 14. Details in our advertisement columns.

Blackpool.—The Corporation invite tenders for poles, plinths, etc., cables, etc., overhead materials, trolley wire, and bonds, 20 electrical car equipments. Tenders by Oct. 21. Details in our advertisement columns.

London, W.—The Directors of the Great Western Railway invite tenders for the supply of the various stores from Dec. 1 next to Nov. 30, 1902. Tenders by Oct. 21. Details in our advertisement columns.

Jaen (Spain).—Tenders are invited for construction of an electric tramway from Liscares to the Mines. The deposit required is 11,105·75 pesetas. Further particulars may be obtained from the Public Works Department, Madrid.

Ilford.—The School Board invite tenders for wiring and all ordinary fittings for about 200 lamps of 16 c.p. Specifications, etc., can be seen at the office of the Board's architect, Mr. C. J. Dawson, F.R.I.B.A., 7, Bank-buildings, Ilford. Tenders by Oct. 7.

Oldham.—The Electricity Committee invite tenders for the work required in constructing the proposed new generating station at Greenhill, Oldham. Specifications, etc., can be obtained on application to Mr. Arthur Andrew, Gas and Water Offices, Oldham. Tenders by Oct. 8.

Luton.—The School Board invite tenders for the supply and erection of fittings and apparatus for using the electric light in the Board's offices and in other buildings in Waller-street, Luton. Specifications may be seen at the Offices, Waller-street, Luton. Tenders by Oct. 15.

Madrid.—The Department of Agriculture invite tenders for the installation and working of an electric tramway for not more than 60 years. The route is from Linares to the mines of San Rogue and Tortilla. The deposit is 11,105 pesetas provisional, and 55,526 pesetas finally. Tenders by Oct. 17.

Leeds.—The Lighting Committee invite tenders for the supply of a main switchboard to deal with the output of three 1,500-kw. 50-period two-phase alternators, and comprising dynamo panels, feeder panels, synchronising apparatus, etc. Tenders by Oct. 8. Details in our advertisement columns.

Newport (Mon.).—The Corporation invite tenders for the supply and erection of winches, cables, overhead construction, complete electric motorcar, and repair shop equipment. Specifications, etc., can be had on application to Mr. H. F. Parshall, consulting engineer, 8 Princes-street, Bank, London, E.C. Tenders by Oct. 21.

Boulder City (Western Australia).—The Boulder City Council invite tenders for construction of about 3½ miles of electric tramway, with all necessary plant complete according to specifications, and the right to construct and run tramways within the municipality. Tenders by Nov. 23. Details in our advertisement columns.

Leeds.—The Corporation invite tenders for supply of 50 electric motorcars. Specification, etc., may be had from Mr. Thomas Hewson, M.I.C.E., city engineer, Municipal Buildings, Leeds; or from Messrs. Hopkinsons and Talbot, consulting engineers, 26, Victoria-street, London, S.W., and 29, Princess-street, Manchester. Tenders by Oct. 15.

Darlaston.—The British Electric Traction Company invite tenders for the construction and reconstruction of about eight miles of tramways in the district between Wolverhampton and Darlaston, in the county of Stafford. Specification, etc., can be obtained on application to the Chief Engineer of the Company, Donington House, Norfolk-street, London, W.C. Tenders by Oct. 18.

Halfway Street (near Sidcup, Kent).—The Greenwich Board of Guardians invite tenders for the proposed electric lighting installation at the new children's homes now building at Halfway Street, near Sidcup, Kent. Specification, etc., may be obtained and plans seen at the offices of the architect, Mr. Thomas Dinwiddy, F.R.I.B.A., 12, Croom's-hill, Greenwich, S.E. Tenders by Oct. 10.

Stourbridge.—The British Electric Traction Company invite tenders for the construction of about 2½ miles of tramways in the neighbourhood of Stourbridge, in the county of Worcester. The electrical equipment of the tramways is not included in the contract. Specifications, etc., can be obtained on application to the Chief Engineer of the Company, Donington House, Norfolk-street, London, W.C. Tenders by Oct. 18.

London, S.W.—The London County Council invite tenders for track rails and fastenings, slot rails and fastenings, tiebars and conductor tees, and roadwork and platelaying required for the construction on the conduit system of the tramway routes between Westminster Bridge, Blackfriars Bridge, and Waterloo Station respectively, and Tooting. Specifications and other particulars may be obtained from the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

London County Council.—The County Council invite tenders for work to be done in supplying, fitting, and fixing lifts, motors, pumps, ventilating fans, lamps, cables, wires, conductors, switchboards, and columns, together with all supports, apparatus, fittings, and accessories which may be necessary or required for the electrical equipment of the Greenwich footway tunnel and its approaches. Specifications, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

General Post Office.—Tenders are invited for the purchase of about 40 tons of guttapercha, 100 tons of old copper wire, plates, etc., 100 tons of iron, a quantity of other metals (brass, zinc, and lead), indiarubber-covered copper wire, tools, raw and limed hide pieces, electric light wire, fittings, glow lamp tops, accumulators, dry battery cells, tarpaulin, felt, jute serving, etc., the whole being arranged in convenient lots. A form of tender, containing all particulars, can be obtained on application, by letter, to the undersigned. Tenders will be received until 10 a.m. on Wednesday, Oct. 16, 1901.

Manchester.—The Electricity Committee invite tenders for supply, delivery, and laying of the following cables: (a) three-core, three-phase, high-tension feeders, approximate length, 74 miles; (b) traction feeders, approximate length, 7 miles; (c) lighting feeders, approximate length, 3½ miles; (d) distributors, approximate length, 33 miles; (e) potential wires, approximate length, 11¼ miles; (f) arc lighting cables, approximate length, 15½ miles; (g) telephone cables, approximate length, 3½ miles. Specifications, etc., may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by Oct. 9. Full particulars appear in our advertisement columns.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a continuous-current 1,500-kw. dynamo working at from 550 to 625 volts, and the erection of these sets in the generating station of the South London Electric Supply Corporation, near Loughborough Junction. Also for three auxiliary 250-i.h.p. vertical high-speed enclosed steam-engines, each coupled direct to a continuous-current dynamo working at from 200 to 225 volts, and for the erection of these sets in the Council's generating station at Greenwich. Specifications and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

London County Council.—The County Council invite tenders for the supply and delivery of two 2,500-i.h.p. vertical steam-engines, each coupled direct to a three-phase 1,500-kw. generator working at from 6,500 volts between conductors, each with an exciter, and for one 750-kw. reversible synchronous motor-generator, with exciter, designed so that either the low-tension or the high-tension side of the set will act as generator, and for the erection of these sets in the Council's generating station at Greenwich; also for nine 300-kw. synchronous motor-generators, working at from 550 to 600 volts on the low-tension side, each with an exciter, and for three 50-kw. induction motor-generators, working at from 200 to 225 volts on the low-tension side, and the erection of these sets in sub-stations provided by the Council. Full particulars may be had at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Oct. 8.

RESULTS OF TENDERS.

Blackpool.—The Corporation have accepted the tender of T. Dryden, Grimshaw-street Foundry, Preston, for supply of 40 arc lamp canopies.

Blackburn.—The Electricity Committee have accepted the tender of Dick, Kerr, and Co. for three 850-kw. steam dynamo sets, with Belliss engines.

Deptford.—The Borough Council have accepted the tender of the Hart Accumulator Company, Limited, Stratford, E., for the supply of 45 of their standard lighting type cells at the public baths, Lauriegrove.

Dundee.—The tenders for the overhead equipments of the Constitution-road and Victoria-road routes have been opened, and those of Blackwell and Co., Limited, amounting altogether to £4,598. 10s. 10d., are recommended for acceptance.

Warrington.—The Tramways Committee have accepted the tender of the British Thomson-Houston Company for eight tramcars at £5,058. 15s., on condition that the car-bodies were provided with the improvements introduced by Messrs. Milnes and Co. in the new cars supplied to the Birkenhead Corporation.

Bournemouth.—The following tenders have been received for the Corporation tramways. Mr. F. W. Lacey, M.I.C.E., borough and tramway engineer, and Messrs. Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, S.W., consulting electrical engineers:

Contract No. 3, boilers, etc.: J. Thompson, Wolverhampton (Section A), £5,000, (B) £1,750, (C) £1,500, (D) £2,750, (E) £7,000—total, £18,000.

Fraser and Son, Milwall, E. (Section A), £4,072, (B) £1,400, (C) £844, (D) £1,738, (E) £5,285—total, £13,339.

Tinkers, Limited, 52, Queen Victoria-street, E.C. (Section A), £4,380, (B) £1,452, (C) £801, (D) £2,320, (E) £3,840—total, £12,793.

Yates and Thom, Blackburn (Section A), £4,061, (B) £1,465, (C) £812, (D) £1,772, (E) £3,767—total, £11,877.

E. Danks and Co., Limited, Birmingham (Section A), £3,610, (B) £1,415, (C) £835, (D) £1,255, (E) £2,285—total, £9,400 (accepted).

Babcock and Wilcox, Limited (tender incomplete).

Contract No. 4.—Water cooler.

W. Watson, Bradford	£3,570
Wheeler Condenser Company, 179, Queen Victoria-street, E.C.	1,721
Doherty and Donat, Manchester	880
Klein Engineering Company, Manchester (cooling surface, 106,000 square feet) (accepted)	859
Couper, Schwarz, and Co., Liverpool (cooling surface, 26,000 square feet)	773
A. Koppel, 27, Clement's-lane, E.C. (cooling surface, 36,432 square feet)	750

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Contract No. 5.—Travelling crane.

Herbert, Morris, and Bastert, Loughborough	1,450
Carrick and Ritchie, Edinburgh	365
Chatteris Engineering Works Company, Old Broad-street, E.C.	363
J. Spencer and Co., Manchester	350
J. Carrick and Son, Edinburgh (accepted)	326
J. Hitchen and Sons, Halifax	285

Contract No. 10.—Permanent-Way Construction (Trolley System).

W. Griffiths and Co., Limited (A) £18,860. 2s. 3d., (B) £37,546. 13s. 11d., (C) £37,430. 18s. 5d.; deduction if 45ft. rails be used, £322. 16s. 6d.

J. G. White and Co., Limited (A) £15,743, (B) £29,687. 15s. 9d., (C) £48,290. 7s. 6d. (accepted); deduction if 45ft. rails be used, £100.

Dick, Kerr, and Co., Limited, (A) £16,237. 16s. 4d., (B) £43,682. 15s. 7d., (C) £52,143. 17s. 7d.; addition if 45ft. rails be used, £1,124. 10s. 3d.

W. M. Murphy (A) £21,802, (B) £53,610, (C) £49,541; deduction if 45ft. rails be used, £3,453.

E. Nuttall (A) £15,194. 11s. 3d., (B) £42,507. 17s. 10d., (C) £42,056. 2s.; no deduction or addition.

McCartney, McElroy, and Co. (A) £17,083. 13s. 5d., (B) £38,524. 5s. 9d., (C) £39,627. 11s. 4d.; additions if 45ft. rails be used, £2,805. 9s. 1d.

B. Cooke and Co. (A) £20,645. 15s., (B) £42,005. 6s. 7d., (C) £44,148. 18s. 5d.; additions if 45ft. rails be used, £1,500.

G. Law (A) £22,836. 9s., (B) £53,710. 16s. 4d., (C) £52,440. 7s. 6d.; additions if 45ft. rails be used, £3,081. 18s. 6d.

Contract No. 11.—Electric Conduit System.

J. G. White and Co., Limited (A) £4,055. 8s. 6d., (B) £26,931. 3s. 4d., (C) £2,000, (D) £25,630. 8s. (accepted); deduction if side slot, £465.

Dick, Kerr, and Co., Limited (A) £4,206. 15s., (B) £30,000, (C) £2,525, (D) £26,925. 10s.; no deduction.

W. Griffith and Co., Limited (A) £2,596, (B) £41,289, (C) £250, (D) £16,171; no deduction.

British Thomson-Houston Company (A) £4,510, (B) £31,175, (C) £2,376, (D) £29,648; no deduction.

British Westinghouse Company (A) £3,093. 2s., (B) £27,493. 12s. 4d., (C) £444. 13s. 6d., (D) £28,084. 15s. 11d.; no deduction.

Worcester.—The following tenders have been received by the Corporation for electrical plant to be installed in the new electricity works. Mr. C. J. Sutherland, city electrical engineer:

Section A.—Boilers.

Renshaw and Co.	£6,750	0	0
Rowland and Co.	6,420	0	0
Danks, horizontal boilers	6,522	0	0
Danks, vertical	5,322	0	0
Allgemeine Electricitats Gesellschaft, Babcock boiler	6,240	0	0
Hornsby and Son (including flues)	6,154	0	0
Stirling Boiler Company	6,055	0	0
Crompton and Co.	5,688	10	0
Babcock and Wilcox (accepted)	5,597	0	0
J. Thompson, Durr boilers	5,275	0	0

Section B.—Engines and Dynamos.

Johnson and Phillips, Clayton engines	9,125	0	0
Johnson and Phillips, Allen engines	9,560	0	0
Johnson and Phillips, Belliss engines	9,670	0	0
Johnson and Phillips, Browett-Lindley engines	9,980	0	0
Johnson and Phillips, Willans engines	10,490	0	0
Witting Bros., Belgian dynamos, Belliss engines	8,500	0	0
Electric Construction Company, Belliss engines	10,058	0	0
Electric Construction Company, Ferranti engines	10,988	0	0
Sir W. G. Armstrong Whitworth Company, Browett-Lindley engines	11,415	0	0
Royce, Limited, Belliss engines	10,200	0	0
British Westinghouse Company, Belliss engines	9,769	0	0
British Westinghouse Company, Ferranti engines	10,750	0	0
British Westinghouse Company, Willans engines	10,894	0	0
British Westinghouse Company, complete gas plant in place of Sections A B C	23,250	0	0
De Grelle, Hondres, and Co., Belliss engines, Brunswick dynamos	8,000	0	0
Mather and Platt, Willans engines	10,740	0	0
Mather and Platt, Belliss engines	10,396	0	0
Mather and Platt, Browett-Lindley engines	10,390	0	0
Parsons and Co., steam turbines, no contingencies, or motor-alternator, or booster included	7,629	0	0
Allen and Sons, own engines. International dynamos	8,348	0	0
Allen and Sons, own engines, Johnson and Phillips dynamos	9,722	0	0
Allgemiene Elektricitäts, Belliss engines	9,912	0	0
Gesselschaft, Ferranti engines	8,162	0	0
Lancashire Dynamo Company, Belliss engines	9,400	0	0
Lancashire Dynamo Company, Willans engines	9,830	0	0
Lancashire Dynamo Company, Browett-Lindley engines	9,230	0	0
International Electrical Engineering Company, Belliss engines, Liège dynamos	8,250	0	0
International Electrical Engineering Company, Allen engines, Liège dynamos	7,940	0	0
International Electrical Engineering Company, Ferranti engines, Liège dynamos	8,495	0	0
British Thomson-Houston Company, Belliss engines	8,872	0	0
British Thomson-Houston Company, Allen engines	8,640	0	0
Vauxhall Ironworks Company, own engines, dynamos to be International Company's Liéges	4,817	0	0
F. Suter and Co., Belliss engines	8,924	0	0
British Schuckert Company, Belliss engines	8,747	0	0
British Schuckert Company, Davy-Paxman engines	8,784	4	0
British Schuckert Company, Browett-Lindley engines	8,580	4	0
British Schuckert Company, Willans-Robinson engines	9,017	0	0
British Schuckert Company, Ferranti engines	8,732	4	0
Laurence, Scott, and Co., Belliss engines	9,400	0	0
Lahmeyer and Co., Belliss engines	9,780	0	0
Siemens and Co., Belliss engines	9,440	0	0
Siemens and Co., Browett-Lindley engines	9,982	0	0
Siemens and Co., Willans-Robinson engines	10,369	0	0
Crompton and Co., Belliss engines	9,840	0	0
Ferranti, Limited, Schuckert dynamos	9,297	0	0
Ferranti, Limited, Dick-Kerr dynamos	10,275	0	0
Ferranti, Limited, Lahmeyer dynamos	10,352	0	0
Ferranti, Limited, Westinghouse dynamos	11,045	0	0
Ferranti, Limited, E.C.C. dynamos	11,347	0	0
Ferranti, Limited, Bruce-Peebles dynamos	11,243	0	0
E. Scott and Mountain, own engines and dynamos	9,400	0	0
Bruce Peebles and Co., Belliss engines (accepted)	9,769	0	0
Bruce Peebles and Co., Ferranti engines	10,917	0	0
Brush Company, Belliss engines	9,785	0	0
Johnson, Lundell, and Co., Shanks engines	8,490	1	6
Johnson, Lundell, and Co., Belliss engines	8,622	16	8
Johnson, Lundell, and Co., Browett-Lindley engines	8,881	7	0
Dick, Kerr, and Co., Belliss engines, English Manufacturing Company's dynamos	9,176	0	0
Dick, Kerr, and Co., Browett-Lindley engines	9,255	0	0
Dick, Kerr, and Co., Willans engines	9,822	0	0
Sunderland Forge Company, Belliss engines	9,716	0	0
T. Parker, Limited, Willans engines	10,075	0	0
T. Parker, Limited, Belliss engines (without spares)	9,163	0	0
T. Parker, Limited, Browett-Lindley engines	9,718	0	0

Section C.—Condensing Plant.

Danks	2,127	10	0
Sharpe and Co.	1,962	0	0
Lucy and Co.	1,892	0	0
Babcock and Wilcox	1,870	0	0
Korting	1,841	0	0
Allgemeine	1,819	0	0
Ledward and Co.	1,800	0	0
Crompton and Co.	1,773	0	0
Sir Hiram Maxim Engineering Co. (accepted)	1,649	0	0
Sharpe and Co. (alternative tender)	1,566	0	0

Section D.—Switchboard.

Witting Bros.	2,040	0	0
Thomson-Houston	1,506	0	0
Ferranti, Limited (accepted)	1,490	0	0
Loughlin and Co.	1,500	0	0
General Electric Company	1,450	0	0
Thomson-Houston Company (alternative tender)	1,378	0	0
S. and H. Heywood and Co.	1,360	0	0
Walsall Electrical Company	1,313	11	0
Nalder Bros. and Thompson	1,312	0	0
Meechan and Son	1,300	0	0
Statter and Co.	1,278	17	9
T. Parker, Limited	1,251	0	0
Siemens and Co.	1,240	0	0
Lahmeyer and Co.	1,217	0	0
British Westinghouse Company	1,212	0	0
Cowans, Limited	1,097	0	0
Brook, Hirst, and Co.	1,084	0	0
Allgemeine	1,065	0	0
Clayton and Co.	1,062	0	0
Dorman and Smith	1,050	0	0
B. Thomas	1,032	0	0
Crompton and Co.	1,002	0	0
Veritys, Limited	956	0	0
Johnson and Phillips	955	0	0
B. Thomas	953	0	0
J. E. Spagnoletti and Co.	931	0	0
International Electric Company	920	0	0
Heaton and Smith	870	0	0
Electrical Transmission Company	830	0	0
British Schuckert Company	695	0	0

Section E.—Overhead Travelling Crane.

Witting Bros., electrical crane	700	0	0
Witting Bros., hand crane	344	0	0
J. Booth and Sons	350	0	0
Broadbent and Son	335	0	0
Bedford Engineering Company	300	0	0
Danks	257	0	0
J. Spencer and Co.	250	0	0
Allgemeine	240	0	0
Chatteris Engineering Company	235	0	0
Carrick and Ritchie	229	0	0
J. Carrick and Sons	190	0	0
H. Morris and Bastert (accepted)	174	0	0

Section F. Accumulators.

Sutherland and Marcuson	2,489	0	0
Tudor Accumulator Company	2,245	0	0
H. E. Keen and Co. (Chloride cells)	1,940	0	0
Chloride Storage Company	1,916	0	0
D. P. Battery Company	1,850	10	0
Electrical Power Storage Company	1,732	7	0
Longstreths, Limited (Lithanode cells)	1,716	0	0
British Power, Traction, and Lighting Company	1,651	14	0
W. O. Roper and Co. (Epstein cells)	1,651	0	0
F. Suter and Co.	1,470	0	0
Allgemeine (Hart cells)	1,407	0	0
Veritys, Limited (Pritchett and Gould cells)	1,403	0	0
Hart Accumulator Company	1,365	13	0
Ashmore, Benson, and Pease (accepted)	1,317	10	0

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King's Lynn.—The Corporation have accepted the tender of the British Insulated Wire Company, at £412. 1s. 2d., for the supply of 920 yards 0·3 square inch concentric cable, insulated and lead covered, with earthenware troughing, joint boxes, compound, etc.

East Ham.—The following tenders for extension of tramways have been referred to the Works Committee:

Dick, Kerr, and Co.	£5,793	7	6
G. Wimpey and Co.	5,955	0	0
W. Griffiths and Co.	6,254	9	6

Hull.—The Town Council have accepted the tenders of Clayton and Co., Limited, Leeds, to supply four boilers at a cost of £2,492. 10s.; and of Thomas Parker, Limited, Wolverhampton, for two dynamos at a cost of £3,951. Tenders had been received for the supply of two steam engines, but none were accepted, they being referred to the engineer for enquiry.

BUSINESS NOTES.

TRACTION.

Erdington.—There is some talk of taking a plebescite of the town on the question of the tramways.

Wigan.—The question of introducing reduced rates on the tramcars for workmen is under consideration.

Chester.—The Town Council have appointed a special committee to deal with all questions relating to tramways.

Cape Electric Tramways Co.—The ordinary meeting of this company will be held at Winchester House on 16th inst.

Maidstone.—At a special meeting of the Town Council a motion for the putting down of six miles of tramway lines was rejected.

Stoke-on-Trent.—A sub-committee has been appointed to draft by-laws in respect of the tramways and light railways in the borough.

Reading.—The Corporation formally took over the horse tramway system on Tuesday. The lines will be equipped for electric traction on the overhead trolley system.

Llanfair Light Railway.—The Montgomery County Council have decided to advance to the Welshpool and Llanfair Light Railway Company a sum of £10,000.

Northampton.—At a special meeting on Monday the Corporation decided by a unanimous vote to purchase the Northampton Tramway Company's undertaking at £37,500.

Gringley-on-the-Hill.—The proposal to build a light railway at this place is creating a good deal of interest in the district, and is receiving the support of the inhabitants.

Folkestone.—It was formally reported at the last Town Council meeting that steps were being taken to apply for powers for an electric tramway from Broadmead-road to Guildhall-street.

Anglo-Argentine Tramways Company.—The Directors have declared an interim dividend of 2s. per share, and carried forward £9,429 to be dealt with in the final accounts of the year.

West Ham.—The Town Council have approved a report from the Highways Committee recommending certain street widenings preparatory to the construction of the proposed tramways.

North Notts Light Railway.—Meetings have been held at Misterton and Gringley in connection with this scheme, when it was unanimously decided to support the proposed light railway.

Soothill Upper.—The District Council have sealed their agreement with the British Electric Traction Company, and the construction of the projected electric tramways will shortly be proceeded with.

Llandudno.—The Urban District Council and the Llandudno, Colwyn Bay, and Rhyl Traction Company, Limited, have arranged terms as to the supply of current by the Council for working the railway.

Harrow.—Concerning the Middlesex County Council's light railways scheme, the Harrow Council have resolved that "Without prejudice this scheme appears favourable to the members of the Council."

Hanwell.—In connection with the projected London United Tramway extensions in Surrey, the District Council have approved plans for a double track at the Ealing and Hanwell boundary in place of the single track.

Bury.—It is reported that the Mayor is to receive a requisition to call a town's meeting, the specific object of which is to discuss the proposed new route for the electric cars along Parsons-lane and Paradise-street.

Birkenhead.—Lieut.-Colonel von Donop, R.E., on behalf of the Board of Trade, has inspected the two new routes of the municipal tramways—Woodside Ferry, Borough-road, to Prenton, and Woodside to Shrewsbury-road.

Crewe.—It was stated at Wednesday's meeting of the Town Council that the Corporation proposed to follow the routes indicated in the scheme of the tramway company which the Light Railway Commissioners have thrown out.

Sedgley.—A trial trip was made on Monday on the recently-completed electric tramway between Sedgley and the Fighting Cocks, near Wolverhampton, a distance of about three miles. The trial, we note, was carried out with much success.

Glasgow.—Colonel Van Donop has inspected the Cumbernauld-road, Shettleston, and Tolleross extensions of the electric tramways. The Alexandra-parade route of lines will be opened after inspection by Mr. Trotter, of the Board of Trade.

Stroud.—The Urban District Council have given their formal approval to the proposed light railway scheme for the district. The Stroud and District Traders' Association are also unanimous "to use every endeavour to promote the scheme."

The Sunderland Appointment.—The number of candidates for the vacant post of traffic manager of the tramways has been reduced to the following three: Mr. G. H. Andrews, Sunderland; Mr. H. England, Bolton; and Mr. R. Simpson, North Shields.

Mannofield.—The *Aberdeen Journal* understands that a number of local gentlemen and others have interested themselves in the formation of a line of electric tramways, to be constructed along the road from Woodside to Dyce, and from Mannofield to Culter.

Successful Collision Claim.—Frederick Newton, cab proprietor, and Barnat Magolier, owner of a milk float, have recovered £18 and £25 respectively from the Manchester Corporation in respect of damage to their vehicles in a collision with one of the electric tramcars.

St. Combs Light Railway.—An arbitration court has been sitting at Fraserburgh for the purpose of assessing the value of land on Lord Saltoun's estate, through which the proposed light railway from Fraserburgh to Cairnbulg, Inverallochy, and St. Combs will run.

Newcastle-on-Tyne.—The property owners on the east side of Osborne-road are protesting against the action of the Corporation in seeking to take forcible possession of their gardens in connection with the tramway scheme without first fixing the amount of compensation.

Dover.—With the extension of the borough boundaries it is proposed to extend the municipal electric tramways out to Kearsney and and River. The system has been highly successful in the three years it has been established, a large yearly profit being made with ½d. and 1d. fares.

Paisley.—Mr. Murphy states that work in connection with the projected electric tramways in Johnstone, communicating with Paisley, "will be proceeded with at an early date." Meantime negotiations are proceeding in regard to the Paisley tramways and the purchase of electric power.

The Shields.—With regard to the proposed "tube" between North and South Shields, the Tramways Committee of the South Shields Town Council have refused to give an expression of opinion upon the question until the parliamentary plans have been deposited and the Bill has been drawn.

Cambridge.—At the half-yearly meeting of the shareholders in the Cambridge Tramways Company last Friday the Chairman stated that they were keeping in touch with the British Electric Traction Company, and "electricity would probably be used for the trams when Cambridge people were educated to use it."

French-Belgian Scheme.—Report says that a French-Belgian syndicate is taking in hand the preliminaries for an electric express line from Paris to Brussels and Brussels to Antwerp. They estimate that the former journey can be accomplished in about 90 minutes, and the latter in one-ninth of that time.

Grimsby.—The tramways, which are now being converted to electric traction, are in the hands of the Street Tramways Company, but current will be supplied from the Corporation electricity works, which were recently opened. The overhead line is now erected, and the trams will be in operation before long.

Rochdale.—The track of the Norden section of the new tramway system is now completed, and the length between the borough boundary in Bury-road and Dane-street is also in an advanced state. No arrangement has yet been made between the Corporation and the British Electric Traction Syndicate as to the point where their respective tramways systems shall meet.

Isle of Thanet.—Car traffic was delayed for some considerable time one day last week in consequence of a collision at Ramsgate between two cars coming in opposite directions. The impact was great, as each car weighed 11 tons, irrespective of passengers. Both vehicles were derailed. The local newspaper report of the accident we have seen does not state the cause of the collision.

Brussels.—The electric tramways are to be completed in the spring of 1903. The total cost amounts to £400,000, half of which will be spent upon the central station. This is to contain four units of a total capacity of 8,000 h.p., to be increased to 14,000 h.p., and even to 30,000 h.p. if required. The work on the circular boulevards in the lower part of the town will be commenced Nov. 1.

Ayr.—On Thursday week Colonel von Donop, R.E., of the Board of Trade, made an inspection of the permanent way and the cars of the new Corporation electric tramways, and the formal inauguration of the system took place in the afternoon, when four cars with members of the Corporation and a number of invited guests traversed the whole route. The cars were afterwards run for public traffic.

Blackpool.—On Tuesday the Corporation resolved to apply to the Board of Trade for sanction to the borrowing of £14,000 for new tramcars, £15,365 for the construction and equipment of New-road, Lytham-road (electrical equipment only), Clifton-street (electrical equipment only), and Waterloo-road tramway extension, and to issue annual contract tickets to school children at 30s. a year.

Stockport.—It appeared from the report of the Tramways Committee at this week's meeting of the Town Council that Cheadle District Council had been asked if they were disposed to open negotiations for the leasing and working by the Corporation of an electric tramway from the new borough boundary at the London and North-Western Railway bridge at Cheadle Heath to Cheadle and Gatley.

West Hartlepool.—It is feared that the objection of the North-Eastern Railway Company to the tramcars being carried over the bridge leading from Mainsforth-terrace to Seaton-road may delay the opening of the new line to Seaton Carew. The railway company, we under-

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stand, also object to permitting the Corporation carrying the electric cables under the roadway of the bridge for the supply of electric lighting to Seaton Carew.

Liversedge.—With reference to the proposed construction of a tramway through the district, a letter was read at Monday's District Council meeting from Mr. Morse, the solicitor to the British Electric Traction Company, Limited, stating that the company had received objection to the compulsory purchase of the land in Halifax-road from Messrs. Chambers and Chambers, on behalf of the Waddington Trustees (owners).

Walthamstow.—The District Council have decided to adopt the provisions of the Light Railways Act, and, subject to the approval of the Light Railway Commissioners, to construct a system of electric tramways. It is proposed that the trams shall run from Tottenham High Cross to Chingford, and from the Baker's Arms, Lea Bridge-road, to the Wilfrid Lawson at Woodford. The cost is roughly estimated at about £120,000.

Barking.—The latest report of the Tramways Sub-Committee recommends the extension of the Beckton light railway to the terminus of the East Ham system, and that the East Ham Council should be granted running powers over the lines. A 4ft. 8½in. gauge is also recommended in place of the 3ft. 6in. gauges. The estimated cost of the whole scheme, which has received the Urban District Council's approval, is about £13,000.

Sheffield.—The traffic receipts for the quarter just completed amount to £49,268. This is the largest amount taken in any three months since the Corporation took over the tramways, but while the receipts have advanced, the opening of new routes has increased the working expenses, and the interest on capital outlay has also grown. The opening of the tramway extension from Hunter's Bar to Firth's Almshouses is announced to take place shortly.

Bradford.—The city surveyor will be instructed to prepare plans and estimates for a proposed new tramway up Church Bank in order to provide a shorter route to Otley-road and Undercliffe. Church Bank is the steepest street in Bradford, and the work would involve the cutting off of the crown of the hill and the filling of the lower portion with the soil removed. Tenders amounting to about £10,000 for the supply of overhead equipment have been accepted.

Liverpool Overhead.—Last week's traffic return of this railway showed a decrease of £224 as compared with the corresponding period last year. "A Shareholder," writing to one of the Liverpool papers on the point, says: "I think others will agree with me that the time has now arrived when the manager and directors should bestir themselves and devise some means whereby this constant decrease of receipts, and consequently decreased value of shares, may be checked."

Birkdale.—The District Council have sealed the agreement between the British Electric Traction Company and the Birkdale District Electric Supply Company and the Council with regard to the supply of current for the proposed tramways. Within the next few days it is expected that an almost simultaneous start with the erection of the power station, the reconstruction and equipment of the tramlines for electricity purposes, and the laying of the cables for electric light, will be made.

Byfleet.—This little village is evidently afraid of the company promoter. The Parish Council, were unanimous in passing the following resolution: "That the Council views with apprehension the growth in Surrey of tramway monopoly in the hands of a private company, as opposed to the best interests of this district and county as a whole, and entreats the Surrey County Council to reconsider its decision not to become the tramway or light railway authority for the county."

Salford.—Colonel von Donop having inspected the permanent way of the completed sections of the new electric tramways, and Major Trotter the overhead equipment, a public service of cars will be commenced to-day (Friday). At the meeting of the Town Council on Wednesday, a resolution was proposed to refer the dispute with Manchester to arbitration. Before the matter had been considered, however, the adjournment of the meeting for a month was moved, and this was eventually decided upon.

Halifax.—A novel state of things is reported in regard to the local tramcar service. Supply of water to consumers is being curtailed, the Corporation's reservoirs, owing to the lack of rain, being seriously impoverished. The water supplied to the electricity works is now being obtained largely from a deep well, and should this supply continue there will be no need to curtail the present daily service of tramcars. No extra cars can, however, be put in use on Saturdays. It is expected that the municipal tramways will shortly be extended to Hebden Bridge.

Devonport.—Owing to the supply of electric power from the Corporation works being insufficient to run the 19 cars on the electric tramways, the number of cars in use on Monday was reduced to six. It appears that the piston and rings of the large engine at the works gave out, and it was necessary to discontinue the use of the engine in order to fit a new piston and rings. As the result, there was in the meantime only sufficient energy to run six cars. The effect of the reduced supply of power, it is stated, will be a loss to the company of £75 a day.

Indian Schemes.—We understand from *Indian Engineering* that the question of an electric tramway was discussed at a recent meeting of the Singapore Municipal Committee. Government wished to know whether the Commissioners would object to a scheme of an electric tramway for Singapore, worked on the overhead wire system. It was agreed by the Commissioners to reply to the effect that they were prepared to consider such a scheme as that mentioned. We further learn that the Dewan of Mysore has rejected an application for the construction of an electric tramway at Bangalore. It is thought that the time is not ripe for such a scheme.

Light Railways in Lancashire.—Mr. C. E. Osborne, secretary of the Electric Tramways Construction and Maintenance Company, Limited, contractors to the Blackpool Electric Tramways (South), Limited, has written to the *Financial Times* to the effect that their parliamentary agents have instructions to apply for an order under the Light Railways Act for an extension of the system from Lytham to Preston. We may point out that the Light Railway Commissioners only last week rejected a similar scheme, not being satisfied "with the way the financial position had been put forward."

Sydney (N.S.W).—The tramways at Port Sydney are proving highly successful. The traffic has increased very largely during the past year, the total number of passengers having increased from 4,143,112 to 6,412,020, or an increase of 2,268,908. A number of improvements are to be made by the Commissioners to better meet the requirements of the district—namely balloon loop at Mosman; extra car-house accommodation at the power-house; extra large feeder from Ridge-street to Mosman; substitution of centre trolley poles for the side poles now in use; the provision of extra accommodation and bringing of passengers nearer to the wharf at Milson's point terminus, besides other minor works.

Batley.—As reported in these columns last week, the Corporation had unanimously agreed a few days previous to give notice to the Board of Trade of their intention to purchase the section of the Dewsbury, Batley, and Birstall tramways within the borough. A peculiar state of affairs has now arisen owing to a report that the company have, subject to certain formalities, agreed to sell the whole system, including the portion in the Batley area, to the British Electric Traction Company. It is stated that the purchase by the traction company does not in any way interfere with the Batley Town Council's right of purchase, only if the traction company are in possession, the Corporation will have to negotiate with them instead of the tramways company.

Prussian Opinion.—According to the Berlin correspondent of the *Standard*, the Prussian Railway Administration has published a report on experiments in electric railway traffic on the Berlin-Wansee line and elsewhere. These experiments, it is said, have shown that electricity as a motive power for passenger trains is not inferior to steam, but that the cost is considerably higher. In fact, the main obstacle to the exclusive use of electricity for railways is an economical one. The Railway Administration has declared its willingness to place lines suitable for electric traffic at the disposal of any parties who would run trains at their own risk, but no one has accepted the offer. It is clear, therefore, that electricity must be made cheaper before there is any chance of its being extensively used for this purpose.

Dundee.—Charged with impeding the progress of an electric car in Perth-road the other day, Robert Guilianatta, eating-house keeper, was dismissed with an admonition. An eye-witness of the occurrence, however, volunteered some information on the subject, which is to be brought before the notice of the Corporation Tramway Committee. The drivers, he alleged, exceeded the regulation speed, travelling often at the rate of 15 miles an hour. The intense glare of the front light was also a frequent source of annoyance. Again, in wet weather the streets were rendered very slippery, and drivers of vehicles had often difficulty in leaving the track of the rails. Dundee streets were too narrow for the proper conduct of traffic—indeed, the street at that part where the accident occurred was so narrow that two vehicles could scarcely pass.

Manchester.—Consideration of the suggested widening of Cross-street to admit of a double line of tramways being laid there has been postponed. Another route of the tramway system was opened on Monday, by which the district of Hightown is connected with Deansgate. A memorial was presented at Wednesday's meeting of the Corporation from residents in Higher Broughton, praying for a speedy settlement of the tramways difficulty and urging resort to arbitration, either by the Board of Trade or any persons or person qualified to decide "what seems to be a very simple matter, and one which, in the interests of the ratepayers in the city and the borough, should no longer be suffered to remain under dispute." It was agreed to send the requisition to the Salford Corporation, asking them to agree to arbitration forthwith.

New Issue.—The Perth (W.A.) Electric Tramways, Limited, are making a new issue of £150,000 5 per cent. first mortgage debenture stock at the price of 97½ per cent. The stock is part of a limited total of £200,000, redeemable by means of a sinking fund calculated to repay the whole amount in 30 years by annual drawings, commencing in 1904, at 107½ per cent., or by purchases in the market under that price. The company was formed in 1898 to acquire a concession from the Perth (W.A.) City Council, expiring (excepting the title to the land) in 1939 if the undertaking be not previously purchased by the city in 1925 or 1932. The company has a share capital of £180,000, which will be increased to £200,000. The present issue of debenture stock is secured by an assignment of the whole property to the Anglo-American Debenture Corporation. The subscription list closes to-day (Friday).

New South Wales.—The report of the Railway Commissions on the working of the Government railways and tramways during the quarter ended June 30 last, shows a considerable increase in the tramway revenue, the additional sum earned being £39,024, while the expenditure is also up by £36,140, leaving a net improvement of £2,884. The earnings per tram mile show a decline of ¾d., but since last year the Glebe Point and Leichhardt lines (both carrying heavy traffic) have been converted to electric traction; and while a very much more frequent service is given by this system, the earnings per tram mile with the smaller trams do not equal those of the old steam system with trams of two, three, or four carriages of seating capacity. On the other hand, the cost of working per tram mile has been reduced by ¼d. There are now 79¼ miles of tramways in operation in the colony.

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Glamorgan.—The County Council have adopted a report of the Parliamentary Committee recommending the Council to approve of application being made for power to construct the following light railways: (1) Aberdare to Bridgend, *viâ* Mardy and Tonyrefail; (2) Swansea to Loughor; (3) Swansea to Ystalyfera; (4) Morriston to Neath Abbey, connecting existing tramways; (5) Briton Ferry to Taibach. The total length of the proposed lines is 51½ miles, and the cost of construction and equipment is estimated at £478,590. A sum of £79,924 is allowed for widenings, so that the total cost of the scheme is put at £558,514, to which must be added 10 per cent. for contingencies. The cost of electrical generating stations is not included in the above estimates, as the committee has reason to think that satisfactory arrangements can be made with established companies for the supply of electrical power in bulk at a reasonable rate.

Leeds.—It was proposed at Wednesday's meeting of the City Council that the Tramways Committee be authorised to place an order for 50 additional cars. A meeting of a committee composed of members of the Parliamentary and Tramways Committees was held on Monday to consider if some arrangement could be made by which the Leeds Corporation and the British Electric Traction Company might have mutual running powers. In the hands of the company are the Spen Valley and Morley light railways, and efforts are being made for joining the company's system with that of the Corporation at the Leeds boundaries. During the meeting the representatives of the company undertook to submit their proposals in writing, and the conference was adjourned in order that the promise might be carried out. The Tramways Committee have passed a resolution authorising the Lord Mayor to order a motorcar for the use of the staff, at a cost not exceeding £276.

Berlin.—The *Morning Post* correspondent at Berlin gives some information on the subject of the dispute with the German Emperor concerning the construction of a tramway across the Linden-avenue. Documents just published show that the Magistracy, acting on the assurance of the President of Police that their plan was approved by the Emperor, purchased at an enormous sacrifice Siemens and Halske's electric tramlines leading to the Linden-avenue. When their scheme was ready for execution they were informed that the Emperor refused his consent to a level crossing, which would spoil Berlin's most imposing thoroughfare, and that he desired that a tunnel should be constructed beneath the avenue. The Magistracy set forth in detail the technical impossibility of a subterranean passage, but did not succeed in effecting a revision of the Emperor's verdict. The Emperor, indeed, declined to grant an audience to the Chief Burgomaster of Berlin. The Magistracy states that it will make a further communication on the subject to the City Council as soon as it has decided in conjunction with the special traffic committee on its future line of action.

The Proposed Brighton Electric.—The proposal to run an electric railway to Brighton would not appear to be causing much consternation in the headquarters of the railway company whose returns might reasonably be expected to show a decided diminution with the projected competition in full swing. On the contrary, Mr. William Forbes, the manager of the London, Brighton, and South Coast Railway, interviewed by the *Daily Telegraph*, is reported as saying that he had no knowledge of any company which proposed to work electric marvels between the Metropolis and the seaside. "But," he added, "if there is any practical scheme for running trains between London and Brighton in half an hour, this company will be the first to pioneer it. We have the finest and best watering place in the kingdom within easy reach of town, and it would be very foolish on the part of the London and Brighton Company, and adverse to the policy of my Board, not to be the first in the field with any practicable scheme for lessening the times between London and Brighton, providing, of course, that some money would still be left for the shareholders."

Blackburn.—An inquest has been held on the body of Richard Dyson Hirst, an insurance agent, who was knocked down and killed by one of the electric trams. The evidence showed that the deceased, having just cleared a car coming in one direction, stepped on to the other track, and was knocked down by a car coming in the opposite direction. He was carried along by the lifeguard a distance of 45 yards. In the course of the evidence, a juror observed that while he wished to attach no blame to anyone, he thought that the double lines were a source of great danger when cars were passing each other. He knew it was a matter of convenience, but they were death-traps in our midst. The coroner said it appeared to be the fashion in other towns to have these double lines, and he was afraid that no recommendation of theirs would do anything towards getting them taken up. Another juryman said the evidence given showed clearly that the brakes were not what they should be, and a third suggested that the cars should slow down when passing each other. Mr. Cowell, tramway manager, said the ringing of bells and slowing down of the cars when passing each other was one of the rules given out to the men, and had always been so. Eventually the jury returned a verdict of accidental death, and Mr. Cowell was requested to see that the rule mentioned be rigorously enforced.

"Tube" to Islington.—An experimental run of the new tube line to Islington, which is an extension of the City and South London Railway, took place on Friday with satisfactory results. We understand from the *Financial Times* that in anticipation of this extension eleven new and enlarged trains are being constructed. The small dimensions of the original tunnels impose severe limits on the width and height of the railway carriages; but within those limits nothing more commodious and comfortable could be desired than the new train which made the journey from Stockwell to Clapham (High-street) and back to Moorgate on Friday night. The trains, which are being built by the Bristol Wagon Company, have four couches with double compartments. They have a roof raised in the centre so as to permit the introduction of ornamental ventilators. The electric lights are enclosed in corrugated globes, but the corrugation is in the interior, so that the outside of the lamps can be kept perfectly clean. The seats are comfortably upholstered, and the carriage is built on special swing boards for the bogie after the style of the Pullman-car, so as to make travelling more easy. The improved lighting of the new trains is being also introduced into the old carriages. The new trains will be put on as they are ready.

Southowram Light Railway Schemes.—Last Friday the Earl of Jersey and Colonel Boughey, light railway commissioners, opened an enquiry into the respective merits of two schemes for a light railway to Southowram. One is the Elland-Southowram scheme, which is for a line 9 miles 6 poles in length, estimated to cost £8,000 per mile, and joining the Lancashire and Yorkshire Company's main line system at Elland; and the other is the Holmfield-Southowram scheme, under which a line 4 miles 2 furlongs 5 chains in length would be laid at a total estimated cost of £63,618. In the course of the enquiry the chairman stated that the Commissioners were not satisfied with the Elland-Southowram scheme. The country presented many difficult features, which did not appear to have been sufficiently taken into account. They felt that the cost of safety sidings and accommodation works required more attention than had been given to it. They could not help thinking that the engineer had been hampered by instructions as to the cost, and that those instructions were too limited for such a difficult country. He did not think, therefore, that it was necessary to call further evidence as to the scheme. The hearing of evidence for and against the Holmfield scheme was then proceeded with. Eventually the Commissioners reserved their decision.

Wakefield.—On Saturday last the Earl of Jersey and Colonel Boughey held an enquiry in reference to an application by the Wakefield and District Light Railways Company for permission to make certain extensions in their scheme of light railways which has recently been sanctioned by the Board of Trade. Mr. Vesey Knox explained, for the promoters, that the existing order authorised about 10 miles of light railway, radiating from the centre of Wakefield in various directions. The line would serve about 61,000 people. The extensions now applied for were really three; one railway would connect Horbury to Ossett. The total length of the proposed Leeds extension was 4 miles 2 furlongs and 6 chains, all in the Rothwell urban district, except a length of one chain in the city of Leeds. It was very desirable that this link should be made between Outwood and Leeds, thus giving a through connection between Wakefield and Leeds, the total length being 8½ miles. The third extension was a small line from the Doncaster-road at Agbrigg, along Agbrigg-road The estimated cost of the permanent way of the proposed extension was £43,864, and for equipment and other matters £63,500. The authorised capital for the original scheme was £160,000, making a proposed total capital outlay of over £260,000. Evidence having been given by several gentlemen in support of the scheme, the Earl of Jersey said the Commissioners would be prepared to recommend that an order should be issued. They were glad to observe that several districts wished to see more of the tramways.

Cardiff.—The Tramways Committee on Friday had two important reports before them on the progress of the new tramway works, the one from Mr. Harpur, the borough engineer, and the other from Mr. Ellis, the electrical engineer. The borough engineer reported that so far as the work entrusted to his charge was concerned he saw no reason why any of those portions of the work should not be completed as requested by the end of the year. Mr. Ellis, in his report, having specified the works in his department that would be completed this year, stated that the greatest delay had occurred with the completion of the engine-house. According to Mr. Harpur's estimate, the roof would not be completed under four weeks from date, which meant practically the end of October. Messrs. Musgrave, from whom the engines were being obtained, and who had to have two engines completed by Dec. 1, a third by Jan. 1, and a fourth by Feb. 1, in order to comply with the specification, distinctly stated at the time that their tender was accepted that they must have possession of the engine-room by Aug. 1, as they would require four months in which to erect the first two engines, including the generators supplied by the British Westinghouse Electric Company. It would, therefore, be seen that as Messrs. Musgrave could not get possession until practically Nov. 1 they would be held back to the extent of three months, which would mean that the first two engines would not be completed before the March 1, the third by April 1, and the fourth by May 1. They had had the first engine completed for nearly two months, and the second one practically completed, so that they were ready to deliver the same almost as soon as they could get possession of the engine room. Mr. Ellis also reported upon the other work in progress. With regard to the dispute between the Corporation and the tramway company, as to the £40,000 purchase money, the committee decided that as the company had treated them so discourteously the Council should pass a resolution informing the tramway company that unless the offer be accepted by Oct. 21 the negotiations would cease, and the whole matter referred to arbitration.

Manchester Electric Express Tenders.—According to the *Manchester Courier*, the report that tenders are shortly to be invited for the construction of the Manchester-Liverpool Electric Express Railway is altogether without foundation. Before this step can be taken many things must be done. Since the Royal assent was given to the Bill no meeting of the members of the syndicate which provided the money for obtaining the Act has been held, but one will take place towards the end of next month, at which it is anticipated arrangements will be made for floating a new company, and also for a new Bill to carry out the agreement already entered into between the promoters and the Salford Corporation when the Bill was before the committee of the House of Commons presided over by Sir Lewis M'Iver. It is intended to complete that portion of the line between Garston at the one end and the Bridgewater Canal at the other by the spring of 1903, by which time it is expected that a portion at least of the generating

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station at Warrington will be in working order, and that two cars will be constructed on the lines of the models which were before the Parliamentary Committees. This portion of the line is about 24 miles in length, and is easy of construction, for it passes through open country, where land is easy to obtain, and where the contractors are not expected to find many difficulties in their way. The main object of the proposed early completion of this portion of the new railway is that it may be used for experimenting upon while the more difficult work in Manchester, Salford, and Liverpool was being carried out. The lessons which it is believed will be learnt from the experiments on the 24 miles section are expected to prove of considerable value, and as they will be carried out under the supervision of the Board of Trade, the effect will probably be that the new line will be opened at a much earlier date than would be possible if the company had to wait until the whole line was completed before any trains were run upon it. It is expected that the two cars will be quite perfect enough for all purposes, but the bulk of the rolling-stock will not be ordered until the early part of 1904, and this will be fitted with the latest improvements suggested by the experiments. The rest of the line will, it is hoped, be completed in 2½ to 3 years from the start, and the whole line opened for traffic some time in 1905.

LIGHTING AND GENERAL.

Penzance.—Mr. Trentham has been asked to report upon the electric lighting of the town.

Felixstowe.—The Urban District Council have resolved to lease their provisional order for electric lighting.

Share Market.—There was a small business doing in electric shares during the week, and prices were very steady.

Bideford.—The Lighting Committee's report on lighting the town has been referred back for further consideration.

Rotherham.—The engineer is about to report as to the cost of erecting arc lamps in certain parts of the borough.

Tottenham.—The District Council resolved on Tuesday night to apply for a provisional order for power to supply electric light.

Pembroke.—The Urban District Council have agreed to reduce the price for electric current from 6d. to 4d. for lighting purposes.

Bamford.—The Works Committee have decided to advertise for tenders for the installation of an electric lighting plant at their new offices.

Barnsley Telephones.—The borough electrical engineer has submitted his report upon the provision of a telephonic system for the borough.

An Enquiry.—We should be obliged if any of our readers would kindly inform us of the London address of the Dayton Electric Company, of Dayton, Ohio.

Morley Telephones.—The Chamber of Commerce are complaining to the National Telephone Company with regard to the inadequacy of wires between Morley and Leeds.

Worksop.—The Urban District Council have decided to consider the advisability of extending the electric light cable the whole length of Gateford-road at a cost of £250.

Waterford (Ireland).—Messrs. Lacey, Clirehurgh, and Sillar have presented the Corporation with a report dealing with the whole question of lighting their town by electricity.

Sutton Coldfield.—The completion of the electric lighting station has been seriously delayed, mainly owing to many of the contractors being behind in carrying out their contracts.

Maesteg.—Messrs. Fletcher and Lewis, electrical engineers, of Cardiff, have been engaged by the Rural District Council to make a report on the cost of lighting Maesteg by electricity.

Catalogue.—We have received from Messrs. Pritchetts and Gold, Limited, manufacturers of storage batteries, Feltham, Middlesex, a new catalogue of their stationary type of accumulators.

Aberdeen.—The chamberlain has been authorised to make application for increased borrowing powers for the next 10 years for the gas and electric lighting department, amounting to £200,000.

Glasgow and West of Scotland Technical College.—The £150,000 proposed to be raised as a building fund has reached something over £100,000. Mr. Carnegie has offered to give one-half of the deficiency upon condition that the other half is promptly subscribed.

Leatherhead.—Messrs. Handcock and Dykes have approved of the suggested site for the erection of the electric lighting station in the pumping station meadow. They are anxious to have the building up by Christmas, if possible.

Metal Labels.—We have received from the Endolithic Manufacturing Company, 61½, Fore-street, E.C., a very elegant black-and-white metal label, highly suitable for switchboards and all kinds of machinery and apparatus.

Colchester.—Sanction has been received to the borrowing of £3,900 for the purchase of lands and buildings, and £8,695 for additional machinery, in connection with the electric light undertaking. The output during August was 4,625 units.

Electric Lighting Boards (British Manufacturing Co).—Sir James Weeks Szlumper, J.P., M.I.C.E., F.G.S., F.R.G.S. (Mayor of Richmond), has joined the board of this company, of which Admiral Sir Henry Nicholson, K.C.B., is acting as chairman for the current year.

Bonnybridge.—The Caledonian Railway Company are introducing electric light to supersede the old oil-lamp system of lighting at Greenhill Station. In all seven lights have been erected in well-selected spots, and an engine for the supply is in construction to the west of the station.

New Company.—The Ilfracombe Electric Light and Power Company, Limited, has been registered with a capital of £15,000, the object being to carry on the business of electrical engineers, electricians, manufacturers of electric apparatus, producers of light and power by electricity, etc.

Anglo-American Telegraph Co.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending Sept. 30 of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock, less tax, payable on Nov 1.

Winding-up.—Application was made on Wednesday to the vacation judge to appoint a receiver and manager of the Hampstead Electrical Supply Company, Limited. The application was made on behalf of the debenture holders, and, the company consenting, his lordship made the appointment for three months.

Derby.—Extensions of the mains have been ordered to Messrs. Eastwood and Swingley's works, London-road, and through Empress-road from Breedon Hill-road to St. Chad's-road. Orders have been given for lighting Empress-road from Breedon Hill-road to St. Chad's-road by electricity. Various wages have been raised.

Dunstable.—In view of Mr. Snell's report the application for an electric lighting provisional order will not be proceeded with. Mr. Snell advises that it would be better to combine a lighting scheme with a joint electric traction scheme under the Light Railways Act (1896) with the borough of Luton and the County Council of Bedford.

Swansea Telephones.—In his circular to intending subscribers the town clerk states that the proposed municipal exchange area would be co-terminous with that of the National Telephone Company's Swansea area, which, as far as he has been able to ascertain, comprises Swansea, Mumbles, Morriston, Pontardawe, Pontardulais, and Gorseinon.

Folkestone.—The Town Council have adopted a report which is against the proposal to enter into an agreement with the Telephone Company as to underground wires, and for a municipal telephone service to be installed in Folkestone. We understand that Mr. Bennett has been approached with a view to getting his advice on the matter.

South Bank.—At a recent meeting of the ratepayers, it was decided to impress upon the Urban Council the desirability of applying for a provisional order for the supply of electric light. It is thought that it would suit local circumstances best if the town obtained a provisional order and then allowed a company to supply the power in bulk.

Luton.—The Electrical Engineer, in his last report, states that the generating plant is working satisfactorily. Three thousand three hundred and twenty-seven units have been generated, 35 consumers are connected with an equivalent of 1,579 8-c.p. lamps (excluding public buildings), and that several customers were giving orders for extensions.

Islington.—At the meeting to-day it will be proposed that mains be now laid as follows: Essex-road, £210; Carleton-road, £430; Holloway-road (A), £90; Holloway-road (B), feeder, £440; York-road, £730; Holloway-road (Loraine-place), £160; Highgate-hill, £260; Junction-road, £80; Hornsey-road, £145—total estimated cost, £2,545.

Belle Isle and Canada Cable.—It is stated in the Canadian papers that the cable between Chateau Bay, on the Labrador coast, and Belle Isle, has been successfully laid. There is now direct communication between the Straits of Belle Isle and the telegraphic system of Canada, which will be of great advantage in connection with the St. Lawrence shipping trade.

London-Brussels Telephone.—The laying of the telephone cable between La Panne, on the Belgian coast, and Ramsgate, which is destined to connect Brussels and London, has been commenced, and is to be finished by the end of the month. The line, which will cost about £36,000, will be about 250 miles in length, while about 56 miles will be submarine.

Removals.—Messrs. Isidor Frankenburg, Limited, Greengate Rubber and Cable Works, Salford, Manchester, are removing their London depôt for electric light cables and wires from 128A, Queen Victoria-street, E.C., to 26, Shaftesbury-avenue, W.—The General Electric Company, of New York, announce the removal of their offices from 110 to 83, Cannon-street, E.C.

Wimbledon.—The electrical engineer has reported upon the position of the undertaking at Aug. 31, 1901, as follows: Private lamps applied for in 8-c.p. equivalent 28,843, street lamps connected in 8-c.p. equivalent 4,448, street lamps to be connected in 8-c.p. equivalent 180—total lamps to provide for 33,471. Number of consumers 542, maximum load reached 375 kw.

Water Softeners.—We have received from Messrs. Desrumaux's Automatic Water Softener and Purifier, Limited, 5, Queen Victoria-street, E.C., an illustrated pamphlet describing their system, and are informed that the plant can be seen in operation by appointment, and that every information will willingly be given on application at the Company's Offices in Bradford or London.

Liverpool.—At the last meeting of the Council of the Liverpool Chamber of Commerce a communication was received from the National Telephone Company pointing out that it was unfair to blame the telephone company for delays in telephonic communication, and that the duty rested with the Postmaster-General to connect up towns with the trunk telephone system.

Leigh (Lancs.).—On Wednesday, Colonel Durnford held an enquiry at Leigh into the Town Council's application for sanction to borrow £11,250 for electric lighting purposes. Though the Corporation have only been supplying for about 18 months, the demand has increased by leaps and bounds, both for power and lighting purposes, and the original works and mains, which cost £10,500, are already inadequate.

Direct West India Cable Co.—The report for the year ended June 30 states that the net profit amounted to £5,236, as compared

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with £5,456 for the previous year. After providing £591 for depreciation, a dividend for the last half-year is declared of 3 per cent., making 6 per cent. for the year. The sum of £2,796 is carried forward, increasing the amount at credit of revenue account to £27,943.

Mexborough.—At Wednesday's meeting of the Urban District Council the engineer was instructed to prepare specifications for the lighting of the destructor and electric station buildings, and also the market and council offices, and submit the same to the Electric Lighting Committee. It was also resolved to charge 5d. per unit for the electric light and 3d. per unit to customers for power purposes. Two arc lamps are to be erected in Station-road.

New Catalogue.—The Union Electric Company, Limited, 151, Queen Victoria-street, London, E.C., are just issuing a new catalogue (No. 20) of Messrs. Korting and Mathieson's specialities in arc lamps and accessories, the sale of which they now control for Great Britain and the Colonies. The list contains various types of both direct and alternating current lamps, searchlights and arc lamps for special purposes, automatic cut-outs and transformers, etc.

Stepney.—Great complaints are heard as to the state of the Whitechapel and Mile End roads through the joint operations of a company in laying electric cables to a generating station in Stratford and the Whitechapel and Bow Railway. The traffic is rendered difficult, etc. No company can lay mains without disturbing a street; nor can a corporation. But in some districts a corporation can do no wrong, and a company no good. And that is where the shoe pinches.

Poole.—The Board of Trade regulations for the supply of energy under the Poole and Branksome Electric Lighting Order, 1897, and in regard to the use of electrical power on the overhead trolley system under the Poole and District Light Railway Order, 1899, have been referred to a sub-committee consisting of the Mayor, Councillors Andrew, Carter, and W. H. Curtis, with power to consult an electrical engineer to advise them as to the sufficiency of the proposed regulations.

West Bromwich.—The Town Council on Wednesday adopted the report of the Electric Lighting Committee, which recommended a reduction in the electricity charges for both lighting and power purposes. It was stated that the tramway company would take from them altogether 600,000 units of electricity annually, and in order to supply this quantity the present plant would have to be extended at a cost of £1,494, but the revenue from the tramway company would be about £4,000, which would leave a balance on the right side of £2,506.

Birkdale.—The District Council have sealed an agreement with the British Electric Traction Company for the transfer of the Council's electric lighting order to the Birkdale District Electric Supply Company for the supply of electricity in the district. The latter company are the nominees of the British Electric Traction Company. The capital of the former will be £30,000 in 6,000 £5 shares, and the British Electric Traction Company guarantee £25,000 worth of the shares.

Stoke-on-Trent. — The Potteries Electric Traction Company, Limited, have informed the Town Council that they are not prepared, under the existing conditions, to propose any arrangement for the supply of current in bulk to the Corporation, but have offered provisional terms, on the basis of a transfer of the order obtained by the Corporation, which the Council have refused to entertain. The North-Staffordshire Railway Company are also unable to supply electricity to the Corporation.

Newburn.—The Council have decided to give the Newcastle and District Electrical Lighting Company. Limited, consent to come into the district, subject to the terms being arranged to the satisfaction of a committee from the Council. We understand that the company propose to limit the time of compulsory purchase to 35 years, street-lighting to be charged at the rate of £2. 12s. per lamp per annum for each 16-c.p. lamp, the same to be lighted from sunset to sunrise all the year round.

Post Office Telephones.—It is reported that the General Post Office and the National Telephone Company have come to a working agreement, and it has been settled that the area covered by both systems shall be the same. The General Post Office central exchange will be on the site of the Savings Bank buildings in Queen Victoria-street, and it is there that all the city business, the heaviest part of the work, will be done. The longest distance the new system takes in at present is Croydon.

Fourpenny Telegrams.—A North London resident, having addressed a letter to Lord Londonderry advocating the introduction of 4d. telegrams for inland transmission, has received, according to the *Daily Chronicle*, the following reply: "Sir,—In reply to your letter of the 17th inst., I am directed by the Postmaster-General to acquaint you that he is not able to hold out any prospect of reduction in the charge for transmission of inland telegrams, which is fixed by Act of Parliament.—John Ardron."

Walker.—The Newcastle and District Electric Supply Company recently submitted to the Urban District Council a plan showing a drain to be laid for the drainage of the boxes on the trunk mains. The Surveyor intimated that the company had asked to have a drain along the Walker-road to drain their boxes on the trunk mains. The Council proposed putting in some gullies to drain this roadway, and will put the drains in and charge the company with two-thirds of the cost for their portion. The estimated cost will be £150.

Embankment Lighting.—The second row of lamps on the Embankment have been burning on trial during the last week, and compare most favourably with the smaller ones on the riverside which were switched on last February. The long-burning open type of the Gilbert arc lamp will be used. These lamps are fitted with exceptionally long pieces of carbon, which greatly lessens the cost of labour for re-carboning, and as the lamps can be lowered to the ground the inconvenience of using ladders in crowded thoroughfares is avoided.

Leeds Telephones.—The City Councillors yesterday again discussed the advisability of establishing municipal telephones, when it was proposed that the Parliamentary Committee be instructed to forthwith take it into consideration and report to the Council at an early date. The chairmen of the Highways and Tramways Committee were to be added to the committee for this purpose, such committee to have power to visit other towns for the purpose of obtaining information, if thought desirable. On the vote being taken, the resolution was lost by one vote.

Barnstaple.—Major C. E. Norton has held an enquiry into an application of the Town Council for power to borrow £27,000 for the purpose of carrying out an electric lighting scheme. Mr. Weatherley, barrister, outlined the scheme, explaining that it was proposed to light by electricity the principal streets of the town, including the chief public buildings and hotels. Mr. Trentham, engineer, had estimated the cost of carrying out the scheme at £26,370. The Council proposed to make use of some of their own premises situate in Castle-street, which being only divided from the river by the railway would be most convenient in the matter of landing coal.

Sleaford.—The electric lighting was switched on as a trial at West Banks station on Wednesday last week by Mr. Charles Smith (chairman of the Urban Council). There were also present Mr. W. C. Bates (chairman of the Electric Lighting Committee), Mr. Charles Hubbard (one of the committee), Mr. C. E. Clements, Mr. Bremner (representing Messrs. Bremner-Smith and Bremner, the consulting engineers), Mr. Spencer Yates (the resident engineer), Mr. Salthouse, Mr. Simmons (representing Messrs. Callender and Co.), and Mr. Turner (employed by Mr. Bratley for electrical lighting purposes). There are large arc lamps of 2,000 c.p. in the main and 16 c.p. incandescent lamps in the side streets.

London Gazette.—The partnership existing between F. Hodgson and A. H. Hodgson, trading as F. Hodgson and Co., electrical engineers, 11, Poultry-chambers, London, 54, Church-street, Kensington, and 45, Montpelier-vale, Blackheath, Kent, has been dissolved by mutual consent. The partnership existing between F. A. Jackson and H. W. Ellis, trading as Ellis and Ward, electrical engineers, 113, Edmund-street, Birmingham, has been dissolved by mutual consent. The first meeting in the estate of J. A. M. Collier, electrical engineer, Claremont-grove, Claremont-place, Gateshead, Durham, will be held to-day at 11.30 a.m. at office of Official Receiver, 30, Mosley-street, Newcastle-on-Tyne, and the public examination on Oct. 10 at 11 a.m. at Court House, Westgate-road, Newcastle-on-Tyne.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Sir Hiram Maxim Electrical and Engineering Company's shares of £1 each, and Urban Electric Supply Company's 30.000 5 per cent. cumulative preference shares of £5 each and 30,000 ordinary shares of £5 each; and to allow the following securities to be quoted in the official list: British Electric Traction Company's further issue of 37,926 ordinary shares of £10 each fully paid and 10.000 6 per cent. cumulative preference shares of £10 each fully paid, Brush Electrical Engineering Company's further issue of 15,731 ordinary shares of £2 each fully paid and 60,000 6 per cent. preference shares of £2 each fully paid, and Potteries Electric Traction Company's further issue of £95,000 4½ per cent. debenture stock.

Personal.—We note that Mr. F. Shakespeare Hanning, A.M.I.E.E. who has had considerable experience in conduit and overhead tramway work, as engineer for India and the Straits Settlements, to the Electric Construction Company, Wolverhampton, and consulting engineer to the Madras Electric Tramway Company, has left Chislehurst for Redruth to carry out the construction of the combined lighting and traction scheme of the Urban Electric Supply Company (Camborne and Redruth Electric Light and Traction) for Messrs. Edmundsons. We are informed that Mr. Justus Eck, M.A., M.I.E.E. electrical engineer, 5, Priory-road, Chiswick, W., has severed his connection with Messrs. Geipel and Lange, and has also transferred his private consulting business, in order to take up the position of technical manager and adviser to the Union Electric Company, Limited, of 151, Queen Victoria-street, London, E.C.

Manchester.—The Corporation propose to apply for sanction to a loan of £477,000 for electricity purposes. It is intended to instal two engines of 8,000 h.p. at Stuart-street station, and to provide buildings and plant for 10 sub-stations, at an estimated cost of £350,000. The whole of the Dickinson-street and Bloom-street works being fully occupied in meeting existing demands and probable future demands for current for both lighting and traction purposes, it has become imperatively necessary to prepare for the future by installing additional plant at the Stuart-street works. At the Dickinson-street station it is proposed to replace at least four of the 400-h.p. engines by two turbo-generators of 3,000 h.p. each. These two additions will ultimately take the place of the 11 400-h.p. sets now installed, and thereby a saving of £3,000 a year is expected in the coal, oil, and wages bills. The cost of these alterations is estimated at £30.000. It is also proposed to borrow £82,000 for the purpose of completing Dr. Kennedy's scheme, and to ask for £15,000 to cover the cost of laying cables to Denton sub-station. These sums make up the total of £477,000. No fewer than 85,000 lamps are awaiting connection. The new Midland Hotel proprietors have guaranteed to take not less than half a million units per annum. A warehouse in Portland-street wants 1,200 lights, and the engineering firm of Messrs. Beyer and Peacock, of Gorton, has asked for electricity to the extent of 500 h.p., increasing to 1,500 h.p., for their works.

Rating Movable Machinery.—In the new assessment which has been made at Norwich, it has been found that, in increasing valuations, the principle of rating movable machinery has been introduced there for the first time. The commercial men of the city have resolved to test the legality of the rate, and the largest manufacturers have raised a guarantee fund for the purpose. Enquiries made by the Norwich

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Chamber of Commerce among 36 other chambers show that at only one other town in the country had any attempt been made to enforce such a system of rating, under which all the small manufacturers taking electric current from the local power company to drive small machines are assessed just as if they possessed power generating plant.

Municipal Telephones in Yorkshire.—At Monday's meeting of the Parliamentary Sub-committee of the Leeds Corporation it was decided to place in the hands of members copies of the engineer's and solicitor's reports, presented recently to the Association of Municipal Corporations—the one giving the engineering aspect of any scheme for municipalising the telephones, and the other the legal aspect. A deputation, consisting of Messrs. C. Wilson (chairman of the Parliamentary Committee), W. H. Clarke, and F. Kinder, was appointed to represent Leeds at a conference of representatives of all corporations in Yorkshire, which is to be held for the purpose of discussing the whole scheme of municipal telephones, and with an idea, possibly, to some comprehensive scheme being put forward.

Hull.—Application is to be made for sanction to borrow £42,000 for electric lighting extension as follows: extension of buildings, £6,600; new chimney, 10ft. by 200ft., £1,700; four Lancashire boilers, £2,400; one Weir feed pump, £120; pipework, etc., £1,200; two engines, £4,800; two dynamos, £4,200; switchboard and connections, £7,500; condensing plant, £1,200; pipework, etc., £750; two transformers, £1,500; two sets switch gear, £250; six high-tension feeders, £3,600; six low-tension feeders, £1,600; low-tension distributors laid in Beverley-road, Salthouse-lane, Park-grove, Wincolmlee, Marlborough-avenue, West-street, Waverley-street, Charlotte-street, Blackfriar-gate, and Dagger-lane, £3,010; additional low-tension mains, £1,000; contingencies, £570—total, £42,000. The city engineer has been instructed to prepare the plans and specifications.

Boyle.—On Saturday last the town of Boyle was illuminated for the first time with electric light, and the experiment was a complete success. There are about half a dozen arc lamps in the principal thoroughfares, and numerous incandescent installations light up all the side streets and surrounding roadways. The introduction of the electric light in Boyle is due to the enterprise of a local miller, Mr. Hugh Stewart, with whom the Town Commissioners have entered into a contract for three years for the public lighting of the town at the rate of £80 per year The water power of the Boyle river, which runs close by Mr. Stewart's mills near the bridge, is utilised to generate the electricity, and the light, it is expected, will be generally used by the townspeople. The Protestant and Presbyterian churches are lighted by electricity, supplied by a local electrical engineer, Mr. James A. Stewart.

Private Telephones and Fire-Alarms.—We are informed that Mr. R. S. Blackburn, A.M.I.E.E., of Hebden Bridge, has recently obtained a number of contracts, from which we note Fielden Joint Hospital Board offices to the Todmorden Workhouse, six miles; Urban District Council offices at Hebden Bridge and Mytholmroyd; also the relieving officer's residence at Hebden Bridge, with the Fielden Hospital; the extension of the fire brigade system of telephones from the Todmorden fire station to the above hospital; Todmorden Corporation, from the surveyor's offices at the town hall, three miles; the new sewage outfall works near Hebden Bridge; the extensions and removals of the fire-alarm system in connection with the Littleborough Urban District Council; new fire station at Hare Hill and the erection of a system of street-alarm boxes; the putting in for the Luddenden Foot Urban District Council a system of electric and steam fire-alarm buzzers for calling up the firemen. This is accomplished by means of an electric pull-box in the street, which at once sets a steam-alarm in action, and can be operated from any distance and from any number of points.

The Metric System.—Messrs. Biggar, Samuel, and Co., who are the publishers of the *Canadian Engineer*, send us a copy of a new chart they are issuing of the Metric System of weights and measures. We are reminded that, starting in France a little over 100 years ago, the Metric System has made its way from one country to another till it is now used by 44 nations, with an aggregate population of 485,000,000. All the great nations, except Great Britain, United States, and Russia, are now using it, and Russia is about to adopt it. The Associated Chambers of Commerce of Great Britain have for years strongly urged it as the only means of saving British foreign trade from falling into the hands of nations who use the Metric System. We have also received by the same mail a miniature copy of the *Canadian Engineer*, which, the publishers inform us, is the first trade paper in the British empire completely reproduced in miniature. While, no doubt, this is an interesting point, we do not see that the "miniature" can serve any useful purpose, the print being of such small size that only those blessed with the most perfect eyesight are likely to find it interesting reading.

Wireless Telegraphy.—The following Ollendorfian conversation is reported to have taken place between the Cunard steamer "Lucania," which arrived at Liverpool on Saturday, and the same company's outward bound steamer "Campania" when the vessels were 36 miles distant from and invisible to each other: "Campania: 'Are you there?'—Lucania: 'Yes, here, Lucania.' Campania: 'Have you anything for us?'—Lucania: 'Yes; Lucania sends best wishes for pleasant voyage. All well.' Campania: 'All right, thanks. Message for Captain McKay: Captain Walker sends his respects to Captain McKay. We have experienced very bad weather since leaving Liverpool. All well.'—Lucania: 'Message received all right, thanks.' Campania: 'Have you seen any ice or have you experienced any fog?'—Lucania: 'No; have seen no ice nor experienced any fog. Have had fine clear weather up to the present. Our position is—latitude, 48·15; longitude, 38·39.' Campania: 'Thanks. Our position is—latitude, 48·50; longitude, 38·29.'" After having been in communication about one hour, "Lucania" said: "Good-bye; pleasant passage," and "Campania" returned the compliment.

Gwyrfai.—At Saturday's meeting of the Rural Council further reference was made to the intention of Mr. Peterson to make a fresh application for a provisional order to supply various villages within the district with water from Cwmdwythwch Lake. It was stated that the letters from Mr. Peterson had been submitted to the representatives of four parishes concerned, the matter having also been further explained to them by Mr. Charles A. Jones, local solicitor for the promoter. Satisfaction was expressed at Mr. Peterson's determination to proceed, but beyond this, judgment was suspended until the Council is furnished with a printed copy of the Bill to be promoted. In connection with the same proposed provisional order, enquiries were received from the Llanfairisgaer Parish Council as to the position of the electric lighting project. Allusion was also made to a bequest of £2,000 left to Portdinorwic for the purposes of a water-supply scheme. A period of two years was specified as the limit within which the money must be spent, and a doubt was expressed as to whether it was to be applied to Mr. Peterson's scheme or a prior scheme formulated by the county surveyor. The whole question was referred to the consideration of a committee of five.

"Canadian Trade Index."—Under this title a useful publication, prepared by the secretary of the Canadian Manufacturers' Association, Toronto, has been issued for the use of British, French, and Spanish importers. The "Index" contains the names of some 800 leading manufacturers of Canada, who have formed themselves into a voluntary association for the purpose of advancing the trading interests of the country. It also contains a brief sketch of the leading export manufacturers of Canada. Glancing through the "Index," we are pleased to notice the names of a good number of the electrical firms carrying on business in Canada. On the other hand, the list, so far as it concerns electrical engineering, is by no means complete, and we miss the names of some well-known Canadian firms, the inclusion of which would make the list complete. As it stands, however, the publication will doubtless prove of considerable value to those for whose use it is intended. The second part of the "Index" gives an alphabetical list of the members of the association, together with a limited list of the articles made by them. The third part contains an alphabetical list of the articles produced by the various members, under which appear the names of the manufacturers of each. The names of the articles are given in English, French, and Spanish. Mr. W. D. Scott, commissioner of the Canadian Section, Glasgow Exhibition, informs us that he will be glad to furnish a copy of this book free of charge to merchants interested in Canadian manufactures.

Cleckheaton.—Last year the Urban District Council obtained an electric lighting provisional order, and borrowing powers have been sanctioned for a loan of £25,000 for electric lighting and tramway purposes within the area of the urban district. The loan provides also for refuse destructor cells, the waste heat generated therein being utilised for raising steam in Lancashire boilers for driving the electric generating plant. Tenders for the greater portion of the work have already been accepted by the Council, and it is now being proceeded with, under the supervision of Messrs. Gibbings and Baker. The contracts have been let as follows: refuse destructor plant, Messrs. Meldrum Bros., Limited; engines, Messrs. Belliss and Morcom, Limited, Birmingham; dynamos, the Johnson-Lundell Company, London; balancer and booster sets, the Phœnix Dynamo Manufacturing Company, Bradford; accumulators, the Electrical Power Storage Company, London; crane, Messrs. James Spencer and Co., Manchester; cables, the British Insulated Wire Company, Lancashire; main switchboard, Messrs. Dorman and Smith, Salford; battery regulating board, Messrs. Dorman and Smith, Salford. The buildings, for which tenders were accepted some time ago, are now in course of erection, to the specifications of Mr. Clifton Lund, the engineer and surveyor to the Council. The system of supply is the three-wire continuous current, with pressures of 230 and 460 volts. It is proposed at the outset to lay about five miles of mains, including one mile of feeders to supply energy to the tramway system shortly to be worked by the British Electric Traction Company.

St Marylebone.—It appears that the Guardians have instructed Mr. Baker, the engineer, not to take any steps with regard to the electric lighting scheme until the Local Government Board had given their sanction to the scheme. The work of specification, however, is to be proceeded with. At the last meeting it was stated that the Local Government Board would not refuse to sanction the carrying out of the scheme, the estimated cost of which, including the whole of the engineer's commission, was £9,039. It was said the proposal would not only lessen the cost of the institution, but would place it upon a better basis. The Borough Council have received a communication from the Board of Trade transmitting a description of the system proposed to be adopted by the Central Electric Supply Company, Limited, for the supply of energy under their Act of 1899, the regulations which the Board propose to make for securing the safety of the public, and the form of consent proposed to be given by the Board to an extra high pressure supply of energy by the company. A notice from the Metropolitan Electric Supply Company, Limited, as to laying a 5in. cast-iron pipe along the west side of Loudoun-road, and the north side of Grove End-road from 3, Loudoun-road to 27, Grove End-road, is being objected to by the Lighting Committee on account of the proposed route, a shortening of which is suggested. Another notice from the same company as to laying a 5in. cast-iron pipe along the east side of Stafford-street from Queen Charlotte's Hospital to No. 13, also along the south side of Nutford-place from the east side of Seymour-place to 41, Nutford-place, has been agreed to.

Spain.—The cry of "Spain for the Spaniards" is the latest from the Peninsula. The Government, alarmed at the large number of foreign engineers, clerks, etc., employed in Spain, are taking steps to provide a better quality and quantity of technical education. The number of foreign engineers, managers of factories and works, book keepers is said to be 1,386, of which 371 are English and 435 French. Their total salaries amount to 5,220,600 pesetas per

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annum, which looks a big figure, but represents only £288,000 or an average of £208 per annum. This is certainly not a princely salary for a competent man, but the Spanish papers complain that employers are finding out that what they have taken for eminent foreign engineers are only simple engine-drivers or engineers whose whole science consists in a knowledge how to engineer themselves into a billet. In the meantime great progress is being made in Spain both in electric lighting and traction. Amongst new firms recently established we note a company called "San Francisco," with a capital of 1,250,000 pesetas with the object of establishing a central station at Villarrobledo, another at Gijón entitled "Sociedad general de productos electroliticos," for chemical products with a capital of 12,000,000 pesetas. Ahlemeyer's, originally founded with a capital of 5,000,000 pesetas, are amalgamating with the "Hispania," and are issuing new shares to the tune of 30,000,000 pesetas, or £1,200,000. A central station at Jijona is just being opened under the management of Falco, Pena, and Co., of Madrid, who are about to erect others at Ochandino (Alava), Cacabelos (León), Calanda (Teruel), Ribadavia (Orense), and Santa Cruz (Canarias). At Oriedo is forming a company to be called Sociedad Electra Asturiana with a capital of 3,500,000 pesetas. Amongst concessions granted with the object of taking water from the river for motor power are: D. Vicente García and Sáenz de Tejada, Logroño, 20,000 litres per second; D. Francisco de Asís de Areyzaga and Elío, Vitoria, 2,000 litres per second; D. Luis Ramírez de Arellano and Echevarría, Bilbao, 35,000 litres per second; Irastorza and D. Bartolomé Irrausquin, Lesaca (Navarra), 8,000 litres per second; D. Manuel Lizarza, Leiza, 80 litres per second. This water falls from a height of 89·35m.

Royal Photographic Society.—The forty-sixth annual exhibition of the Royal Photographic Society was inaugurated by a private view on Saturday last at the New Gallery, Regent-street, and in the evening the president (Mr. Thomas R Dallmeyer, F.R.A.S.) entertained the members and their friends at a *soirée* at the same place. The exhibition will remain open daily from 10 a.m. to 6 p.m., and on Mondays, Thursdays, and Saturdays from 7 to 10 p.m. until Nov. 2. A lecture and lantern-slide exhibitions will take place each evening. The exhibition is divided into various sections, foremost amongst which are the selected pictorial photographs. Where everything is excellent the critic's occupation is gone, and one can only congratulate the Hanging Committee upon their judgment. Much the same may be said of exhibits classified under general professional photography, where an advanced technical and artistic treatment have combined to produce effects undreamed of a few years ago, when the photographer's stand and the dentist's chair were closely assimilated in the minds of most people. The scientific, technical, and photomechanical exhibits do not number very many this year. Close to the entrance of this section we noted a large photogravure by Meisenbach, Riffarth, and Co. representing a panorama of the great working hall of the German Electrical Company. The main attractions are three-colour reproductions by Carl Hentschel, Limited, John Swain and Co., Limited, B. B. Roxby, W. E. Breverton, photogravure in colour by the Art Photogravure Company, associated with the Strand Engraving Company, the Bohemian Graphic Society, Unie, and others. Dr. John Hill Edwards shows half a dozen fine radiographs taken at the Imperial Yeomanry hospitals at Deelfontein and Pretoria during 1900 and 1901. Then there is a series of experiments by MM. Henri Becquerel and H. Deslandres, including the Zeeman phenomenon on anomalous dispersion of sodium vapour and experiments on radiation of radio-active bodies, as follows: (1) radiograph of an aluminium medal made in 1896 with rays from uranium; (2) deviation of the radiation of radium, by a magnetic field in the air, and in a vacuum; (3) deviation of the radiation of radium by an electrical field; (4) dispersion of the radiation of radium in a magnetic field. Unequal absorption of the rays unequally deviated. Another series shows an analysis of the radiation of radium dispersed by a magnetic field: (1) separation of the deviable part and of the non-deviable part of the radiation; (2) unequal penetration of the rays deviated through a plate of aluminium. Unequal production of secondary rays; (3) isolation of homogeneous rays. Transmission without distortion through a sheet of aluminium. Production of secondary rays. Thomas E. Freshwater, F.R.P.S., exhibits direct photomicrographs from geological specimens. There is also a platinum print—Aylesford on Medway, taken from a balloon at 2,500ft., by Edgar Scamell, F.R.P.S.; a telephotograph, taken at a distance of 15 miles, and another taken from Mürren, across the Valley of Lauterbrunnen, distance 10 miles, both by Bagot Molesworth; Dr. J. M. Eder shows selections from a series of spectrum analyses of argon, iron, etc.; photographs showing colour sensitiveness of gelatino-bromide of silver; photography applied to the study of tree life and growth; high-tension sparks with Ruhmkorf coils and Leyden jars upon gelatino-bromide of silver plates. A number of interesting prints on wave-clouds and waves generally, by Vaughan Cornish, D.Sc., F.G.S., F.C.S., F.R.G.S.; and a number of exhibits by the Royal College of Science, comprising photographs of metallic spectra, showing enhanced lines—titanium and iron; star spectra; and various zoological and geological specimens will be found of interest in this section. The stereoscopic apparatus, containing Lumiere's and Sanger Shepherd's coloured photographs mark the greatest advance made during the last year. Of apparatus, there is hardly anything new, barring a few new types of cameras, such as the Nydia and Natti, by Ross, Limited, who also show an arc lamp for projection and laboratory use, and Sanger Shepherd's apparatus and outfit for the three-colour process. Messrs. Watson and Sons exhibit an electric ruby lamp. On Monday evening Mr. E. Sanger Shepherd showed some of his beautiful slides, and explained his three-colour process. The method of taking these pictures is extremely simple. Glass which has been coloured red, blue, and green not giving the exact results required, intermediate colours are used, being a combination of two of these minus the third. Three of these colour records are on a long slide, through which three exposures are made. From the first an ordinary lantern slide is prepared. This negative, which has been taken through the red filter, is stained Czar blue—*i.e.*, minus red. From the green and blue filter two gelatine prints are obtained. The first is dipped into pink (minus green) and the second into yellow (minus blue). The three superimposed give at once the picture in its natural colours, which can be viewed in the hand or shown on the screen in any ordinary lantern. This is an undoubted advantage to lecturers, as one can now make slides in natural colours at comparatively little expense, and on arriving at the lecture-room hand the box of slides to the lanternist without remark, with the certainty that the audience will not be irritated by dim pictures or faulty register. Brilliant pictures up to 12ft. discs can be shown with the ordinary oxy-hydrogen lime-light or with the electric arc light up to 20ft. or 30ft.

Hampstead.—The Borough Council on Thursday adopted a report of the Finance Committee recommending that the London County Council be informed that this Council is prepared to accept their sanction to the borrowing of £7,078 for 42 years in respect of expenditure on the electric lighting undertaking to March 31, 1901, and of £2,545 for meters for 10 years (such sums being included in an application by this Council for sanction to borrow the sum of £17,874), on the understanding that the sum of £395, wrongly disallowed by the County Council, shall be included in the next loan sanctioned for electric lighting purposes; that, as regards the above-mentioned sum of £7,078, this Council do resolve as follows: "That the Council do agree that the cost of all plant and machinery covered by the loan of £7,078, which it may be necessary to renew or replace during the currency of such loan—viz., 42 years—shall be defrayed out of a sinking fund to be provided for that purpose or out of maintenance account, and that the London County Council be asked to lend the above-mentioned sums of £7,078 and £2,545 on loan to this Council on the terms mentioned in their letter." From the report of the town clerk (Mr. Arthur P. Johnson) on the electric lighting undertaking for the year ended at March 31, 1901, we note that the electric lighting undertaking continues its successful career, and that its growth has been continuously steady throughout the year. As compared with the previous year, the consumers have increased from 1,671 to 2,060, the number of 8-c.p. lamps installed from 104,579 to 125 892, the maximum load from 1,198 kw. to 1,506 kw., and the number of units sold from 1,418,442 to 1,759,147. For the year, the works cost of the station came out at 2·30d. per unit, an increase of ·36 over those of last year, and the total costs are 2·73d. per unit, an increase of ·37 over those of the preceding period. The coal bill accounts for ·33 of this increase. The connections per mile have increased to 55, as against 50 last year, and the units sold per lamp have likewise increased to 15, as compared with 14·8 last year. Mr. Geo. H. Cottam, M.I.E.E., chief electrical engineer, in his report upon the proceedings of this department for the 12 months ending March, 1901, states that the profit for the year has been £2,017, excluding £365 accrued interest on the reserve fund investment. During this period the majority of the building and machinery extensions passed in the summer of 1899 have been completed, increasing the capacity of the station to a large extent. The following plant has been added: four three-crank tandem compound enclosed engines, 800 i.h.p. each, by Belliss and Morcom, of Birmingham; one two-crank cross compound ditto, 80 i.h.p., by the same firm. The power of these is increased 25 per cent. when exhausting to condenser. Evaporative condensing plant is provided for two of the larger engines and the small one. Two Siemens alternators of 500 kw. each; two Feranti ditto. The Siemens have condensing plant attached to their engines, which increases their output to 625 kw. each. One exciter by Crompton and Co. (50 kw. non-condensing, 62 kw. condensing). The last two of the six Economic boilers ordered in the summer of 1899 went into commission on Nov. 11, making a total of 14. With the eight extra ones ordered in October, 1900, there will eventually be 22. A further water softener for the new tanks over the south boiler-house and offices, which is now doing its work satisfactorily, has also been added. Mains have been laid during this period, making a total laid of 1,180 yards feeder, 8,557 yards distributor, 900 yards arc cable 697 yards three-way conduits, 40 yards 3in. cost-iron pipes for the 12 months, the whole costing £4,965; or, from the commencement, a total of 36,345 yards feeder, 67,043 yards distributor, 20,532 yards arc cable, 697 yards three-way conduits, 100 yards 3in. cast-iron pipes, 8,246 yards 2in. cast-iron pipes. Six new sub-stations have been built, making a total of 41 sub-stations and five transformer pits. The following new transformers have been added: 2 50-kw., 10 25-kw., 4 18-kw., the cost of the sub-stations and transformers being £2,121, making a total of 3 50-kw., 49 25-kw., 19 18-kw., 2 20-kw., 1 10-kw., 2 6-kw., 3 4-kw., 2 3-kw., 1 2-kw., 8 being in houses and 74 in sub-stations. The number of connections per mile of distributor has increased to 55 at March, 1901, against 24 at March, 1897. The following figures for the year, together with those for the previous 12 months, are given for the purpose of comparison: Capital outlay per kilowatt of power installed, 1900-1901 £69, 1899-1900 £79; increase of consumers, 389 (405); increase of lamps connected, 21,313 (21,907); units sold, 1,759,147 (1,418,442); increase of units sold, 340,705 (416,526); maximum load, 1,506 kw. (1,198 kw.; smallest summer peak, 636 kw. (708 kw.); weekly output (largest winter) 73,679 units (63,441 units); weekly output (smallest summer) 20,831 units (14,633 units); units sold per lamp (connections during year being averaged), 15 (14·8); revenue per lamp (connections during year being averaged), 5s. 4d. (6s. 2d.); average price obtained (private lighting), 4·27d. (5·14d.); ditto (public lighting), 2·69d. (2·69d.). Tenders were accepted for the following further plant, for which specifications and drawings were got out as advised in his report for the year ending March, 1900: eight boilers (four to be ready for winter of 1901 and four for winter of 1902), Davey, Paxman, and Co., £10,905; pumps, steam, and water-pipes, Aiton and Co., £2,953; detartariser, Maxim Electrical and Engineering Company, £1,198; economiser, E. Green and Son, £1,453; water-tank, Rowland, Carr, and Co., £580; blow-off tanks, J. Spencer and Co., £140.

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PROVISIONAL PATENTS, 1901.

SEPT. 23.

18921. A method of utilising the up-draught in kitchen range and other chimneys for the purpose of driving dynamos for generating electricity. David Gordon Stevenson, 100, Wellington-street, Glasgow.

18946. Adjustable connections for electric lamps. Thomas Hargreaves Brigg, 321, High Holborn, London.

18947. Improvements in electric current controllers. Thorsten Zweigbergk, 18, Southampton-buildings, Chancery-lane, London.

18962. Prepayment electric meters. George Lewis Gowlland, 4, South-street, Finsbury, London.

SEPT. 24.

18990. Improvements in or relating to electrical ignition devices for internal combustion motors. David Nicholson, 18, Hertford-street, Coventry.

18993. Improvements in and relating to incandescent electric lighting. Henry Soar and William Holloway Fellows, 166, Fleet-street, London.

19000. An electrical bolt or lock. Henry Walker, 150, Church-road, North Strand, Dublin.

19037. Improvements in and relating to electromagnetic traction-increasing apparatus. Albert Alonzo Honey, 77, Chancery-lane, London. (Complete specification.)

19053. Improvements in or connected with automatic electrical fire-alarm apparatus. Richard Pearson, 53, Chancery-lane, London.

19057. Improvements in casings for electric arc lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (The Lea Electric Manufacturing Company, United States.) (Complete specification.)

19062. Improvements in and relating to electric railways and the like. Albert Neumann Connett, 322, High Holborn, London. (Complete specification.)

19066. Improvements in life guards and obstruction catchers for electric cars and like vehicles. William Henry Rymer, 6, Lord-street, Liverpool.

19068. An improved process for electrolytically precipitating and simultaneously amalgamating metals. Wilhelm Siegmund Henneberg and Ernst Christian Hermann Pape, 6, Lord-street, Liverpool. (Complete specification.)

19076. Improvements in and connected with electrolytic meters. Arthur Wright and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

19088. Improvements in electric igniting devices for explosion motors. Pierre Marius Mauguin, 47, Lincoln's-inn-fields, London.

SEPT. 25.

19116. Improvements in telephone switch apparatus. Walter Crookell, 6, Bank-street, Manchester.

19132. Improvements in the electro-deposition of metals. Herbert Champion Harrison, The Limes, Upper Richmond-road, Putney, London.

19136. Cover for electric cells. Caésar Vogt, 72, Cannon-street, London. (Complete specification.)

SEPT. 26.

19210. An improved and replenishable dry primary cell or battery. William Strickland, 4, Lauderland-buildings, Aldersgate-street, London.

19216. Device for generating electricity on running cars. Eustace Hopkins, 4, South-street, Finsbury, London.

19217. Power transmission regulator for electromagnetic coupling. Eustace Hopkins, 4, South-street, Finsbury, London.

19218. Automatic switch for current-generating machines. Eustace Hopkins, 4, South-street, Finsbury, London.

19224. Improvements in electricity meters. The British Thomson-Houston Company, Limited, and Frank Holden, Bush-lane House, Cannon-street, London.

19225. Improvements in incandescent electric lamps. The British Thomson-Houston Company, Limited. Bush-lane House, Cannon-street, London. (John W. Howell, United States.) (Complete specification.)

19226. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Harold Edwards, United States.) (Complete specification.)

19227. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Hermann F. T. Erben and Arthur F. Knight, United States.) (Complete specification.)

19228. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Augustine R. Everest, United States.) (Complete specification.)

19229. Improvements in governors for steam-engines. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (William Le Roy Emmet, United States.) (Complete specification.)

19230. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Walter C. Fish, United States.) (Complete specification.)

19231. Improvements in automatic electric circuit breakers. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Caryl D. Haskins, United States.) (Complete specification.)

19245. Improvements relating to dynamo-electric machines. Charles Prosper Eugene Schneider, 45, Southampton-buildings, Chancery lane, London. (Complete specification.)

SEPT. 27.

19256. Improvements in trolley heads for electrically-propelled tramcars. Aaron Jonah Jacobs, 8, St. Paul-street, St. Paul's, Bristol.

19269. Guards for oscillating electric trolley wheels. Horatio Marsh Ward, 11, Lowe-street, St. Helens, Lancs.

19274. Improvements relating to electricity meters. Charles Herbert Offord and Archibald Carlyle Barfield, 18, Southampton-buildings, Chancery-lane, London.

19308. Improved high-voltage ceiling rose. Albert Edward Short, 7, Croyland-road, Lower Edmonton.

19309. Improved high-voltage safety fuse. Albert Edward Short, 7, Croyland-road, Lower Edmonton.

19314. An improved electric coupling. Walter John Murphy, 19, Holborn-viaduct, London.

19317. Improvements in wireless telegraphy. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (Lee De Forest, Edwin H. Smythe, and Clarence E. Freeman, United States.)

19325. Improvements in and relating to electricity meters. William Morris Mordey and Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

SEPT. 28.

19347. Improved means for braking or retarding the wheels of electric and other cars, and for preventing the skidding of such wheels. Giles Atherton, 5, John Dalton-street, Manchester.

19364. Improvements in globes, shades, reflectors, and similar articles used in connection with electric, gas, and oil illumination. Thomas Taylor Burn and John William Hinks, 11, Burlington-chambers, New street, Birmingham.

19375. Improvements in or in connection with electric fire-alarms. James Hills Hartridge, 30, Park-row, Leeds.

19376. Improvements in electrodes. James Hargreaves and John William Stubbs, May Villa, Farnworth-in-Widnes, Lancs.

19377. Improved means of fixing carbons for dynamos and motors. Wilson Hartnell, Volt Works, Kirkstall-road, Leeds.

19393. Improvements in or connected with electric motors. Hans Fomm, Karl Fomm, and Georg Fomm, 40, Chancery-lane, London. (Complete specification.)

19400. Improving and simplifying the production of electric power. George Mason, 47, Lincoln's-inn-fields, London.

19404. Improvements in accumulators. Carl Freiherr Auer von Welsbach, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane London.

19408. Improved regulating switch for charging and discharging accumulators. Frederick Walker, 165, Queen Victoria-street, London.

19412. Improvements in trolleys or contact devices for electric railways. Edmund Lichtenstein, 6, Lord-street, Liverpool. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 19.

1900.

17128. Telephonic apparatus. Newton. (Rabbidge.)

17246. Prepayment electricity meter with coin-freed control mechanism. Avena.

17490. Manufacture of secondary battery plates. Kuettner.

17496. Ceiling roses and terminals for electrical lamps and power installations. Hirst and Bevis.

19588. Automatic electrical switches and circuit breakers. Booker.

19612. Renovating of electric incandescent lamps. Boult. (Saymar Omnium Industriel de Electricité Soc., Anon.)

20016. Electric switches. Oppenheimer. (Actien-Gesellschaft Mix und Genest.)

21233. Secondary batteries. Pescatore and Tudor Accumulator Company, Limited.

21274. Electric incandescent lamps. Lake. (Firm Electrische Glühlampen Fabrik "Watt" Scharf and Co.)

21722. Trolley wire and other conductors for electric traction. Heyl-Dia.

21740. Dynamo-electric machines. Langdon-Davies and Soames.

21806. Trolleys, switches, and crossings used in connection with overhead wires for electric traction. McCullough.

23700. Electrical couplings. Langford.

1901.

3636. Devices for connecting electrical circuits to earth in case of emergency, chiefly for use with overhead wires. Hollingsworth.

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13947. Electrical heaters for water and other liquids. Hill.

14943. Electrical brush-holders. Wilson and Wilson.

15368. Safety device for exposed electric leads. Siemens Bros. and Co., Limited. (Siemens und Halske Actien-Gesellschaft.)

16874. Electrolytic apparatus for production of chlorine and alkali. Mactear.

17024. Insulating material for electrical apparatus. British Thomson-Houston Company, Limited. (Fish.)

17029. Lightning arresters. British Thomson-Houston Company, Limited. (Sargent.)

TRAFFIC RETURNS.

Line.	Returns for week ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Sept. 28	850	801	− 49	—	—
Birmingham Tramways	,, 28	5,304	4,900	+ 404	175,117	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 27	582	456	+ 126	19,565	17,555*b*
Blackpool Corporation	,, 27	1,543	1,032	+ 509	32,599	24,472
Blackpool-Fleetwood Tramways	,, 28	922	767	+ 155	17,876	17,662*b*
Bolton Corporation	,, 29	1,568	1,288	+ 280	56,883	45,764*b*
Bradford Corporation	,, 29	1,368	571	+ 787	38,872	16,924
Bristol Tramways Company	,, 27	4,123	3,402	+ 720	—	—
Carlisle Tramways Company	,, 28	192	189	+ 3	2,735*b*	2,650
Central London Railway	,, 28	5,902	—	—	—	73,993
City and South London Railway	,, 29	1,938	1,574	+ 364	24,207	19,620
Cork E. T. and L. Company	,, 26	488	443	+ 45	18,337	16,167*b*
Darwen Corporation	,, 27	205	152	+ 53	7,274	5,916
Dover Corporation	,, 28	268	255	+ 13	8,669	8,233*b*
Dublin & Lucan Electric Railway	,, 29	101	95	+ 6	1,789	1,532
Dublin U. T., electric cars	,, 27	3,529	3,651	− 122	—	—
Dublin S. District, Electric	,, 27	803	854	− 51	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 28	14,277	9,748	+ 4,529	—	—
Halifax Corporation*	,, 29	2,307	1,652	+ 655	30,843	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 28	1,702	1,277	+ 425	22,439	17,234
Liverpool Corporation	,, 21	9,576	9,836	− 260	339,900	297,254*b*
Liverpool Overhead Railway	,, 29	1,589	1,685	− 96	22,120	22,680
Oldham-Ashton-Hyde Tramways	,, 27	523	123	+ 400	19,588	18,843*b*
Portsmouth Corporation	,, 28	1,284	—	—	—	—
Potteries Tramways	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 29	3,682	—	—	—	—
Southampton Corporation	,, 26	969	735	+ 234	—	—
Southport Corporation	—	—	—	—	— *d*	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. *b* From Jan. 1. *d* From April 1. 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £157 decrease.

Barcelona Ensanche y Gracia, £29 decrease. Barcelona, £167 increase.

Brisbane, £419 decrease.

Buenos Ayres and Belgrano Electric, £624 increase; (month of Sept.) £1,870 increase.

Calcutta, £134 increase.

Cape Town (month of Aug.), receipts, £14,799; expenditure, £7,009.

Manchester Corporation (Sept. 21), £2,127.

Mexico Electric (month of Aug.), receipts, £17,900; expenditure, £10,800.

Perth Electric, £219 increase.

Port Elizabeth (month of Aug.), receipts, £3,151; expenditure, £1,844.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅜-⅝
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	9/16-11/16
—— Ordinary, 1-125,000	1 ..	⅜-½
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-6¾
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4¾-5¼
Brush Electrical Engineering, Ordinary	2 ..	1¼-1⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	110-114
—— Ordinary	5 ..	15-16
—— 5 per cent. Pref.	5 ..	5⅜-6¼
Crompton and Co.	3 ..	3¼-3⅝
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	1-1⅛
—— 5 per cent. Debentures	5 ..	1¼-2¼
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89 xd
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2⅛
—— 7 per cent. Cumulative Pref.	2 ..	2⅛-2⅜
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	97-100 xd
W. T. Henley's Telegraph Works, Ordinary	5 ..	16¼-17½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10 ..	22-23
—— 4 per cent. Debentures	100 ..	100-103 xd
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10¼-11¼
—— 5 per cent. Cum. Pref.	5 ..	5¼-6½ xd
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-⅝
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	95-100 xd
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10¼
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	7⅞-8¼
—— 7 per cent. Preference	5 ..	8¼-8⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7⅛-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	5¼-5⅜
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	8¼-9⅛
—— 6 per cent. Cumulative Pref.	10 ..	11¼-12¼
—— 5 per cent. Debenture Stock	100 ..	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9⅛
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	104-107
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5⅜-6¼
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5⅜
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7¼-8⅛
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	101-104 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	112-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15¼-16½
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7⅜-8¼
—— £4½ Shares, New	4½ ..	7-7½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5¼-6¼
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-102 xd
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11½-12½
Electric Railways.—		
Central London, Ordinary	100 ..	102-105
—— 4 per cent. Pref.	100 ..	105-108
—— ,, deferred	100 ..	98-101
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	51-54
—— Ordinary	10 ..	xd
—— 4 per cent. Debenture Stock	100 ..	113-118
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4-4¼ xd
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-128
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¼-3⅜
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6-6¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	101-103 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14-15
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11¾-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	121-124 xd
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅜-2
—— "A" 6 per cent. Cm. Pf., 1-40,000	*b* ..	5¼-5⅜ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	104-107
—— Prov. Cert., all paid	100 ..	98-101
Cape Electric Tramways, Nos. 1-400,000	1 ..	1¼-1⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5¼-5⅜
—— 4 per cent. 1st Mortgage Debentures	100 ..	103-106
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,600, Red.	100 ..	97-100 xd
Imperial Tramways, Ordinary	all ..	22-22¼
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	105-107
New General Traction, Ordinary	5 ..	3-3½
—— 6 per cent. Cum. Pref.	10 ..	4⅛-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-10¼
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8s. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	3¼-4⅛
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5
—— 4 per cent. Deb. Stock, Red.	100 ..	96-99
—— 3½ per cent. Deb. Stock, Red.	100 ..	95-98
Oriental Telephone and Electric Company	1 ..	¾-1

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NOTES.

London Underground Railways. The full report and minutes of evidence before the Joint Select Committee on London Underground Railways has just been issued as a parliamentary Blue-book. It is unnecessary for us to go further into the matter in these columns, as we have already given the conclusions of the committee on the various "tube" schemes promoted in the last session of Parliament in a previous issue.

Wireless Telegraphy in the Navy.—According to a letter received at Plymouth from Berehaven, where the Channel Squadron is now lying, the cruisers "Minerva" and "Fearless" successfully notified Roche's Point signal station by wireless telegraphy of the arrival of the vessels at the rendezvous. At the time the messages were dispatched the "Minerva" was 134 miles away from Roche's Point, and the other cruiser 162 miles. The latter distance is believed to be a record between ship and shore.

Rontgen Rays Produced by Oudin's Resonator. Prejudicial effects from the application of the Rontgen rays are sometimes observed when the vacuum tube is very near the patient and worked by a powerful induction coil. In order to obviate this risk, if possible, Mr. R. Demerliac recently conducted some experiments in France with Oudin's resonator. He has observed that tubes worked by alternate currents of high frequency and high potential exhibit effects which are curative instead of injurious, and he therefore proposes to utilise this instrument. The experiments showed that tubes designed especially for this mode of working will give as good results as the ordinary ones now in use give with powerful coils.

Dr. J. W. Swan.—We are pleased to note that the honorary degree of doctor of science of the University of Dublin was last week conferred on Mr. J. W. Swan by Principal Gurney. In a speech made at the time attention was drawn to the vast debt which modern photography owed to Mr. Swan. It was stated that he not only invented the dry plate, but also originated the carbon process of printing. To us, as electrical engineers, however, the new doctor is better known for his original inventions in incandescent lamps, and in spite of the litigation which has taken place on the subject, we look upon him as the man to produce commercial incandescent lamps, without which electric lighting as practised to-day would be impossible.

Proposed International Exhibition in Edinburgh.—Probably moved by the desire to imitate the example of the Glasgow Exhibition, which it is widely known has already proved a big financial success, and having fresh in their minds the memory that their own effort in this direction some years ago was a financial failure, some of the leading citizens of the Scottish capital are now taking up a proposal to hold an international exhibition in 1904 or 1905. A preliminary meeting has, we understand, already been held in Edinburgh, when the matter was considered at great length. The question of securing a site in the centre of the city was the chief topic of discussion. Eventually the whole matter was left to a specially-appointed committee, whose duty it will also be to deal with all preliminary questions.

Erratum.—Referring to our note in last week's issue on "Induction Motors for Electric Railways," we have to correct an error in manuscript which unfortunately occurred in the table of figures given with regard to expenses of installation and amount of power required. The mistake was made in giving the totals of the second and third columns of figures relating to (B) alternating-current motors with rheostatic current, and (C) alternating-current motors with concatenated control. Obviously, from the several items set out these totals should have read £371,140 and £401,540, in place of £204,340 and £244,540 respectively. Thus the comment, "the direct-current system offers decided advantages in economy if installed at the same price as the alternating-current system, and that the same economy cannot be obtained with alternating current, no matter at what cost," holds good.

London-Brussels Telephone.—The cable which will shortly put the English Metropolis in direct communication with Brussels is to be landed at Paune and Ramsgate on the Belgian and British coasts respectively. Although it was originally stated that telephonic communication between the two capitals would be established early in July this year, the work of laying the cable has only just been taken in hand. By the end of the present month, however, it is now promised that the cable will have been completely laid. The line from London to Brussels, which is to cost over £37,000, will be some 270 miles in length, of which about 60 miles will be submarine. Although the new cable is ostensibly being laid with a view to putting London and Brussels in direct telephonic communication, it will also admit of conversations being carried on between the more important English and Belgian towns.

An Electrical Water-Heater.—We see described in the *Scientific American* an interesting device designed by Mr. H. M. Hill for heating water by electricity. The apparatus consists of a combination of heating resistance and switch, which is so arranged that out of the one tap either hot or cold water can be drawn. The device is also such that the current of electricity used to heat the water is always switched off when the tap is closed. The arrangement of contacts which enables this to be done will be obvious to any electrical engineer who gives thought to the matter, but Mr. Hill is to be congratulated on the device which he has brought out for heating quickly a circulating stream of water. In consequence of the water moving as it passes over the resistance material, a much higher current density can be used in the same than is usually the case, as the current is never left on resistance when the water is not in motion.

Australian Telephones.—The present state of the telephone in Australia is, we learn, being seriously considered in Melbourne with a view to placing the telephone system throughout the country on a uniform basis. Melbourne itself, with a switchboard 30 years old, is said to lag farthest behind, and the want for a standard system of telephony is being keenly felt. It is even stated that not a single telephone system in Australia is equipped with modern apparatus. A conference of the electrical experts attached to the postal departments of the several Australian States was recently held at Melbourne to consider how best the telephone system could be standardised. It was then arranged that the members should visit the more important towns in Australia in order that all of their members might be personally acquainted with the different systems in vogue, and presumably be more fitted to fix upon the best system for use throughout the Commonwealth.

Quantitative Estimation of Copper in Pyrites.—A quick and exact method for the quantitative estimation of copper in pyrites by precipitation with aluminium and electrolysis is given by C. N. Heidenrich in *Zeitschrift für Analytiche Chemie*. Two to five grammes pyrites are dissolved in aqua regia, the nitric acid evaporated off, and the residue redissolved in five cubic centimetres of dilute hydrochloric acid and 10 cubic centimetres of water. The whole is washed into an Erlenmeyer, diluted to 100 cubic centimetres, and warmed with excess of sheet aluminum on

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the sand bath. When the solution is colourless, showing that all the iron oxide is reduced, the solution is filtered, and the residue (copper and aluminium) is washed free from chlorine, the filter paper burned, and the copper and aluminium dissolved in nitric acid. The copper is then subjected to the ordinary electrolytic estimation.

Parsons Steam-Turbines. — We note that a syndicate has been formed at Berlin for the purpose of constructing and disposing of all kinds of vessels equipped with steam-turbines on the Parsons system and for dealing in turbines alone. The company, which is known as the Turbina, Deutsche Parsons-Marine Aktien-Gesellschaft, is the sole licensee for Parsons's turbines so far as ships are concerned, and the German patents have been assured. Messrs. Brown, Boveri, and Co., of Baden, are said to be largely interested in the new concern, and the name of Mr. C. E. L. Brown, of that firm, appears on the list of gentlemen composing the board of inspection. The other members of the Board are: Mr. F. Barker, of Parsons Foreign Patents Company, Limited, London; Mr. D. J. Hoeter, of the Disconto-Gesellschaft, Berlin; Mr. Max Huth, German Credit Anstalt, Leipsic; and Mr. C. J. Leyland, chairman of Parsons Marine Steam-Turbine Company, Limited, Wallsend-on-Tyne.

Civil and Mechanical Engineers' Society.—On Thursday evening last week the winter session of the above institution was inaugurated at St. Ermin's Hotel, Westminster, with an address from the new president, Prof. Robert Henry Smith. Having assured the meeting that the prospects for the coming session were good, the president devoted his address to the practical question of safety in the construction of engineering works. Uncertainty as to the proper ratio of safety in designs, he pointed out, completely swamped the utility of scientific calculations, and until some more intelligent procedure were introduced all refinements and scientific theory would be futile The results of the experience of the engineering profession were not chronicled with sufficient accuracy, or rather, the chronicles were not analysed with enough care. The evil he was sure would disappear if the methods of calculation accorded more with a theory of whose correctness they could feel absolutely certain.

Tramways in Ecuador.—We gather from a note in the *Scientific American* that the municipal council of Guayaquil, Ecuador, has granted to an American syndicate a charter authorising the construction of an electric tramway system in that city, which has a population of close upon 50,000. The charter also grants the use of electricity for lighting and power. The concession runs for 35 years, at the end of which time the tramways will revert to the city without compensation. At present Guayaquil has a very poor mule-car system, despite which dividends as high as 25 per cent. have been paid annually for a number of years past. The principal streets of the city are now lit by gas of an inferior quality—some sections by kerosene lamps—so that the supply of electricity for lighting purposes is sure to be welcomed by the inhabitants of Guayaquil. One disadvantage of the concession, however, is that the climate of the district is exceedingly unhealthy, and a large number of deaths amongst the white staff of the electric light and traction undertaking is to be expected. In fact, we believe that for three or four months in the year the town is a perfect death-trap to Europeans.

Approved Meters.—The Board of Trade, who, according to the Electric Lighting Acts, has in its hands the approval of electric light meters to be used on consumers' premises, has been exceedingly chary in giving its approval, as is only right. We believe that up to the present no more than three types of electricity meters have been actually approved as meeting the requirements of the Board of Trade. These requirements are exceedingly numerous and at the same time onerous. The object of the test made is not only to ensure accuracy under normal conditions, but to prove that the meter will also be accurate under extreme variations of temperature, and over considerable periods of time. In view of the care which is taken over the testing of electricity meters, it is always a matter of congratulation when any firm obtains the approval of the Board. We have this week to congratulate the Schattner Electricity Meter Company on the fact that they have obtained the official approval for their long Schattner prepayment meter. Apart from the fact that this meter must have been found to give accurate results before being so marked for approval, we believe it is the only one at the present time of the prepayment class which has been approved by the Board of Trade.

Automatic Field Regulator.—In a recent paper published on the Continent, Mr. B. Krausse describes an automatic field regulator for shunt-wound dynamos. The arrangement consists of a toothed wheel connected to the switch arm of the regulating rheostat, and over this wheel are arranged two oppositely-turned feed pawls mounted below a balance beam at equal distances from and on opposite sides of the fulcrum, the balance beam bearing detents for locking the feed pawls, so that when the balance beam is horizontal both pawls will be held out of engagement with the toothed wheel. The balance beam is actuated by the damped core of a solenoid connected, for example, as a shunt to the dynamo terminals, so that, when the core sinks, one pawl will be released and will engage with the toothed wheel, and when the core rises, the other pawl will be released and engage with the toothed wheel. Between the feed pawls, which are drawn together by a spiral spring, a lever oscillates driven by a connecting rod and crank from a small flywheel and having a projection for alternately tripping a second pair of detent levers, also holding the feed pawls. By this means, when the pressure rises, one pawl will be released, and will swing into contact with and be actuated by the oscillating lever so as to turn the toothed wheel and rheostat arm in one direction, and when the pressure falls the rheostat arm will be turned in the other direction in a similar manner by the other pawl.

Telephony in Diplomacy.—The *New York Times* has made the interesting discovery that with the recent extension of the European long-distance telephone lines a good deal of international misapprehension might be avoided if diplomats would resort to the telephone more freely. Verbal communications, our American contemporary thinks, "are likely to be much more frank and confidential than letters can safely be, since they cannot be subsequently referred to or verified by the production of the manuscript." On the contrary, this appears to us to be just the difficulty. "Documentary evidence" is most necessary in diplomatic relations, and, of course, this is impossible in telephonic communication. The *New York Times*, however, goes on: "While the telephone may not be suitable for the discussion of grave questions of State on which the fate of nations depends, it may very well tend to keep out of that classification a thousand minor matters which are exaggerated by formal treatment and become 'significant,' without really having any significance." This may be all very true, but the main objection to the proposal of our contemporary, we think, rests on the fact that it would be exceedingly difficult to ensure secrecy. With such long lengths of line which are required for connecting up the capital towns of Europe, it is quite a simple matter to

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obtain a secret connection with the circuit between the two points in communication so that a conversation can be overheard without either of those taking part being aware of the fact.

French National Patent Office.—France has been rather behindhand in adopting the procedure agreed upon at the International Convention on Patents of 1883, at which each contracting State undertook to establish in their respective countries a special department of patents. The long-promised reform, however, has come at last, and a national patent and trade marks office has been established at the Conservatoire of Arts and Trades in Paris. It is intended to build a new wing for the special use of the department, but until that is finished the work will be carried on in rooms which have been set apart in the existing building. According to the old conditions the descriptions and designs of expired patents were received at the Conservatoire of Arts and Trades, while the designs, models, etc., of patents in force were lodged at the Ministry of Commerce and Industry. The inconvenience of this arrangement has been strongly felt in the past, it being often as necessary to consult expired patents as those in force. Such procedure, however, is now rendered unnecessary by the establishment of a permanent patent office. Among the other reforms just introduced in this department is the publicity which will in future be given to patents. This is, of course, very necessary, as serving a triple purpose. It will enable the public to better study the existing inventions for which patents are granted, to improve upon them, and to prepare to work the same when they expire. Special credits have been granted from the Budget to enable the Minister of Commerce to carry out this improvement.

A New Form of Permeameter.—At the recent Glasgow meeting of the British Association, Prof. F. G. Baily, M.A., described a new form of permeameter, which presents several noteworthy features. The apparatus depends on the measurement of the ratio of B to H in the sample experimented with. A complete magnetic circuit is formed by two lengths of the sample joined by short iron blocks at the ends. Magnetising coils are placed round the sample. In one of the blocks is a narrow gap perpendicular to the direction of the lines of force. Above this is pivoted a pair of astatic magnets. The lower magnet is influenced by the difference of magnetic potential between the two sides of the gap, the force being proportional to B. Round the upper magnet is placed a small coil in series with the main magnetising coils, which acts on the magnet with a force proportional to H. Using the principle of the sine galvanometer, the coil is rotated until the two forces are balanced, the position of the magnet system being along the line of the gap. Then $\mu = \frac{B}{H} = f(\theta)$. The coil is shaped to give an almost uniform scale through some 80deg. of arc, and the permeability is read directly on the scale. The scale is calibrated for a standard size of specimen, and the value for any other size is obtained by multiplying by the ratio. A wide range is obtained by using only a part of the magnetising coils when the permeability is high. The magnetising force is read on a separate instrument, such as a suitable amperemeter. Regulating resistances, a reversing switch for demagnetising, and a switch for altering the range are added.

Distribution of Potential in Short-Circuited Three-Phase Generators.—A valuable paper on this subject by Mr. E. Rosenberg is abstracted in the current number of *Science Abstracts* as follows: "When a single-phase alternator is short-circuited, the E.M.F. in any section of the armature winding is balanced by the fall of potential along the same section. In the case of star-connected three-phase generators, this statement does not hold good. Experiment shows that there may then be a considerable potential difference between the neutral point of the winding and the short-circuiting conductor, and that if these two be connected by a stout conductor (an ammeter being included in the circuit), a considerable current will flow through this conductor. Curves obtained with several different machines are given which exhibit this effect very clearly. The explanation is to be found in the presence of a third harmonic in the E.M.F. wave. The author describes a number of experiments, all of which go to prove the fact that the frequency of the current obtained in the conductor connecting the neutral point with the short-circuiting conductor is three times the frequency of the current in each phase. A detailed graphical discussion of the effect is given. In the directions issued to fitters it is frequently stated that when running the machine on short-circuit, in order to heat up the coils before a test under load, the rise of temperature may be estimated by placing the hand in contact with the coil, and that there is no danger in doing this. The author points out that in the case of many three-phase machines such a procedure might be attended with danger to life.

Municipal Telephones.—The Municipality of Swansea have lately been canvassing the town on the question of establishing a telephone exchange in competition with that of the National Telephone Company. The original circular sent out by the town clerk on the subject would not appear to have had the desired effect, for another pamphlet is being circulated among the townspeople, pointing out that whereas a municipal telephone exchange would afford the same facilities as are now granted by the National Company, it would, furthermore, possess the following advantages: (1) subscribers would not be able to hear other subscribers' conversation; (2) the operator would not be able to listen to the conversation without the knowledge of the subscriber; (3) if a subscriber to whom you wish to speak is engaged, you would be called up from the exchange as soon as the number is disengaged; (4) the cost of a line for all these benefits, including mutual intercommunication with the National Telephone Company's subscribers, together with facilities for using the Post Office trunk lines, would be £5 per annum, or, if preferred, subscribers would probably be able to get an instrument placed on their premises at about £2 per annum and 1d. per call, or £3 per annum and ½d. per call. In the face of these offers and the experience already gained at Tunbridge Wells, where the Corporation by their active competition have forced the company to bring their tariff down to an exceedingly low figure, it will be surprising if the town of Swansea does not agree to go in for a municipal system. Putting the question of economy on one side, local telephone competition must result in a much more perfect system being obtained.

A Royal Car.—The Duke and Duchess of Cornwall and York are said to be the first European Royal personages to possess an electric car constructed especially for their accommodation. It was constructed by the Ottawa Electric Railway Company, and has been set apart for the exclusive use of the Duke and Duchess while in Canada. A description of the car is given in the *Railway and Engineering Review*, from which it would appear to be an exceedingly handsome carriage of the Pullman pattern, and equipped on the most approved style. The brake and the motor equipments are entirely of Westinghouse manufacture. Four railway motors of 50 h.p. each drive the car at a rate of 50 miles per hour, and at this high speed the motion is entirely controlled by automatic air brakes. The car is

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50ft. in length, straight sides and vestibuled at both ends, with full monitor roof of the Pullman pattern. The colour of the car is also Pullman standard, with the British coat-of-arms conspicuously displayed on its front and rear. The interior is finished in antique polished oak, with a handsomely decorated ceiling of three-ply bird's-eye maple vendor. At either end of the car and set in frames are two large British plate mirrors that greatly enhance the beauty of the interior decoration. Rich bronze trimmings — the hat racks, hooks, etc., are of solid bronze—heighten the luxuriousness of this Royal car, which at night is resplendent with the illumination of five beautifully clustered groups of incandescent lamps. A rich Royal blue velvet carpet covers the floor, and from the windows hang highly ornamental curtains of the latest pattern. For the comfort of the Royal occupants, large easy-chairs are provided.

French Telephone Charges.—Some excellent reforms have just been introduced into the Paris telephone system, which, in view of the approaching inauguration of the Post Office exchange in London, are of considerable interest. In comparison with other Continental towns, especially Berlin, the new tariff appears to be still sufficiently high. Previously subscribers to the telephone in the French metropolis have been obliged to sign contracts running for a whole year. In future they will have the option of adopting what are termed "season subscriptions"—*i.e.*, they can pay a fee of £8. 6s. 8d. for the first three months and £4. 3s. 4d. for every ensuing quarter. In the case of the non-subscribers, the tariff has been reduced from 2½d. to 1½d. per call of five minutes' duration. These reforms, it is stated, have already had the effect of inundating the Post Office with applications from intending subscribers, but it is understood that the French Postmaster-General has at present under consideration a scheme which will still further reduce the telephone charges in Paris. Some two or three months must elapse, however, before these later modifications can be brought into force. As regards the provincial service, the alterations in the fees are stated to be more satisfactory still. Up to Oct. 1 provincial subscribers had to supply and to maintain the apparatus at a cost of about £16. 13s. 4d., and also to pay a fee of £2. 1s. 8d. According to the new tariff, however, they will pay a fee of £4. 3s. 4d. for the first year, £3. 6s. 8d. for the second, £2. 10s. for the third, and £1. 13s. 4d. for each of the following years. The charge for a non-subscribers' call in provincial towns will in future be 1d. instead of 1½d. The season tickets now introduced in Paris will also apply to all towns in France with a population of over 80,000.

Municipal Loans.—We note that the London County Council is now adopting almost a standard practice for all electric lighting loans made to local authorities within its area. This seems to be that for ordinary work a period of 42 years over which repayments are to be made is to be allowed. When, however, the money is required for electric light meters and for fuse gear to be placed on the consumers' premises, the period of the loan is reduced to 10 years. This seems to us to be reasonable. The point, however, which has our most ample approval is that of the postponement of the repayment of instalments for the first three years after the granting of the loan. This, we believe, was first done in the case of the Battersea electric lighting undertaking, but other councils are now getting the same clause inserted in their agreements. By deferring the repayments in this way for the first three years, the undertaking is not so unduly burdened as has been the case with electric lighting works in the past. No commercial undertaking expects to get together a good reserve and appreciation account during the first two or three years of its working. Electric lighting undertakings owned by municipalities have up to the present been compelled to do so by the fact that the repayment of loans, as well as interest, commenced from the time the money was borrowed. The result has been to frighten certain corporations, and to hinder them from spending the money on extensions which is always wanted in opening up new districts for electric lighting. These extensions becoming necessary before the earnings have reached a normal value, it requires a strong faith in engineers' reports in order to obtain the requisite authority for new loans. We trust that this cause of want of progress will now be removed, and that the Local Government Board will adopt the same lines on which to grant their loans as have been adopted by the London County Council.

Edison's Alkaline Storage Battery.—Mr. A. E. Kennelly recently read a paper before the American Institute of Electrical Engineers in which he gave a good description of Edison's alkaline storage battery. The paper will be found in abstract form in the current number of *Science Abstracts*. It appears that the negative active material of this accumulator consists of finely divided iron; the positive active material of a finely divided superoxide of nickel; and the electrolyte of a 20 per cent. solution of potassic hydrate. On discharge the iron oxidises, while the nickel oxide is reduced to a lower state of oxidation, but the potassic hydrate takes no part in the ultimate products of discharge at either electrode, and the quantity of electrolyte required is, therefore, very small. The processes employed for the preparation of the active materials are not indicated, nor the compounds of iron and nickel from which they are obtained; but it is claimed that those actually used are the only ones which will give any results, and that all others can neither be reduced nor oxidised electrolytically in an alkaline solution. The active materials are mixed with a nearly equal volume of flake graphite, and moulded under pressure into thin rectangular cakes 3in. by ½in. Each cake is enclosed in a very thin sheath of perforated nickeled steel, and they are built up into electrodes by placing a number of them in slots in a thin sheet grid of the same metal, and clamping rigidly together in a hydraulic press. The graphite is used to improve the conductivity of the active materials, and does not take any part in the cell reactions. Discharge curves are given of a small experimental cell, and the following figures relate to its performance: initial voltage of discharge after recent charge, 1·5 volts; mean voltage of full discharge (about), 1·1 volts; normal discharge current per square foot of active element (positive or negative), 8·64 amperes; storage capacity per pound of total cell weight, 14 watts.

German Chemical Industries.—The pre-eminence of the German Empire in chemical industries is attributed in some quarters to the signal capacity shown by German students for the prosecution of research by which improvements of processes and economies in production are brought about. This, at any rate, is the chief reason given by Dr. Rose, his Majesty's consul at Stuttgart, who has compiled a report, showing in a statistical form the superiority of the German system of education over that of other countries, and the part which the study of pure science has played in that country in building up the enormous chemical industries of the German Empire. At present, it appears, there are 22 universities in Germany, each provided with well-equipped chemical laboratories, and, in addition, there are 11 technical high schools, which devote great attention to teaching technology; so much so, indeed, that prominent men in Germany are beginning to

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think that pure science runs some danger of being neglected in these institutions. The total number of students attending universities in Germany was in 1899 about 40,000, while the high schools accounted for 13,432; these figures showing an increase of only 12 per cent. in the case of the former and 206 per cent. in the latter since 1882, a state of things to be accounted for by the neglect of technical education at the former. Great efforts are, however, now being made, in particular by the German Society of Applied Chemistry, to induce the university authorities to devote more attention especially to technical chemistry. In 1899 over 17 per cent. of the students were foreigners. Of these the greatest numbers came from Austria and Russia, and comparatively few from the United States, Great Britain, and France. Dr. Rose regrets that so few British students should avail themselves of the opportunity of spending some time at a German university, and so acquiring an insight into the characteristic life of these institutions and their methods of education. As regards the progress of chemical industry in Germany, Dr. Rose points out that the country possesses no natural advantages which should secure for it its present pre-eminence in chemical industry. The position Germany at present holds in this respect can only be accounted for by its excellent organisation of chemical education.

Field Telegraph Lines. — Some very interesting information relating to the use of field telegraph lines in wartime is to be gathered from an article by Lieutenant S. Gibbs, jun., a signal officer of the United States Volunteers. The article in question, which was contributed to a recent issue of the *Journal* of the Engineering Society of the State University of Iowa, treats solely of the use of such lines in the Philippine Islands at the time of the insurrection which followed the Spanish-American War. A typical system of field connections was the one used with the United States army operating against the city of Manilla. Adjacent to the flag station communicating with the war vessels and army transports lying at anchor in the harbour of Cavité was installed a telegraph station from which ran a line around Manila Bay to Camp Dewey, a distance of about 20 miles. For this line No. 14 galvanised iron wire was used, it being put up partly on pine lances, partly on trees, and for some distance on the poles of the old Spanish line, at that time being used by the insurgents. Pony insulators on ordinary light brackets insulated the line, and at the terminal stations, which were semi-permanent, Morse sets, consisting of relay, sounder, and key, were used. The battery was made up of gravity cells placed 12 in a box, and carefully packed to withstand rough handling. From the Camp Dewey station two No. 14 copper wires were run toward and within half a mile of the American trenches. Here they separated, and ran to the extreme flanks of the trenches, where offices were cut in. A similar wire was laid on the ground back of the trenches connecting these offices, and also including an office midway between the two. Leaving Camp Dewey the wires were raised on bamboo poles high enough to be out of the way of marching troops, but as they approached the trenches they ran along the ground, being less exposed to damage from shell fire. Thus it will be seen that all these stations were connected by an endless metallic circuit, or without the use of a ground. However, batteries were placed in the line at the two flank stations, as well as the Camp Dewey station, so that in case both lines were shot away there would still be communication between all the stations along the line of entrenchments. This arrangement was actually carried into effect immediately after the first line, which was a single one, was carried away by a Spanish shell on one occasion. A noteworthy feature of the line was the vibrator, or "buzzer," as it was commonly called. This is an instrument constructed for the purpose of working through lines that can no longer be operated by the Morse system. The first form of this instrument was invented by Major Cardew in this country in 1881, and the various types in use in the United States at the present time depart but slightly from the original pattern. One side of the "field kit," as the stout wooden box is called, contains the battery of eight dry cells. The other side holds an electro-magnet with an armature mounted upon a spring, and a back contact stop, the coils, armature, and stop forming, with the key, a local circuit for the battery. When the circuit is completed by the key the armature is attracted, breaking the battery circuit, thus allowing the armature to fly back and re-establish the circuit. The telephone receiver used is usually of the head type, and is worn by the operator during the entire time he is on duty. The intermittent current produced by this instrument penetrates seemingly impossible conditions of line, and on several occasions has been known to work satisfactorily over breaks where the separate ends of the wire were lying on the ground as much as 2ft. from each other. Thus, in the case of the Philippines, messages were got through on a line that was incapable of being worked with Morse instruments.

Electrolysis of Fused Salts.—In the current number of the *Journal* of the Chemical Society will be found the results of some experiments which Mr. Richard Lorenz has carried out in connection with the electrolysis of fused salts. It was found that a cell containing fused lead chloride with carbon electrodes, the one dipping into fused lead, the other being saturated with chlorine, behaves like an accumulator. When the electrodes are properly separated from each other the cell maintains a constant E.M.F. of 1·2 volts at 600deg. for three hours, so that there is no doubt as to the real E.M.F. of this combination. If the dark grey solution of lead surrounding the cathode of the polarised lead chloride cell passes over to the anode, the E.M.F. at once sinks, and only returns to its original value when the fused lead chloride surrounding the anode has become transparent again owing to the conversion of the dissolved lead into lead chloride. Unless great care is taken in separating the anode and cathode liquids the polarisations observed are always lower than the normal values. This partial depolarisation is accompanied by a disappearance of the products of the electrolysis, so that the lower the polarisation the smaller is the yield. It was also found that when a lead chloride cell was polarised for a short time and then allowed to discharge, the polarisation fell very rapidly to a fairly constant value, nearly 0·5 volt below the normal E.M.F. After each repetition of the polarisation, however, the discharge E.M.F. remained for a longer time at the normal high value before falling, and then passed through the lower value much more quickly. The cause of this was found by studying the evolution of chlorine at the carbon anode. Especially with a new anode the quantity of chlorine evolved in the early stages of electrolysis is considerably less than equivalent to the quantity of lead deposited; since the fused salt round the anode always has the composition $PbCl_2$, the missing chlorine is absorbed by the carbon anode, and it is only when this is saturated that the normal value of the polarisation is reached. The apparently anomalous lower values of the polarisation are all due to partial depolarisation. In passing, the author states that optical experiments have shown that the dark grey "metallic fogs" observed round the cathode are actually solutions of the metals in the fused salts.

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BATTERSEA ELECTRICITY WORKS.

The old Vestry of Battersea obtained an electric lighting provisional order in 1896 as a protection against a company who wished to obtain electric lighting powers within the district. At the time when the order was obtained the Vestry did not take any very active steps towards the establishment of works. They advertised for competitive schemes as to the best way to light the district. We believe that Mr. R. A. Dawbarn sent in the scheme and drawings which were adjudged to be the most suitable. The Vestry, however, although awarding the prize, did not agree to spend the money required in order to carry out the scheme. After a lapse of several years the matter was again brought forward, and Dr. A. B. W. Kennedy was chosen to design the works and to supervise the erection of the plant. The architectural work in connection with the scheme has been done by Mr. C. Stanley Peach. The result of the united efforts of these gentlemen, assisted by the borough surveyor in all matters of street work, has resulted in a thoroughly up-to-date electricity works, of which the Borough Council may well be proud.

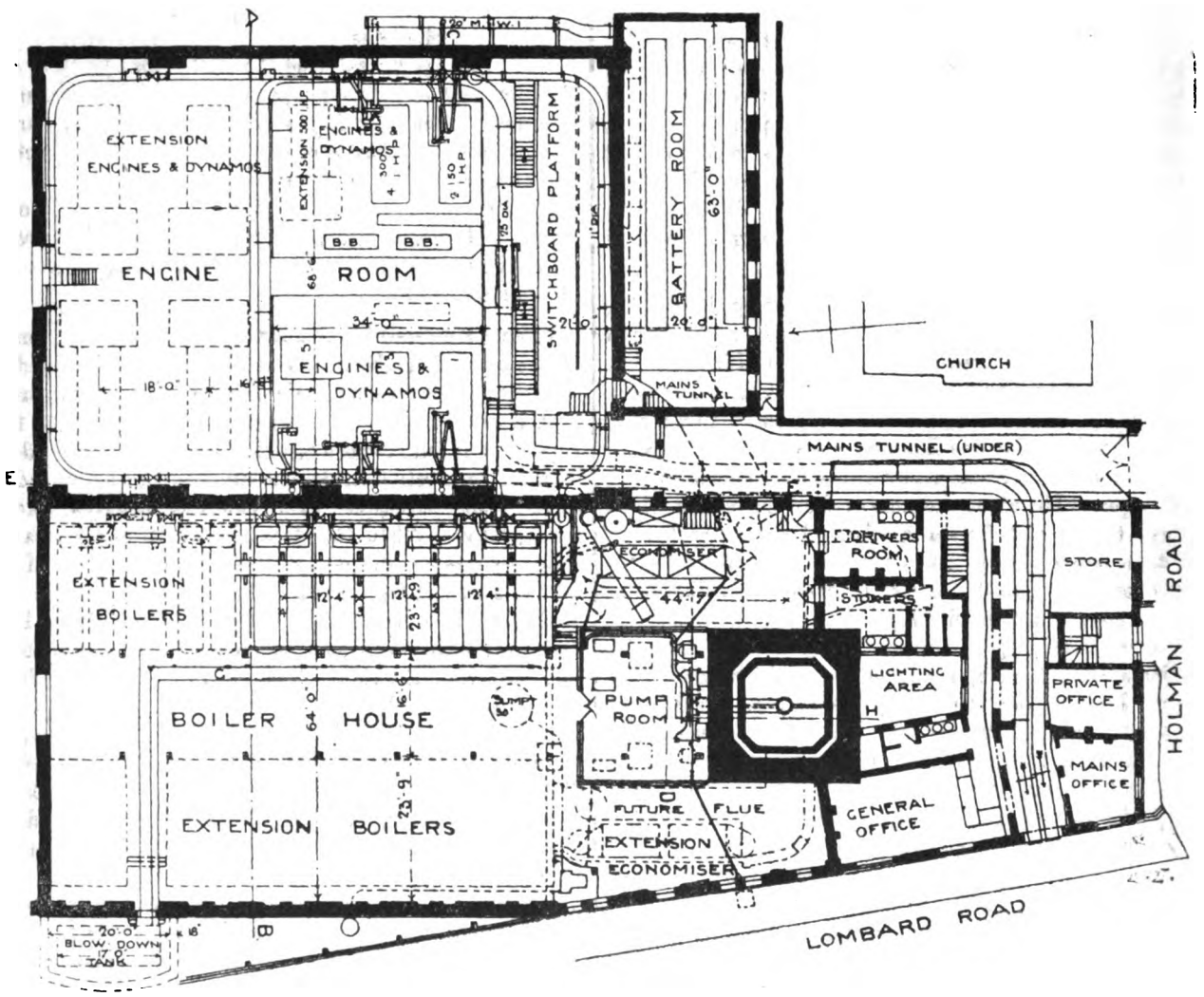

Fig. 1.—Plan of the Battersea Electricity Works.

At the opening ceremony the pride felt by the members of the Council on the success of their labours was amplified, because in the carrying out of the work Battersea had again made a socialistic record, as these works are the first to be erected without a contract and by labour directly employed by a municipal authority. Of course, we refer only to the building work and to the laying of the mains, as the engineering contracts have gone through in the usual way. Before we join with the Battersea councillors in their self-congratulation on the above grounds, we should like to have some information to show how far the course adopted has been advantageous and economical to the ratepayers as a whole, as distinct from those who have been working under the direct employ of the Council.

The design of these works from an engineering point of view leaves nothing to be desired, and on inspecting the same one is at once impressed by the careful way in which Messrs. Kennedy and Jenkin have designed for the future. Thus, while 1,500 h.p. in plant is now installed, the works are obviously not put together on that basis. They are rather electricity works of some 7,000 h.p. to 8,000 h.p. with only a small amount of the final plant installed. The extensions as required can be added without any alteration to the buildings, and without any expense in adapting the engineering equipment. It, therefore, devolves upon the Battersea Council to provide the only remaining requirement for success—we mean a load. They have arranged for the lighting up of a large number of the streets, on which great stress was laid when the works were being opened. The income from this source, however, will be only a small proportion of that required to make the undertaking a success. The price charged to private consumers is about 5½d. per unit, with small discounts, and this, we think, should be quickly lowered. The supply at a low price is particularly required in Battersea because of the class of consumer to be supplied. In fact, we would advise the Electric Lighting Committee to contemplate working at a loss for the first two or three years in order that they may supply at a sufficiently low price to get numerous consumers. The Battersea electric station, while admirable as showing the municipal enterprise of the Council, is designed to supply electrical energy, and the harder it is worked, the better will be the result.

The works are situated at the junction of Lombard-road and Holman-road. The principal front of the building is in Lombard-road, and it is this road which divides the works from the river frontage and wharves owned by the Council. Adjoining these wharves are numerous other

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departments of the Council, and it is from a dock on the land in question that coal for the electric light station will

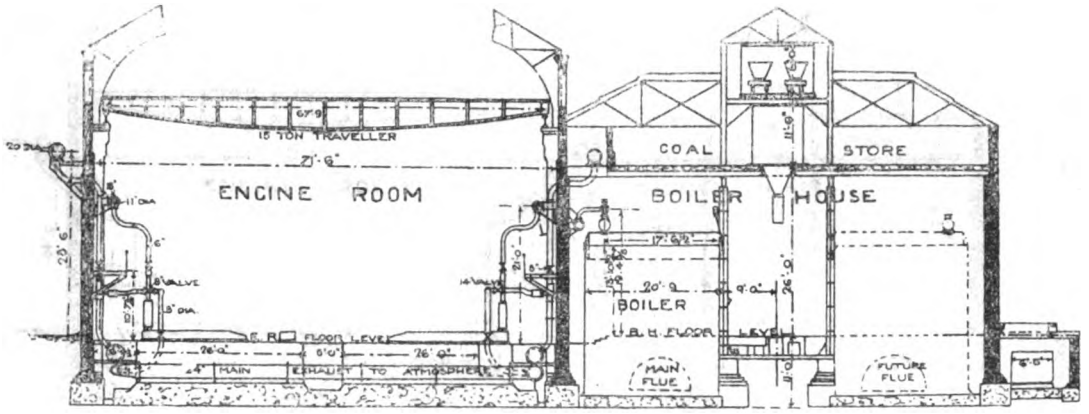

FIG. 2.—Sectional Elevation at A B.

be obtained. Eventually it is proposed to transfer the coal from the barges into the coal store over the boiler-house by means of an elevator and conveyor. But these two con-

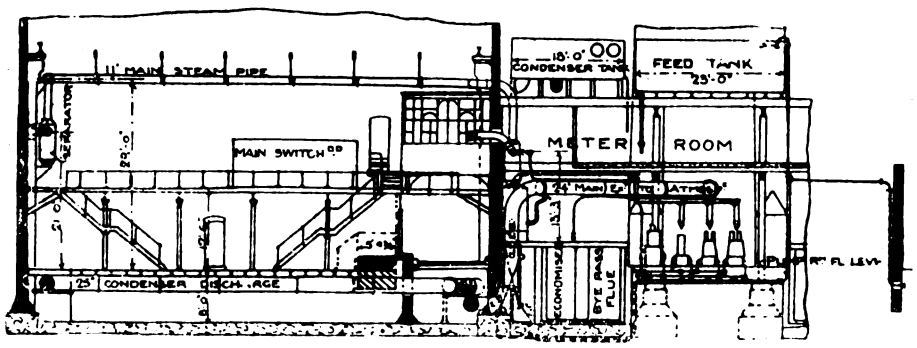

FIG. 3.—Sectional Elevation at C D.

veniences will be added when the station has been worked for some time, so that a considerable quantity of coal is required. The arrangements of the buildings and the plant

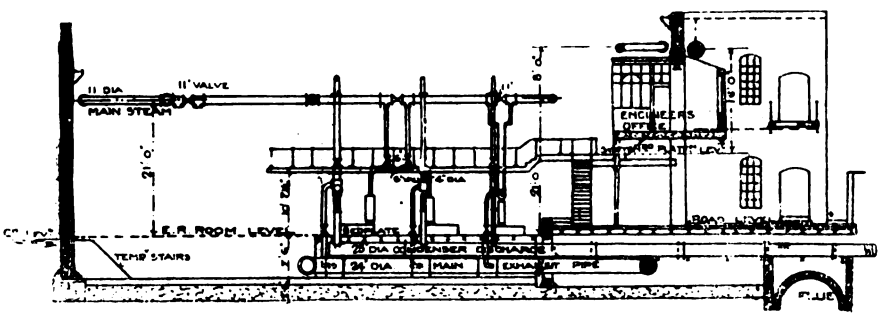

FIG. 4.—Sectional Elevation at E F.

can be seen in Fig. 1, and from the elevations, Figs. 2, 3, 4, and 5.

The boiler-house contains at present four water-tube boilers, which have been supplied by Messrs. Babcock and

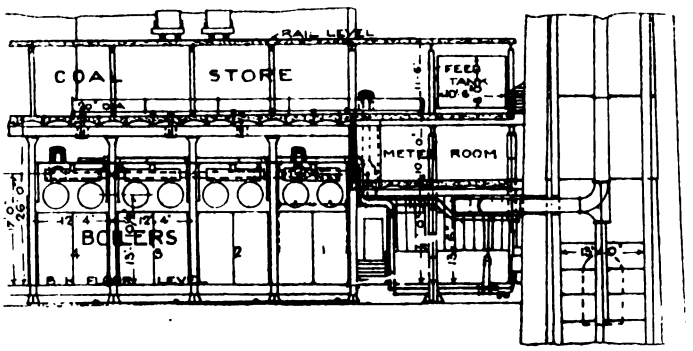

FIG. 5. Sectional Elevation at G H.

Wilcox. They are of this firm's well-known type, but made higher than usual so as to give the maximum amount of steam for minimum floor space. Each boiler is designed to evaporate at the normal rate of working 11,000lb. of water per hour into steam at 200lb. pressure per square inch, but when necessary it can be fired at a higher rate, so as to give an evaporation of from 12,000lb. to 14,000lb. per hour. The boilers are fired by Babcock and Wilcox chain grate stokers, two to each boiler. Each chain grate consists of a continuous flat band, either 4ft. or 4ft. 6in. in width, formed of cast-iron links, the band passing over horizontal rollers at the front and back of the grate. The front roller is rotated slowly by a ratchet and pawl gear driven by rods from an overhead shafting, the power being supplied by two small engines of 10 h.p., made by Messrs. Reavell and Co., of Ipswich. The upper portion of the band travels slowly from the front to the back of the grate, carrying with it a layer of small coal, which is fed on to the band by a hopper at the front of the boiler. Means are provided by which the thickness of the

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layer of coal can be varied at will by the fireman, who can also regulate the speed of the band. The products of combustion from each boiler are led into a main flue running underneath the boilers to the chimney placed at the south end of the boiler-house. The usual dampers for regulating the draught are fixed in the connection from each boiler to the main flue, these dampers being worked from the front of the boilers. On their way to the chimney the hot gases are passed around the 256 tubes of a Green's economiser. After having had the chill taken off it in an exhaust steam heater, referred to below, the feed water for the boilers is pumped through the tubes of the economiser, and in this way it is heated to a temperature approaching nearly to the temperature of the water in the boilers, this arrangement leading to a considerable economy in fuel consumption.

The steam from the boilers (Fig. 1) is taken to the engines through a ring system of lap-welded steel pipes so arranged as to secure a duplicate supply to each engine. The main steam-pipes are 11in. internal diameter, and are supported by cast-iron brackets fixed to the walls of the engine and boiler houses. A duplicate system of feed piping is run along the fronts of the boilers and the valves in the connections to the latter are so arranged that they can be worked from the firing floor. The feed pumps are of the Weir pattern, consisting of two pumps, each capable of delivering 5,500 gallons per hour, and a third pump capable of delivering 2,750 gallons per hour against the full working steam pressure of the boilers. These pumps are placed in a pump-room at the base of the chimney shaft at the south end of the boiler-house. The suction pipes for the pumps are provided in duplicate, one suction leading direct from the condenser tank over the pump-room, and the other suction being connected to the

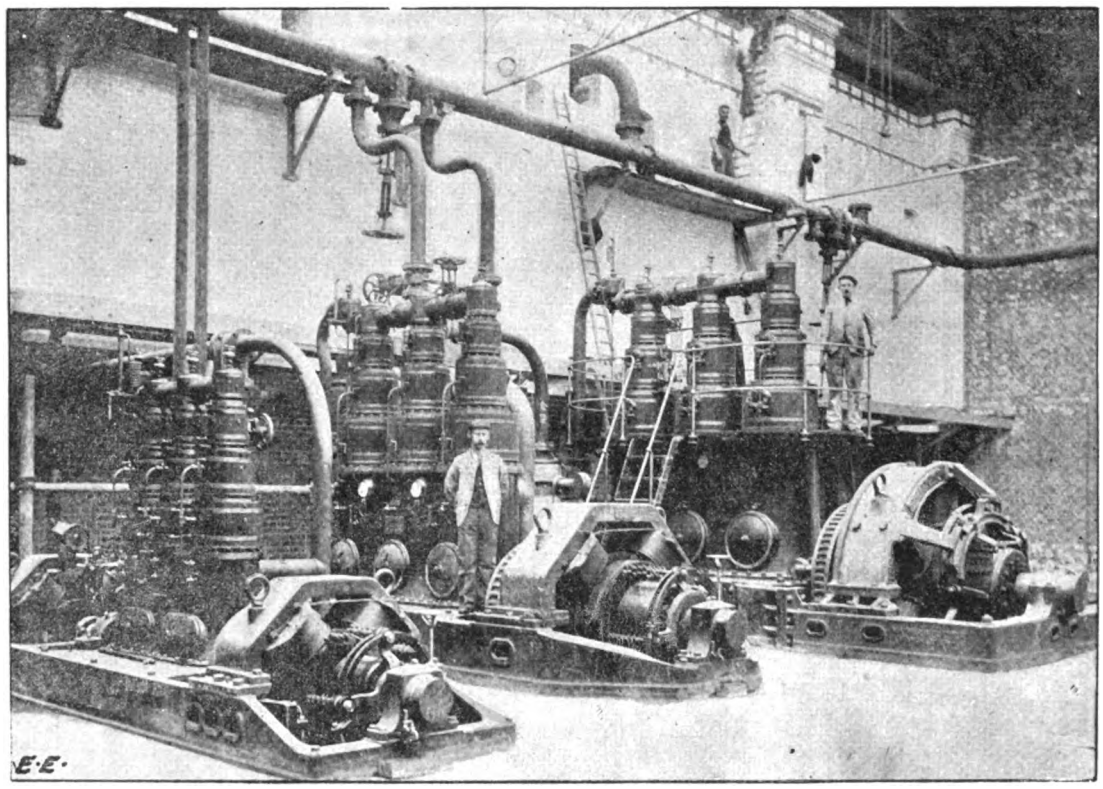

FIG. 6.—View of Battersea Engine-Room and Willans-Mather and Platt Steam Dynamos.

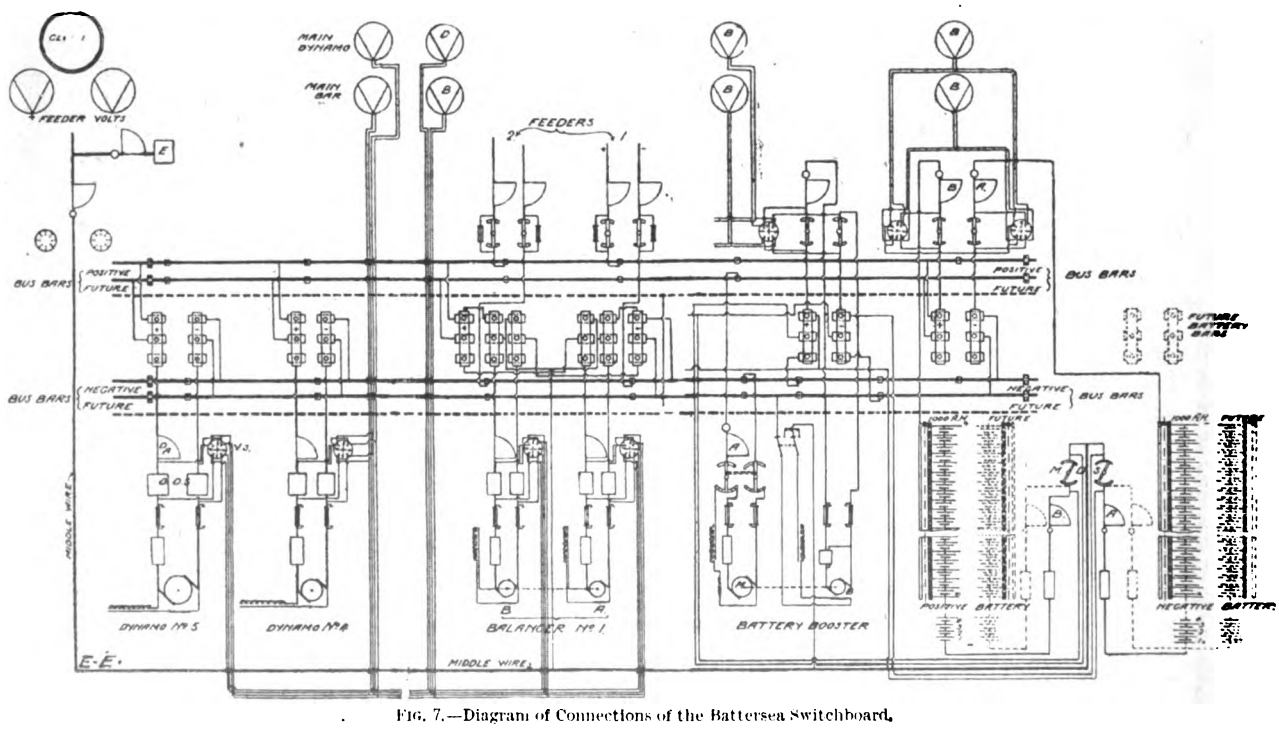

FIG. 7.—Diagram of Connections of the Battersea Switchboard.

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hot-well in the economiser-room. This hot-well receives the slightly-heated water from the exhaust steam heater, the latter being supplied from the feed tank. The pumps force this water either direct into the boilers, or through the economiser and thence into the boilers, as may be desired. The mud-drums of the boilers are connected through valves to a main blow-off pipe running along the back of the boilers and discharging into a blow-off tank placed outside the west wall of the boiler-house. From this tank the water blown from the boilers is discharged through a pipe running under Lombard road into the river. Above the boilers a coal store has been constructed, which is capable of holding about 1,000 tons of coal.

The engine-house (Fig. 6) is adjacent to the boiler-house, and is a well-lighted and lofty building. At the south end is the main switchboard, placed on a gallery 12ft. 6in. above the engine-house floor. From this gallery other galleries run along either side of the engine-house, giving access to the platforms of the engines and to the hand-wheels of the valves on the main steam-pipes. The plant at present in the engine-house consists of two balancing sets, each with two dynamos and three main sets. Each of the balancer engines develops 150 i.h.p., and each of the two dynamos driven by the one engine has an output of 46 kw. The dynamos can be adjusted to give this output at any voltage between 230 and 280 when running at the normal speed of 460 revolutions per minute. These machines work between the middle wire and either of the two outer conductors of the three-wire system. The two sets are placed at the south end of the engine-house nearest to the switchboard gallery. Next to them are two 360-i.h.p. sets and one set of 575 i.h.p. These are the main steam dynamos, which are connected between the outer conductors of the system. The dynamos of the 360-h.p. sets are designed for an output of 192 kw. at any pressure from 460 to 560 volts when running at the normal speed of 355 revolutions per minute. The dynamo of the 575-h.p. set is designed for an output of 400 kw., which it will give between the same limits of pressure regulation as mentioned above for the 360-h.p. set. Its normal running speed is 325 revolutions per minute. All these dynamos are guaranteed to work with constant load of the brushes and with abnormally low temperature rise. Thus, with the exception of the largest set, they will all work for six hours' full load without exceeding a maximum temperature rise of 45deg. F. These engines and dynamos have been supplied by Messrs. Mather and Platt, of Salford Ironworks, Manchester. The engines are of Messrs. Willans and Robinson's well-known central-valve make, the balancer engine being of their 3-G.S. size, the 360-h.p. engines and the 575-h.p. engine being of their 3-P and 3-R sizes respectively. The engines are of the vertical triple-expansion tandem three-crank type. The exhaust steam may be either discharged to atmosphere through one system of exhaust pipes, or led by another pipe into ejector condensers made by Messrs. T. Ledward and Co., of 35, Queen Victoria-street, E.C. Each engine in the station is provided with its own condenser. The main exhaust pipe is 24in. internal diameter and of cast iron. It is led round the side of the engine-house, and is connected to a vertical pipe running up the centre of the chimney. By this means it is possible to work the engines either condensing or exhausting to the atmosphere.

The switchboard is provided with all the necessary meters, instruments, and switches for measuring the quantity of current and the electrical pressure, and for distributing the energy through the various feeders into the distributing mains. The arrangement of the switches makes it possible to run all the dynamos in parallel at the same pressure on all the feeders, or when it is necessary, part of the plant can be run at one pressure on the short feeders and the remainder at a higher pressure on the longer feeders. By means of pilot wires and feeder voltmeters, the pressure at each one of the feeding points can be read at the station and kept at the proper figure. The switchboard is also fitted with the necessary apparatus for controlling the two batteries of accumulators. For assisting in the charging and discharging of these batteries, two special sets, each consisting of a motor coupled to a 20-kw. shunt-wound dynamo, have been provided in connection with the switchboard. The motor drives the dynamo, the latter either assisting in raising the normal switchboard pressure when charging, or, by being reversed, it assists in discharging when the pressure on the battery terminals has dropped below the switchboard pressure. In addition, there is a small motor coupled to a dynamo, which is placed in a partitioned-off space at the end of the battery-room, and which is used to charge any individual cell whose condition may require such treatment. From the special use to which this set is put, it is usually termed a "milking booster." The three booster sets have been made by the Brush Electrical Engineering Company, of Loughborough. They were, however, only sub-contractors, as the machines in question were included in the switchboard contract, which was placed with the Edison and Swan United Electric Light Company, Limited. The construction of the switchboard itself and its general arrangement were, of course,

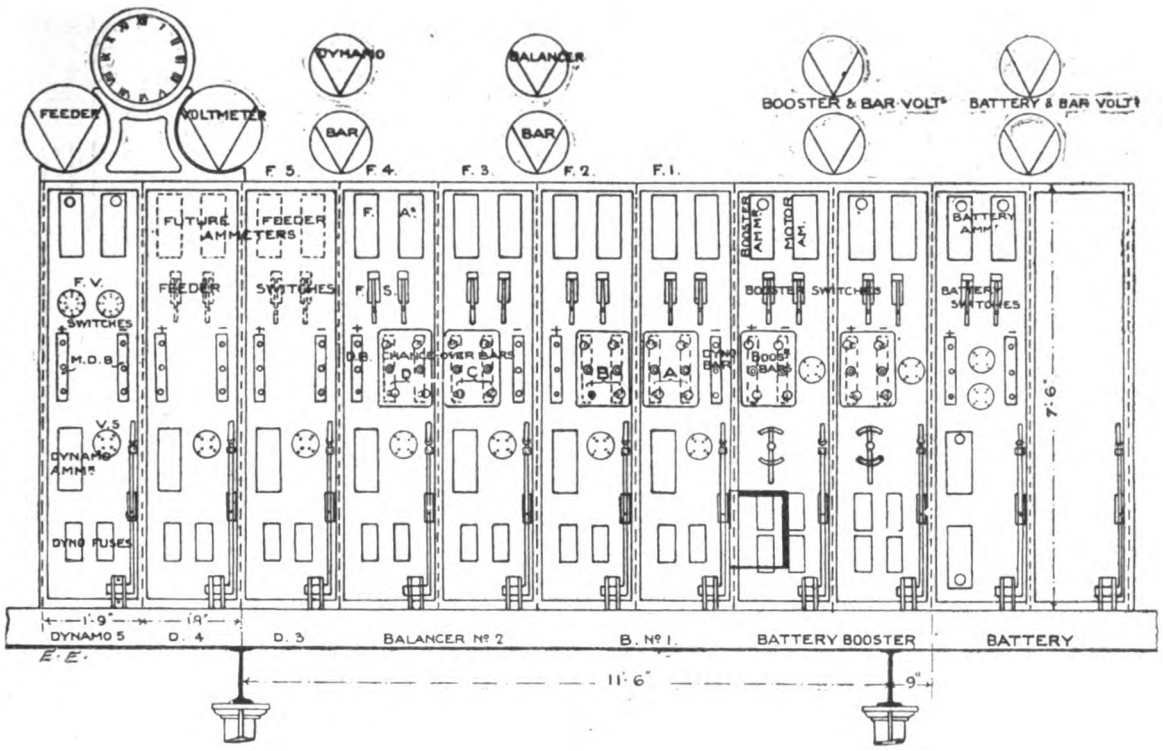

FIG. 8.—Front Elevation of Switchboard.

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designed in the first instance by the consulting engineers. The details of construction, however, were got out by the Edison and Swan Company to the engineers' approval, and in these details we notice several improvements over ordinary practice. In Fig. 7 we give a diagram of connections, which will explain what the switchboard has to do. In order to get the illustration in reasonable space it has been necessary to cut out a number of panels, which were, however, only duplicates of those. connections of which are reproduced. For instance, we only give the connections for one booster panel and one balancer panel, although two of each are provided in the board. The number of dynamo panels we have also reduced to two. The voltmeter switches, marked V S in the diagram, are conveniently arranged for paralleling purposes. For instance, when the two-way switch, marked V S, is closed the main dynamo voltmeter is connected on to No. 5 dynamo, and the circuit of the main 'bus-bar voltmeter immediately below it is also closed. The switchboard attendant thus sees two voltmeters, one immediately below the other, the indications of which must be exactly the same before he closes the switch of No. 5 dynamo. These two voltmeters are used for paralleling all the dynamos. In order to ensure that a short-circuit between a fully excited machine and a machine which has not yet built up shall not be caused by the closing of two of these voltmeter switches, they are arranged with key handles. Only one key is provided for the whole of the dynamo voltmeter switches, and the key is inserted through holes in the glass faces in front of the switches. The same device is adopted for the balancer voltmeters and for the battery booster voltmeters. A single key is provided for each type of panel, and the keys are so designed that they are not interchangeable one with the other. Fig. 8 shows the front elevation of the switchboard, and Fig. 9 a section through the switch gallery. It will be seen from this last illustration that the main double-pole switches are placed behind the main switchboard, and are worked from this by means of levers of the railway signal type with a locking device for securing them firmly in either the on or off positions. The switches are thus well clear of the switchboard, and can be inspected readily from the raised floor seen in the drawing. Another good arrangement is that of the field-regulating rheostats. The hand-wheels for these are placed near the edge of the switchboard gallery, and the field-regulating resistance is hung to the underside of the gallery. Ample ventilation is thus secured, and the resistances can be easily inspected from the engine-room floor. Another new feature on this board is the interlocking shutter used in connection with the plug-bars. This we illustrate in Fig. 10. It consists of an interlocking ebonite shutter having two holes in it and also two semicircular recesses on its periphery. The disc can be moved round a centre between the two vertical plug bars into either one of the three positions shown in Fig. 10. This movement can only take place if both plugs are out, and it is impossible to reinsert both of the two plugs unless the disc is in one of the three positions shown. In other words, no diagonal connections such as will cause short-circuits can be made, as the two plugs when inserted must be in the same horizontal line. The device, which is an exceedingly simple one, is due to the Edison and Swan Company's staff. The duplex fuses at the base of the board (Fig. 8) are carried

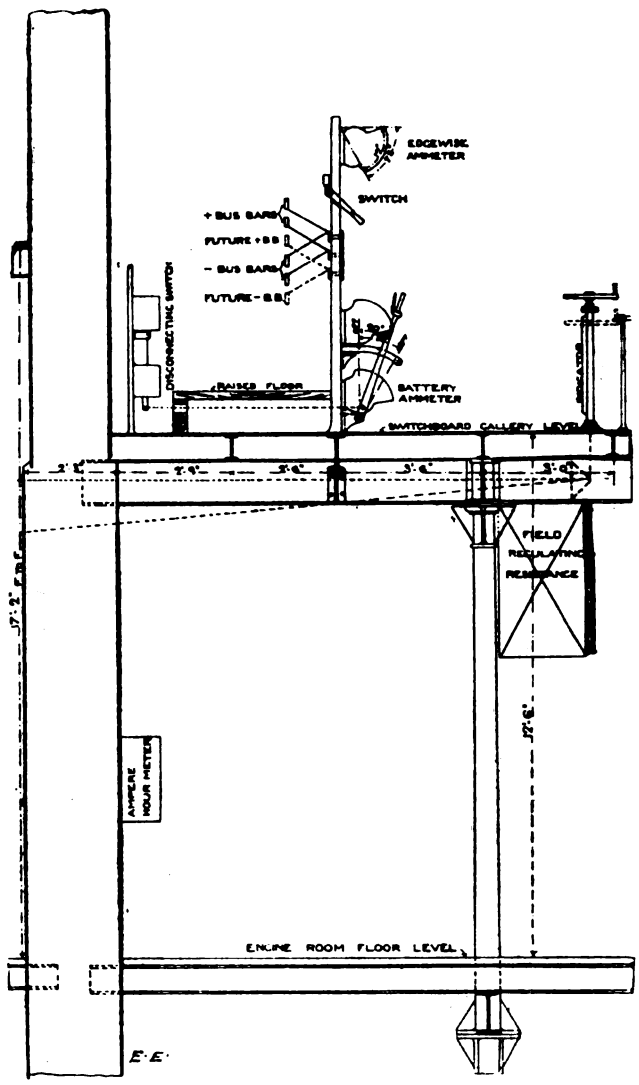

FIG. 9.—Section of the Battersea Switchboard.

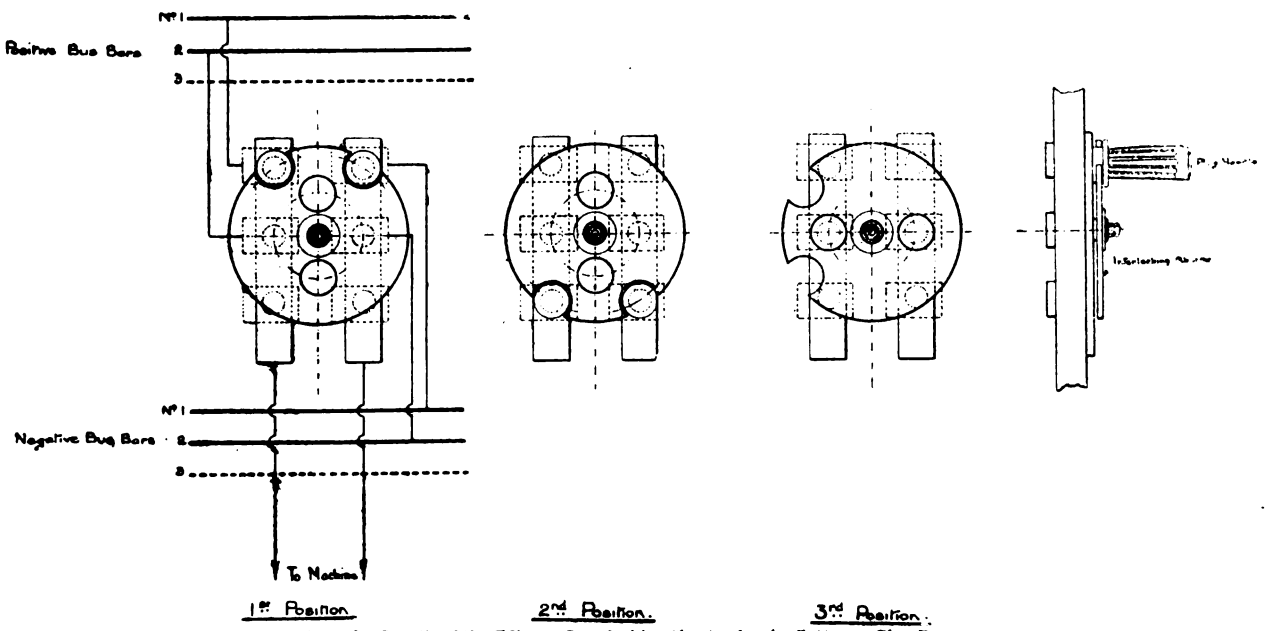

FIG. 10.—Details of the Ediswan Interlocking Shutter for the Battersea Plug Bars.

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in heavy cast-iron troughs with handles facing outwards. These troughs are lined throughout with asbestos, as otherwise the circuit was not broken when a fuse went. The measuring instruments used on the board are of the edgewise type throughout, and they can be read from the engine-room floor level with reasonable accuracy. As will be seen from the general plan and elevations, the switchboard gallery is continued round the engine-room, and ready access can be had from this extended platform to the platforms of the larger engines.

The lighting of the engine-room of a central station is not an easy matter, on account of the travelling crane. If arc lamps are suspended from the roof at the correct height from the floor to give a good light on the machines, the conductors and supports are in the way when the traveller has to be moved. The resident engineer at Battersea, Mr. H. R. Forbes Mackay, has accordingly arranged a number of arc lamps supported from brackets from the side walls. These brackets hinge on their supports, and can be turned back against the wall in the event of their being in the way of the moving crane. The lamps used for the station lighting are of Messrs. Johnson and Phillips's type, being of their "Ark" long-burning type, and the same firm also supplied the long hinged brackets for supporting the same. These can be seen in Fig. 6, but the lamps were not attached at the time the photograph was taken.

The two storage batteries installed at Battersea were supplied by the Hart Accumulator Company, Limited, of Stratford, and consist each of 140 cells. These cells have a capacity of 200 amperes for a five-hour discharge, or 265 amperes for over a three-hour discharge. They are also capable of discharging at 400 amperes for periods of half hour. In any case the E.M.F. is guaranteed not to fall below 1·85 volts per cell at the end of the discharge. The containing boxes are made of teak and lined with sheet lead, the stands consisting of wood bearers supported by iron frames. The plates are the firm's standard central-station type, and are connected together by the twin-plate method, by which the use of heavy 'bus bars is entirely obviated, any pair of plates being easily removed at any time and others substituted. By this method of connection internal short-circuits render ineffective the adjacent plates only, and not the whole cell, as is often the case.

The whole of the cables for the mains, feeders, arc lamp circuits, and services have been supplied and laid by Callender's Cable and Construction Company, Limited. The distributing mains are all laid on the solid system. The arrangement consists in laying three cables side by side in a cast-iron trough provided with a covering of hard blue Staffordshire tiles. Wood bridges are placed at intervals to keep the cables away from the bottom of the trough, and at the correct distance apart one from the other. Finally, after the cables have been laid in position, the trough is filled with molten bitumen and the tile covering laid on. Two sizes of mains have been used. In the large size each of the outer conductors consists of cables having a sectional area of 0·15 square inch, while the middle-wire cable has a section of 0·08 square inch. In the smaller size of main the sectional areas are 0·1 square inch and 0·08 square inch for the outers and the middle wire respectively. The cables themselves are insulated with vulcanised bitumen, and finally provided with a braided yarn covering. Although the bitumen with which the trough is filled also acts to a small extent as an insulator, its main object is to afford further mechanical protection to the cables, in addition to that which is provided by the cast-iron

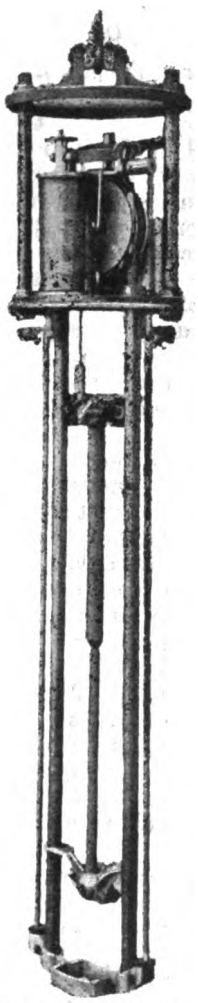

FIG. 11.—The G.E.C. Angold Arc Lamp

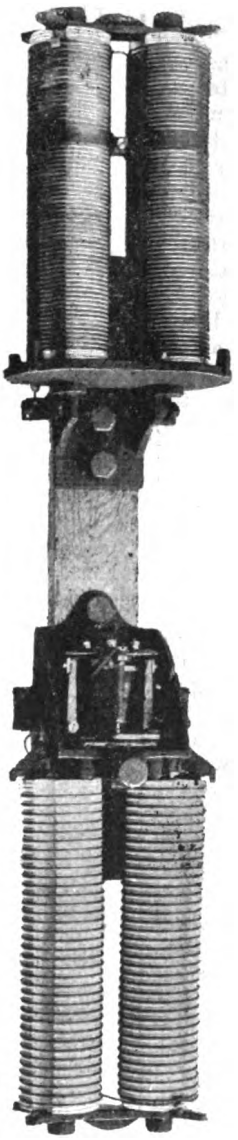

FIG. 12.—Sub-Station Resistance and Cut-Out for Arc Lamp, with Circuit Resistance above.

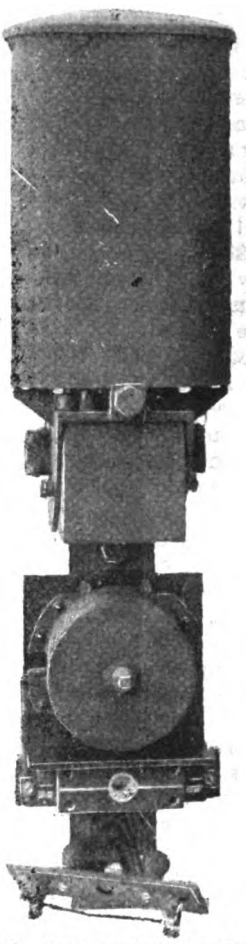

FIG. 13.—Resistance Switch and Fuses for Arc Lamp.

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troughing and tile covering. Similar cables for arc leads of ·022 square inch section are laid in the same trough as the distributors. At points where two or more mains meet, and at feeding points, special cast-iron boxes are provided, into which the cables are brought. These boxes contain all the necessary terminals and links by which any section of main may be entirely cut off and isolated when required for testing or for remedying defects, connecting services, etc. These disconnecting boxes are placed in brick pits under the pavements, so that they are easily got at by lifting the pavement covers. The service cables to the consumers' premises are also laid on the solid system, the connection to the distributing mains being made in a special cast-iron box fixed in the run of the troughing. The feeders at present laid are five in number. Each consists of a concentric cable having a central stranded copper core of 0·5 square inch sectional area. This core is provided with a layer of insulation, which acts as a bedding for an outer concentric wrapping of copper wires forming a second conductor of the same sectional area as the central core. Three of these feeders are laid on the solid system, as described above, in connection with the distributing mains. The remaining two feeders are provided with steel tape armouring over the insulation and laid direct in the ground. These five feeder cables are laid from the station to feeding points on the mains situated at the following places: (*a*) corner of north end of Latchmere-road and Battersea Park-road; (*b*) Austin-road; (*c*) corner of south end of Latchmere-road and Lavender-hill; (*d*) Broomwood-road; (*e*) Victoria-road. A three-core pilot wire is laid beside each feeder and connected to the distributing mains at the feeding points. A middle-wire connection from two points in the distributing network is also brought back to the station, and the cables laid for this purpose have a sectional area of 0·25 and 0·5 square inch. These cables are, of course, only single conductors. The whole of the trenching work and making good has been done by the works department of the Council. In order to allow of more feeders being added, stoneware ducts have been laid in certain streets to avoid reopening up the footways when the feeders are required.

The arc lamps for the street-lighting are 240 in number, and have been supplied by the General Electric Company, Limited, of Queen Victoria-street, E.C. They are designed for a current of 10 amperes. The lamps are supported on ornamental cast-iron pillars, in most cases being suspended from a bracket from the top of the pillar, but in a few cases they are supported in a central carrier. The design of the pillar, bracket, and central carrier is based on that specially prepared some years ago by the School of Art in Edinburgh for the lighting of that city. The same design has since been used in several other places, including Westminster and Carlisle. The whole of the pillars have been supplied by Messrs. J. and A. Law, of Rae-street Foundry, Glasgow. These lamps are connected 10 in series across the 460-volt mains. Each lamp takes about 41 volts, so that this leaves 50 volts per circuit for the line resistance, etc. This allowance, although less than usual, is found to give excellent results with the lamps in question. The makers claim as an advantage for these lamps that the leads pass down through the lamp in tubes to terminals on the under side of the lamp bases without going into the mechanism chamber. The heated gases from the lamp thus do not get into the chamber, and so cannot deposit carbon dust in it. Details of this lamp and its equivalent resistance are shown in the illustrations (Figs. 11, 12, and 13). The equivalent resistance (Fig. 12) is wound on two porcelain bobbins enclosed in a waterproof cover, and one is placed in every post. The cut-out (Fig. 13) is placed below the equivalent resistance in an iron box. Special attention had to be paid to the design of this apparatus, owing to the small variations of voltage and current, because if all the cut-outs were to act together the line resistance would take only 90 volts, leaving as much as 37 volts for each parallel set of lamps and equivalent resistance. This could not actually happen in practice, as the cut-outs take 70 volts each to lift them; but six or seven cut-outs might act together, and the result would be probably the same. For the same reason difficulty was experienced in arranging the apparatus to cut in again when the carbons come together, at the same time leaving sufficient pressure on the contacts, when the equivalent resistance is in circuit by itself. However, these difficulties were entirely overcome. The two end posts of each circuit contain one single-pole switch and fuse. The latter is of the General Electric Company's well-known H.V. type, with lined fuse chamber, and has been successfully tested on a dead short-circuit on 500 volts. The switch and fuse are placed below the cut-out. The second post in each series contains the necessary line resistance, also wound on two porcelain bobbins in a waterproof cover (Fig. 12) It is adjustable, and can be arranged to absorb more than the normal 50 volts.

In conclusion, we have to express our thanks to Messrs. Kennedy and Jenkin for their kindness in lending us the drawings from which the enclosed illustrations were made. Mr. Forbes Mackay has also been most courteous in showing us the station and explaining the details of the plant.

RECENT TRAMWAY PRACTICE.*

BY JAMES MORE, JUN., M.I.C.E., F.R.S.E.

(Concluded from page 481.)

Bearings.—The bearings are properly proportioned, and of the best bronze. They have a well holding about one pint of oil, which is siphoned through wicks to the journals. Emergency lubrication is supplied in the form of a grease-box filled with grease, which melts if undue heating occurs in the bearings, and so runs down on to the journal.

Gearing.—The pinion wheels are made from hammered machine steel, and the teeth are cut out of the solid metal. The spur-wheel for the car axle is made of the best crucible cast steel, is cast in two halves, and the teeth cut from the solid metal. The halves are held together by eight bolts, and can be fixed on the axle without removing the wheels. Both the spur and pinion run in an oil bath. Fig. 28 shows the method of suspending the motor, and Fig. 29 its characteristic curves.

Car Equipment.—Controllers are now either of the magnetic or solenoid blow-out type. They are both largely used, but the writer is more familiar with the latter, which is used on many corporation installations. It is, perhaps, more effective than the other, having a solenoid at each contact, and so reduces the damage done by flashing. All cars should be fitted with incandescent lamps inside and outside, some of the latter to illuminate class and destination signs. They also are provided with the necessary resistances, lightning arresters, circuit breakers, fuses, etc Fig. 30 shows the wiring and connections between controller and the motors, the resistances, fuses, circuit breakers, etc., on a four-wheeled car with double equipment, without an electrical brake. Fig. 31 shows the wiring and controller connections, etc., of the same car with an emergency electric brake.

Brakes.—Everyone realises the necessity of quick, powerful brakes on an electric car. The old spindle brake was quite sufficient for a light horse-car travelling at about 6½ miles per hour. The electric four-wheel car is about five times as heavy, and, as a rule, the speed will be over seven and sometimes as much as 15 miles per hour. The momentum being so much greater, it follows that a quicker brake is necessary, and also an emergency or reserve brake. This is so apparent that there is a tendency to have too many emergency brakes, adding to the weight of the car and the confusion of the driver when an emergency occurs. Of course all the cars must have the ordinary hand brake, either spindle or screw. The latter is slower but more reliable, and can be put on more delicately to avoid skidding the wheels, which is most objectionable. When the wheels skid, a car runs further than if there is just sufficient pressure on the blocks to get the maximum friction without stopping the wheels. It need not be pointed out that skidding soon spoils the wheels by causing flats, and necessitating the trueing up of the treads by grinding or turning if they are of steel. If the wheels are not ground up, the flats make most

* Paper read in Section VII. of the Glasgow International Engineering Congress.

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uncomfortable running, and cause serious fatigue to the motors, car bodies, and, as a matter of fact, to the whole fabric. Assuming the car has a hand brake, it is interesting to consider what is the purpose of an emergency brake. Is it to act as a reserve in case of the hand brake giving way, or is it a stand-by to assist the hand brake? the wheels, causing them to remain skidded. Considering these facts, the writer has come to the conclusion that speed in applying the brake is the most important of all factors, especially in a runaway, as a few seconds mean an enormous increase in momentum. In this respect air brakes are most effective. They are also independent of

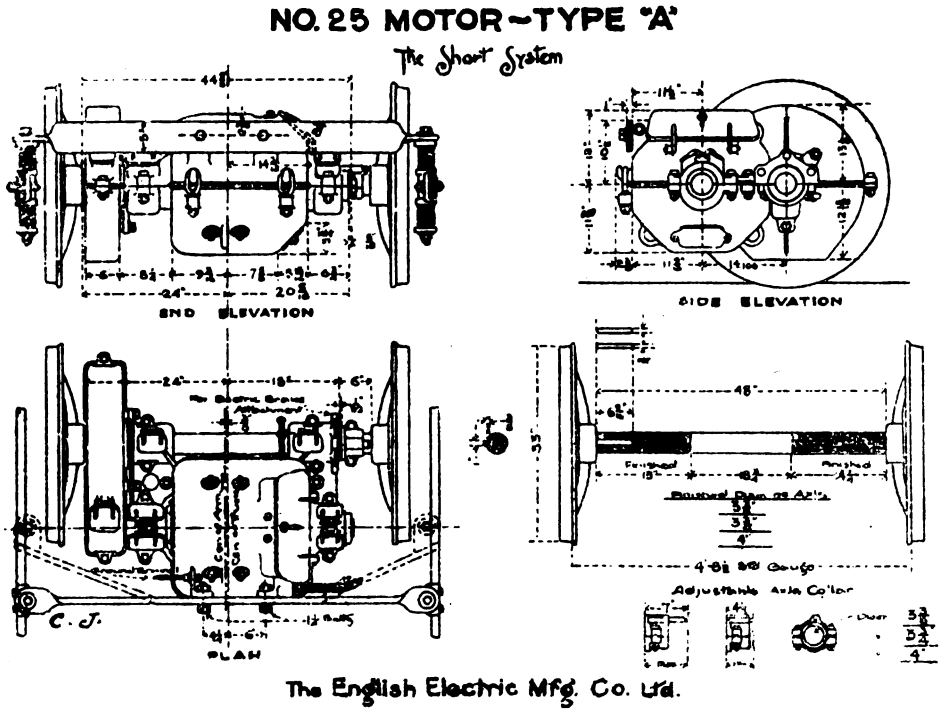

FIG. 28.

This point must be decided before one can say what kind of emergency brake is best. It may be said in passing that the prime purpose of such a brake will differ on different roads, and this is correct. When the roads are comparatively level the main purpose will be to replace the broken brake, but when there are stiff gradients the purpose will primarily be to augment the the electric current, which in the case of a runaway is generally not available, owing to the trolley wheel leaving the wire. The air brake is an independent unit in such circumstances, and should be applied to the wheels and used as the ordinary brake, more especially in descending gradients. A hand brake should be fitted as a slipper brake to act on the rails, and actuated by a

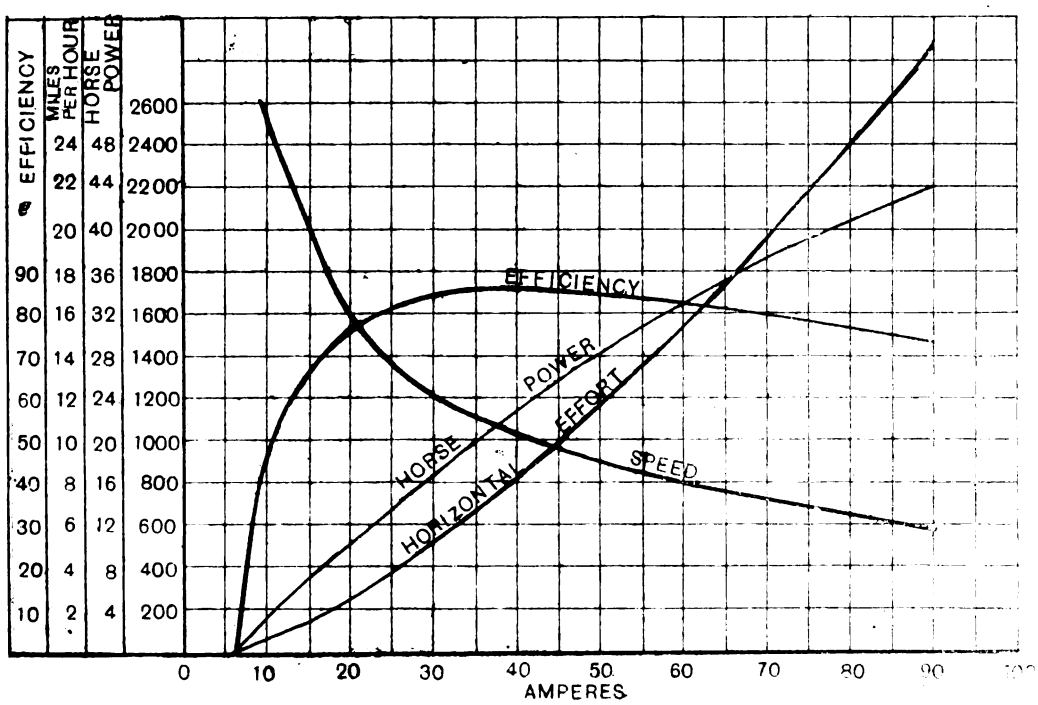

FIG. 29.

retarding power of the hand brake. By a properly designed hand brake a man can skid the wheels, and probably will in an emergency. It is therefore evident that any increase of pressure on the wheels or on a drum on the axle is useless as an auxiliary. The writer thinks it is also useless in these circumstances to apply a slipper brake acting on the rails, as this only reduces the weight on screw as in locomotives, to give delicate application and so act as little counter as possible to the wheel brake. This screw spindle should have a heavy handwheel and the screw kept in fine running condition. Lastly, there may be an electrical emergency brake to act on the wheels or axle. The writer has had considerable experience of the action of brakes on severe gradients, and has had strongly

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impressed on his mind the great importance of quickness in application of any brake, but more especially the wheel brake, which is the most effective of all.

OPERATING.

Assuming that a manager has had a thoroughly efficient installation handed over to him by the engineers, his problem is how to get the best financial results from it. To accomplish this end he has many different circumstances to take into account. The principal one, however, in the writer's opinion, is to reduce the traffic expenses to a reasonable minimum. This can only be done by getting the maximum number of miles from his car per day. To put it briefly, he is a manufacturer who has a machine for making car miles, and he must get the greatest possible output with standing on-cost charges. This, of course, is merely a principle to be observed, and is subject to the demand, as are all manufacturers. He must bring his experience of traffic to bear on his practice, otherwise he would be losing fares by too infrequent stops. Indeed, the principle could be reduced to an absurdity by running the cars without stopping. If the manager decides to adopt stopping places, as is generally done now, he must give hi mind to the subject carefully and fix them at the most convenient places to pick up passengers, even although they are not equidistant. Such natural stopping places occur in every town. He must also avoid having his stops too frequent. The writer has known places where the old method of stopping anywhere was abandoned, and stopping places fixed, with the result that the effective speed of the cars was lowered and consequently the miles per day. There are other cases where the stopping places are so few that undoubtedly many pick-up passengers are lost, who perhaps only want to travel 500 or 600 yards. They naturally will not take a car if they have to walk 200 of the yards. In the large busy towns the writer thinks that with ½d. fares and very frequent stopping places, or, indeed,

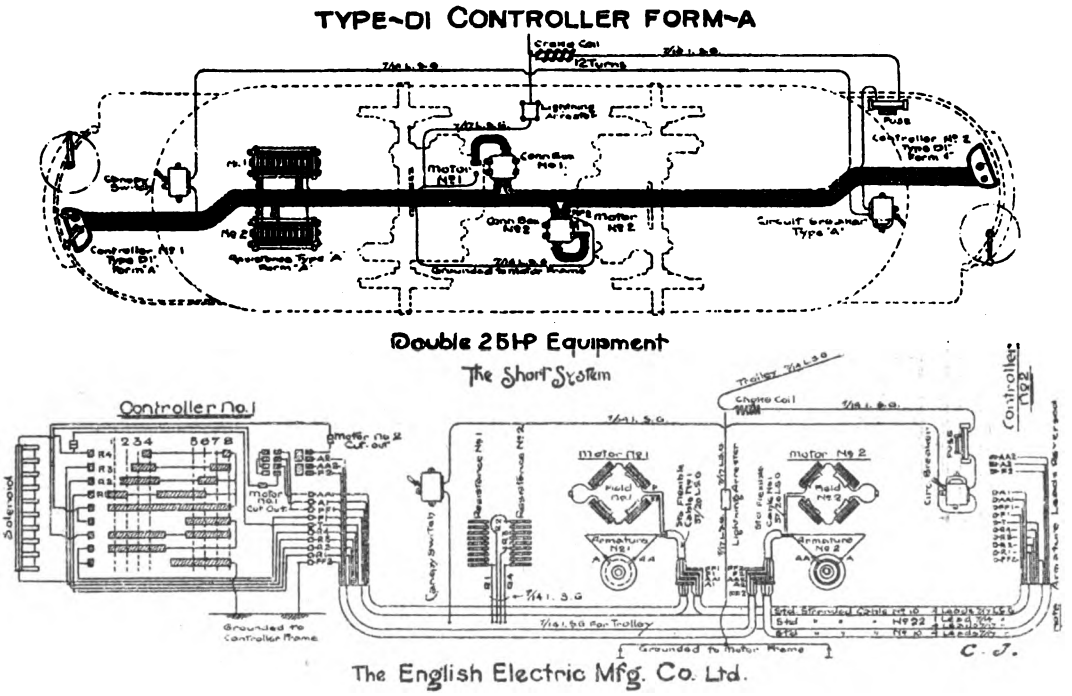

FIG. 30.

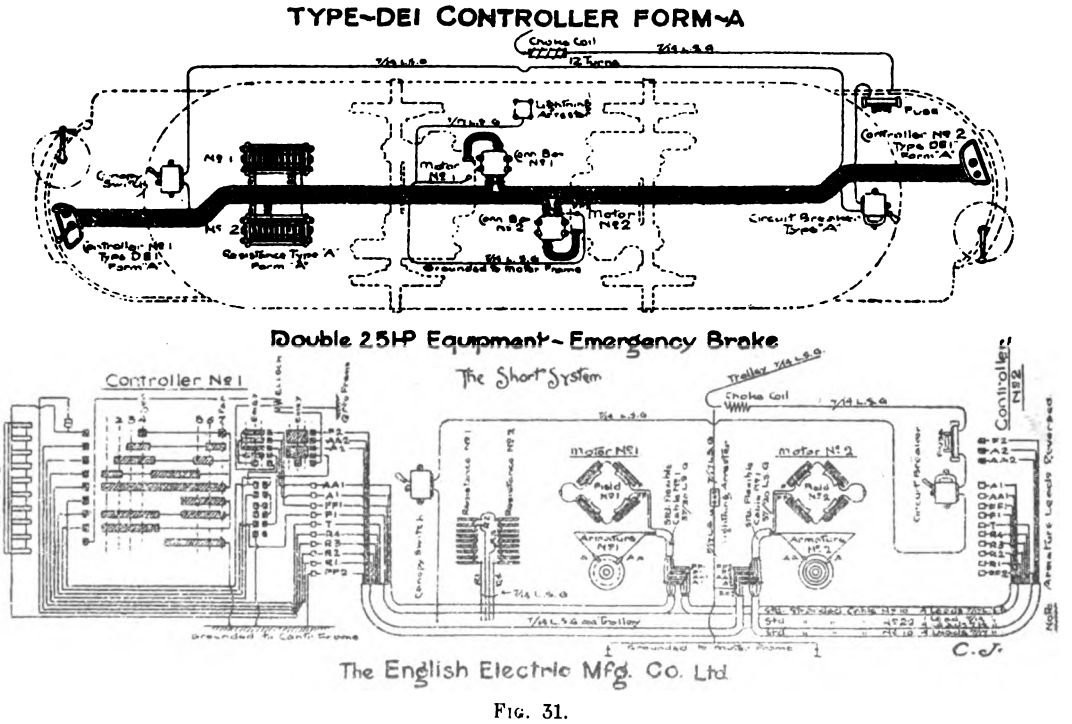

FIG. 31.

with no fixed stops, there would be a considerable increase in pick-up ½d. passengers; put tersely, the seats would be kept warm. This, of course, does not apply to the suburban districts, where there are few excepting through passengers, and where the cars can make good speed, which they cannot in the town streets, even if they would.

The commonest fault in management, and one that

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TABLE 32.—Operating Results.

Name of town.	Service in minutes. Quickest	Service in minutes. Slowest.	Number of cars.	Miles per car per day.	Total car miles per day.	Total car miles per annum.	Receipts per car mile.	Expenses per car mile.
							d.	d.
Glasgow, Springburn	2	6	47	91	3,000	927,870	13·89	6·26
Leeds	1	10	130	110	14,300	2,379,380	12·77	6·55
Sunderland	2½	5	41	100	4,000	1,460,000	12·375	9·60 (including depreciation)
Dublin	2½	10	201	92	18,800	6,500,000	8·0	5·0
Aberdeen	5	15	11	117	1,287	402,831	15·5	6·03

absorbs many miles, is the unnecessary delay at the termini. The motorman and the conductor naturally consider it the finish to a piece of work, that a journey is "something attempted, something done," and that they are entitled to a spell of leisure. On short routes it is astonishing, if one calculates, how many miles are lost compared with those on a circular route of the same length. A strong firm inspector should be posted at the termini to bustle off the cars within about two minutes of their arrival. Of course, he must have discretion in a case of bunching of cars owing to a breakdown. He, however, should try to respace them rather by accelerating the front cars than delaying the rear ones. The manager ought always to be consulted, and his advice taken, if he is an experienced man, as to the position and capacity of the various car sheds. These should be of moderate size and distributed over the system. Many mistakes have been made in this respect. Car-sheds have been made so large and inconvenient that it unnecessarily occupies a great amount of time to get the cars out of and into them, irritating the men at a late hour, while they are being paid for wasted hours. The sheds are also fixed, in many cases, in the suburbs for sake of a cheap site, whereas had a convenient site been selected in the town, the difference would have been redeemed in the first two or three years by saving the dead mileage of the cars. All cars should get into work as soon as possible after leaving the shed. Shorter hours for the men could easily be obtained with economy for the manager, by carefully locating and distributing the car-sheds. In most towns the traffic is uneven, and on certain days and certain hours of the day subject to heavy rushes. The manager has to consider and provide for this by bringing out more cars and sending them back to the sheds. If the sheds are conveniently situated this is simple enough, and is convenient for using the reserve men who are putting in short time. On the other hand, if the sheds are large and in outlying districts, both the men and the cars lose good time in going to and from the depôts. Another disadvantage of large imposing car-sheds is the serious result of fire, or a breakdown in the circuit. In the first case many cars might be destroyed, and in the second many would be locked up in the depôt, and the traffic dislocated for a needlessly long time.

As to the collection of fares and checking, it is surprising the differences of opinion there are. Everyone is agreed, however, that some means must be taken as to checking, whatever mechanical fare register there is in use. The number of checkers varies greatly in different towns. Bell-punch registers and fare boxes have each their advocates. The writer favours the latter, as the conductor never handles the actual fare. He has only to account for a certain amount of copper which he takes out for the purpose of giving the passengers change. One good principle to act upon, whatever system is used, is to collect the receipts from the conductors as often as possible during the day. As to service or mileage, this should, along with high effective speed, be carefully gauged by the receipts per mile. In a large town with a service under five minutes and popular fares, the writer thinks the mileage should be run up till the receipts per car mile are brought below, say, 1s. Table 32 gives the comparative working results of five different electric installations.

The writer may just say, in conclusion, that some of the results given in the tables appear to be incompatible. They are as he has got them from the various engineers and managers, and he has no means of checking them. The difference may be merely one of book-keeping, or allocation between the lighting and traction departments. In some cases the consumpt per kilowatt per hour, and per indicated horse-power per hour, the writer has had to convert by calculation. He thinks, however, they are near enough to give an interesting comparison.

In concluding, the writer wishes to express his thanks to the following gentlemen for the results and information they have taken the trouble to give him: Mr. John Young, Glasgow; Mr. William Clark, M.I.C.E., Glasgow; Mr. W. Wharam, Leeds; Mr. J. F. C. Snell, A.M.I.C.E., M.I.E.E., Sunderland; Mr. C. W. Gordon, Dublin; Mr. J. Alex. Bell, A.M.I.E.E., Aberdeen; Mr. E. R. E. Rotter, A.M.I.C.E., Portsmouth; Mr. Chas. F. Wike, M.I.C.E., Sheffield; Mr. A. Ellis, M.I.E.E., Cardiff; Mr. Robert C. Quin, Blackpool; Messrs. Dick, Kerr, and Co., Limited, London; Messrs. the British Insulated Wire Company, Prescot; Messrs. the Electric Railway and Tramway Carriage Works, Preston; Messrs. the English Electric Manufacturing Company, Preston; Messrs. W. F. Dennis and Co., London; Mr. Arthur A. Day, A.M.I.E.E., Bolton.

MODERN COMMUTATING DYNAMO MACHINERY, WITH SPECIAL REFERENCE TO THE COMMUTATING LIMITS.*

BY H. M. HOBART, M.I.E.E.

(Continued from page 483.)

In the curves of Fig. 14 are given the results obtained for these models when measured without any pole-pieces, which corresponds to the condition of minimum inductance—*i.e.*, the condition in coils at the instant of commutation under the brushes. It is interesting to observe that for the six-coil model the reactance is still 45 per cent. of the uni-coil model, and when it is pointed out that these two

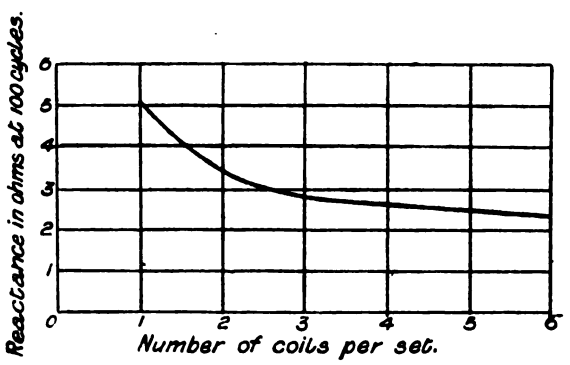

Fig. 14.

models represent very extreme cases, one will be inclined to admit that, with the very much smaller variations in shape and numbers of slots encountered in practice in continuous-current machines, the value of the inductance as expressed in flux per ampere-turn per centimetre of length will not be greatly different throughout the range of proportions common in the modern projection type of continuous-current dynamo. In fact, while the two cases sketched in Fig. 15 represent diagrammatically the cases of models 1 and 5, the most extreme cases which would be met with in practice in continuous-current dynamos—as relates to coils simultaneously commutated—would not vary from one another so much as the two depicted in Fig. 16.

The writer has gone into this matter so much at length because it has considerable bearing upon his contention that one is justified, without

* Paper read in Section IX. of the International Engineering Congress, Glasgow, 1901.

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much regard to the slot proportions or the numbers of slots, in taking a representative value as he has done, say four lines per ampere-turn per centimetre of embedded length, in instituting comparisons of the reactance voltage of various machines. If one analyses the results of

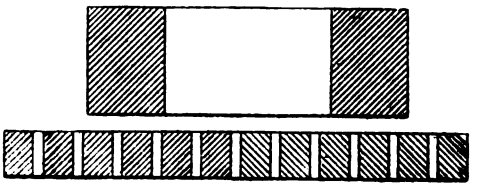

FIG. 15.

the curve of the Fig. 14, changing the values into C.G.S. lines per centimetre of embedded length and neglecting the free length, one obtains the results given in the curve of Fig. 17. Treating the entire 6·3cm. between flanges as magnetic iron—*i.e.*, neglecting the 10 per

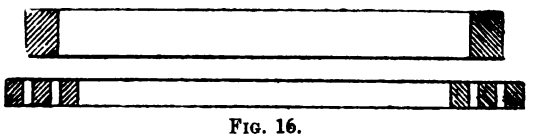

FIG. 16.

cent. of insulation between plates—tends to offset the error involved in failing to assign a portion of the total lines to the influence of the "free length." But, as already stated, the models are too small to serve suitably for a basis for obtaining useful fundamental constants of this sort, being intended for ascertaining the approximate percentage

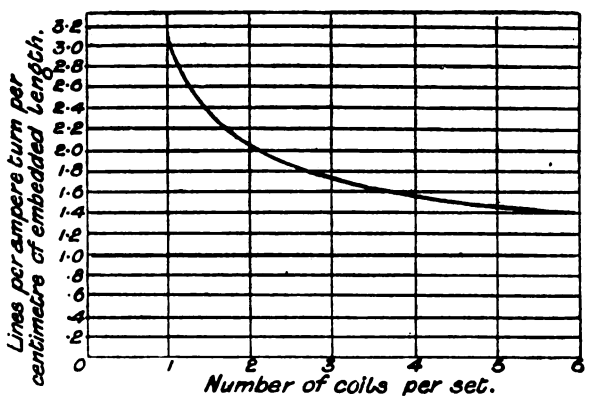

FIG. 17.

decrease in the reactance secured by distributing a winding of a given number of turns in many slots. For the purpose of studying the extent of the influence of the shape of the slot, the writer had built a series of models of the dimensions and with the windings shown in Fig. 18. The inductance tests made upon these five models give the results set forth in Table XVI.

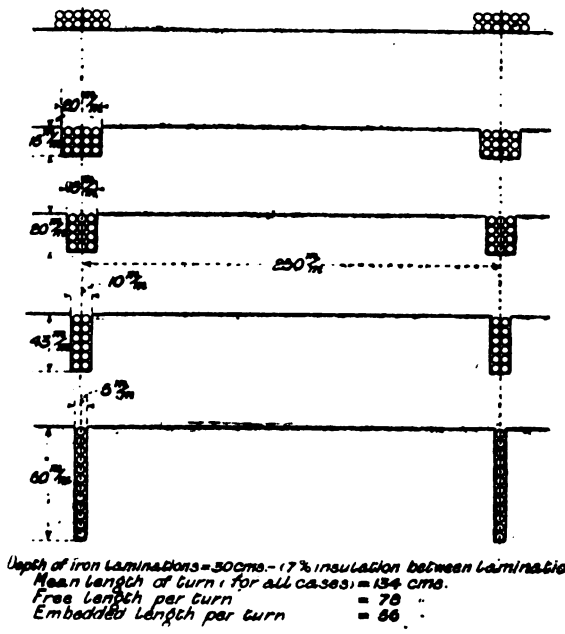
Depth of iron laminations = 30cms. - (7% insulation between laminations.)
Mean length of turn (for all cases) = 134 cms.
Free length per turn = 78 "
Embedded length per turn = 56 "

FIG. 18.

In Fig. 19, the inductance of Model I., corresponding to the case of a smooth-core winding, is taken as 1·0, and the relative values for the other models are plotted in terms of the ratio of the width to the depth of the slot. From the curve it is seen that considerable changes

TABLE XVI.

Model.	Width of slot (mm.).	Depth of slot (mm.).	Width ÷ depth.	A. Observed inductance (henrys).	B. Inductance corrected to correspond to more normal wave form (henrys).	C. Lines per ampere-turn corresponding to column B.
I.	—	—	—	·000280	·000243	169
II.	20	15	1·33	·000365	·000317	220
III.	15	20	·75	·000400	·000347	242
IV.	10	43	·23	·000495	·000430	299
V.	5	60	·083	·000805	·000700	485

in the slot proportions are necessary to even slightly affect the inductance of the winding. Furthermore, since in these models the "embedded length" has the high value of 45 per cent. of the total length per turn, the shape of the slot would in actual machines be

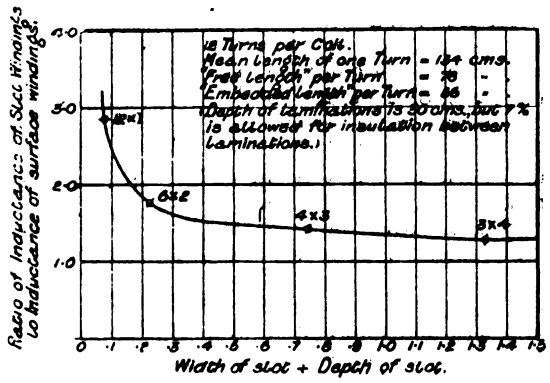

FIG. 19.

even less influential, since in them the "embedded length" rarely exceeds 30 per cent. of the total length, and the inductance of the remaining 70 per cent. constituting the "free length" is, of course, entirely independent of the shape of the slot. If for the models of Fig. 18 we estimate the inductance of the "free length" at 0·8 lines per centimetre, then for the "embedded length," working from column C of Table XVI., the results set forth in Table XVII. are obtained for the inductance per centimetre of "embedded length."

TABLE XVII.

Model.	Lines per centimetre of "embedded length."
II.	2·8
III.	3·2
IV.	4·2
V.	7·5

It must not be forgotten, in considering these results, that very extreme cases were examined. Then tests were made with a coil of which the inductance was measured, first with the coil at the bottom of the slot, and then in positions successively higher and higher, until finally the coil was entirely removed from the armature. The results

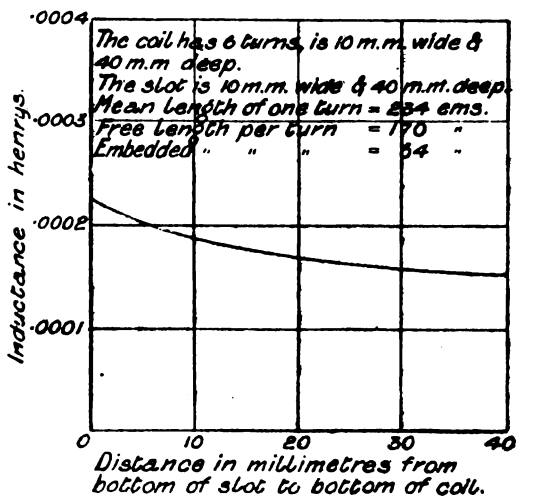
The coil has 6 turns, is 10 m.m. wide & 40 m.m deep.
The slot is 10 m.m. wide & 40 m.m. deep.
Mean length of one turn = 234 ems.
Free length per turn = 170 "
Embedded " " " = 64 "
Inductance in henrys.
Distance in millimetres from bottom of slot to bottom of coil.

FIG. 20.

are shown in the curve of Fig 20. We may analyse this case as follows:

Lines per ampere for "free length" ..... = 170 × ·8 × 6 = 815
Lines per ampere for "embedded length" ..... = 64 × 4 × 6 = 1,540

Total flux (C.G.S. lines..... = 2,355
Estimated inductance 2355 × 6 × 10^{-8} ..... = ·00014 henry.
Observed inductance with a coil 40mm. × 10mm. in one slot with abnormal wave-form supplied ..... = ·00022 ,,
Corrected 15 per cent. for more normal wave-form ... = ·00019 ,,

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Had the coil been rather spread out, say part in one slot and part in the adjoining slot—this representing a more average practical condition—this 36 per cent. excess of the corrected observed result over the estimated result would have been decreased.

In the preceding test the "embedded length" was only 27 per cent. of the mean length per turn. This tended to obscure the influence of

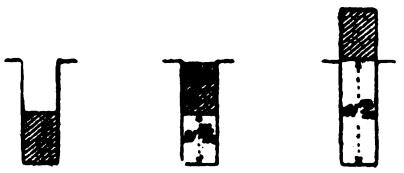

FIG. 21.

the depth in the slot of the "embedded length." Another test was made upon a five-turn coil of which the

Mean length of turn ..... = 105·cm.
"Free length" per turn ..... = 56·cm.
"Embedded length" per turn ..... = 49·cm.

the "embedded length" thus constituting the high proportion of 47 per cent. of the mean length per turn. Measurements were made in four positions of the coil: 1. Coil at the very bottom of the slots. 2. Top of coil just level with top of slot. 3. Bottom of coil just level with top of slot. 4. Coil free in air.

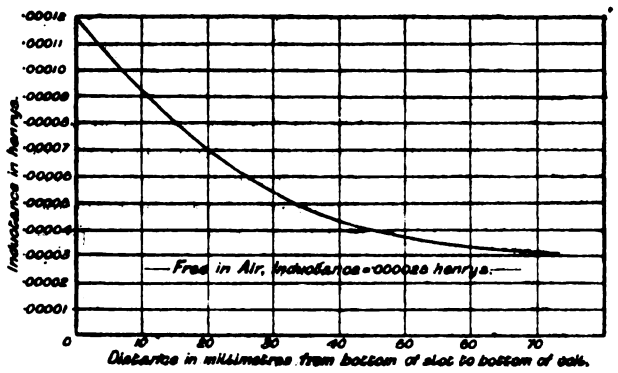

FIG. 22.

The coil was 20mm. high × 10mm. wide. The slot was 41mm. high × 10mm. wide. The three first positions are shown in Fig. 21, and the results are given in the curve of Fig. 22.

Effect of End Connections.—Tests with coils with different lengths of end connections were then made on the three five-turn coils shown in Fig. 23 For all three cases the "embedded length" was 49cm. The coils were all of a section of 10mm. wide by 20mm. deep, and

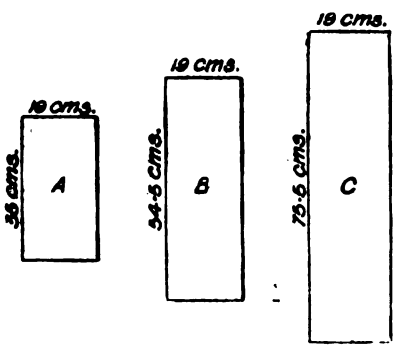

FIG. 23.

were measured in slots 10mm. wide by 41mm. deep. Three sets of measurements were made with the coils respectively at the bottom, at the top, and directly above the slots. The results are given in Table XVIII.

TABLE XVIII.

Coil.	Length of one turn in centimetres.	"Free length" in centimetres.	"Embedded length" in centimetres.	Ratio of embedded length to free length.	Inductance, with uni-slot alternator in henrys.		
					Coil at bottom of slots.	Top of coil level with top of slot.	Bottom of coil level with top of slot.
A	105	56	49	·47	·000120	·000070	·000041
B	147	98	49	·33	·000124	·000079	·000054
C	189	140	49	·26	·000142	·000093	·000068

These results are plotted in three of the curves of Fig. 24. The fourth curve is interpolated for the case of a coil lying half-way between top and bottom of the slot, but even this would not be the practical equivalent of an actual armature winding, since then, considering coils short-circuited at both the positive and negative brushes, the group of conductors concerned occupies the whole depth of the slot, and generally two neighbouring slots are concerned. For these reasons, as well as because the measurements were made on the circuit of the uni-slot alternator, the results are considerably too high. It will, nevertheless, be of interest to analyse the case equivalent to this fourth

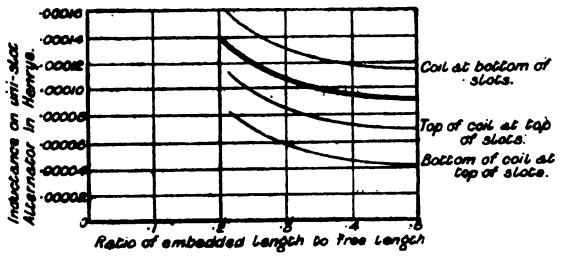

FIG. 24.

curve: 1. When the 49cm. of "embedded length" constitute 20 per cent. of the length per turn:

Lines set up by 196cm. of "free length" ..... = 196 × ·8 × 5 = 784
Lines set up by 49cm. of "embedded length" = 49 × 4 × 5 = 980

Total C.G.S. lines linked with coil ..... = 1,764
Inductance for sine form of wave = 1,764 × 5 × 10^{-8} = ·000088 henry.
Inductance from observations shown in Fig. 24..... = ·000138 ,,
Ditto corrected 15 per cent. for wave-form..... = ·000120 ,,

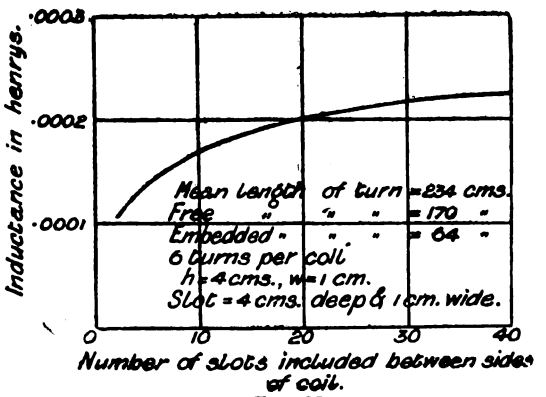

FIG. 25.

leaving 36 per cent. to be accounted for by the less height of the coil, and by its not being spread out as it would be in an actual machine.

2. When the 49cm. of "embedded length" constitute 50 per cent. of the length per turn:

Lines set up by 49cm. of "free length" ..... = 49 × ·8 × 5 = 196
Lines set up by 49cm. of "embedded length" ... = 48 × 4 × 5 = 980

Total lines linked with coil ..... = 1,176
Inductance for sine form of wave = 1,176 × 5 × 10^{-8} = ·000059 henry.
Inductance from observations shown in Fig. 24..... = ·000092 ,,
Ditto corrected for wave-form ..... = ·000080 ,,

leaving, as before, 36 per cent. to be accounted for by the other respects in which it differs from the conditions of practice. It might at first sight be objected to the method employed by the writer for estimating the reactance voltage that it takes liberties with the general ideas of magnetomotive force in so considering the magnetomotive force per unit of length of coil, instead of considering merely ampere-turns. The observations already described fairly effectively dispel this objection. The following test still further justifies the method pursued: A coil was successively widened out to span more and more armature slots of a given core, and corresponding measurements of the inductance were made. The results shown in the curve of Fig. 25 show comparatively little variation until the coil became extremely narrow. A similar test was made on the same coil when entirely free in air. It was successively narrowed up from an original width of

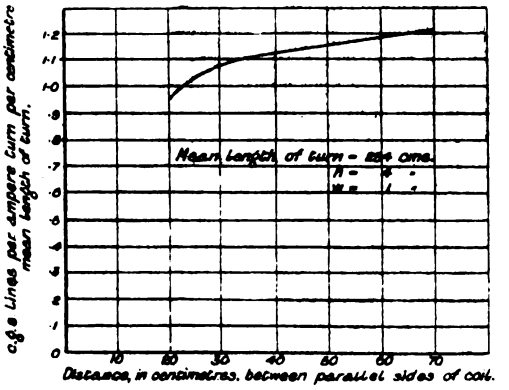

FIG. 26.

70cm. down to a final width of only 20cm. The value of the inductance in the final form is still 80 per cent. as great (expressed in C.G.S. lines per ampere-turn per centimetre of mean length of turn) as for the 3·5 times greater width of the coil in its original form. The results are plotted in the curve of Fig. 26.

(To be continued.)

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SWITCHBOARD EVOLUTION.

The now generally accepted theory of evolution is that the present perfection in any species of animal life has only been arrived at by the painful process of destroying the weakly members of that species, and the consequent survival of those individuals best fitted to withstand the enemies of the animal in question. The same theory can be well applied to engineering practice, where one frequently sees standard machines of 10 years ago consigned to the scrap heap. A good deal was written last autumn on the standardisation of electrical machinery, and the difficulties of standardising even the outputs of engines and dynamos was gone into carefully at meetings of the Institution of Electrical Engineers. When, however, one comes to the design of switchboards, these difficulties become more numerous. Electrical engineers are prepared to accept standard measuring instruments for their switchboards, but the very idea of a standard arrangement seems to be repugnant. A general inspection of the numerous electric lighting stations which have been opened this year emphasises this. It would seem as though the engineer, having been compelled to accept manufacturers' designs of boilers, engines, and dynamos, enters into a firm resolve to show his individuality in the arrangement of his switchboard. The outcome of this, from the evolution point of view, is interesting, and already there are indications as to what the survival of the fittest will lead to in the future. The process of this evolution is not so slow as has been the case in the animal kingdom. For instance, a five hundred-volt switchboard for a three-wire system which we have in our mind is remarkable for its extreme compactness. We do not think that its life will be long, and believe that when the end does come it will have a short and fiery death. In fact, the fingers on both hands are not sufficient to count up the central-station switchboards in this country which have suddenly ceased to be. This applies not only to alternating high-voltage boards, but also to switchboards designed for low-tension direct-current working. Looking into the question of these failures, and comparing them with the latest switchboards which have been made to the requirements of our best consulting engineers and by our best manufacturing firms, one is able to draw a few conclusions. The first of these is that electrical switchboards in large central stations are gradually becoming anomalies, in that they do not contain any electrical switch gear. Instead of grouping together all the switches required on to one plain surface, it is becoming the custom to place these well away from the switchboard itself, and in such positions that no damage will be done to the surroundings should any switch fail to break its circuit. In England these isolated switches are usually worked by means of levers or other mechanical devices from the surface of the switchboard. The Westinghouse Company in America have taken up the use of compressed air for operating these switches at a distance, while another firm have a system of subsidiary electric circuits with small motors for the same object. This system of isolating the switches in position where no damage can be done has two further advantages. The first is that of safety to the operator in the case of high-voltage working, and the second, the saving in cable, which in accumulator work first led to the practice. The next feature which one notices in this same process of evolution is the tendency to reduce the number of connections in any one circuit. Loose terminals have been the cause of numerous failures, as there is nothing like a loose contact for starting a destructive arc. One great saving in this direction is made by the use of the newer types of measuring instruments, in which the actual current to be measured is never put through

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the measuring instrument. The last point to which we wish to draw attention in the evolution of switchboard design is the inter-locking of the various operating levers and switches in such a way as to protect the board against the ignorance or forgetfulness of its operator. This is a most necessary precaution, and an interesting device for the protection of a plug board will be found in another column of this issue. On most switchboards using plug bars there is nothing to prevent an operator causing a short-circuit by the insertion of a plug in the wrong hole, and the result is disastrous both to the operator and to the metal work round the hole in question. The same thing applies to other switch gear. We well remember the graphic description of interlocked switchboard in the Paris Exhibition by an American engineer. Pointing to a main switch for closing a circuit between his plant and one of two independent supplies, he said: "If the other circuit is closed, a fool can hang on to that handle until h—ll freezes without doing any damage." So the evolution goes on, and we trust that the construction of the weaker examples will prove to be so satisfactorily fireproof that they can destroy themselves without injuring their surroundings.

ELECTRIC TRACTION ON THE "UNDERGROUND."

PRELIMINARY MEETING OF THE COURT OF ENQUIRY.

At 10 o'clock on Monday morning last the Hon. Alfred Lyttleton, K.C., M.P., the arbitrator appointed by the Board of Trade, sat for the first time to hear matters relating to the dispute between the Metropolitan District and the Metropolitan Railway Companies as to the system of electric traction to be adopted on the Inner Circle. The proceedings were held in the council chamber at the offices of the electrical department of the Board of Trade, 8, Richmond-terrace, S.W.

Mr. Fletcher Moulton, K.C., M.P., and Mr. J. W. Gordon are the counsel representing the Metropolitan District Railway Company; while Mr. C. A. Cripps, K.C., M.P., Mr. Roger Wallace, K.C., and Mr. F. G. Thomas are appearing on behalf of the Metropolitan Railway Company.

Mr. Lyttleton is assisted in the arbitration by Mr. Horace F. Parshall (representing the District Company) and Mr. Thomas Parker (representing the Metropolitan Company). This, it may be noted, is a point of no small significance. Advised by these gentlemen on the technical aspects of the matters in dispute, Mr. Lyttleton will receive valuable assistance in getting conclusive information from the witnesses. In fact, both experts may be relied upon to know the worst features of the system they are not advocating; and it is from this, rather than from their advocacy of their own particular system, that Mr. Lyttleton will be able to arrive at a just conclusion.

Both Mr. Yerkes and Mr. R. W. Perks, M.P. (the new chairman of the District Railway), watched the proceedings on Monday. The former gentleman's anxiety to get the matter definitely settled once and for all, can only be attributed to his earnest desire to see the "Inner Circle" working electrically within the shortest possible time, and on a system which shall have been proved to be the best for underground operation in London. In a talk with our representative, Mr. Yerkes said: "I want you to see who it is that is really causing this delay. As you know, we are quite ready to go on with the arbitration at once." This statement was amply borne out by the turn the proceedings ultimately took.

Mr. CRIPPS first addressed the Court on behalf of the Metropolitan Company. The main question to decide which the tribunal had been appointed, he said, was of the greatest importance, but the only question to consider that day was as to the most convenient procedure. So far as the Metropolitan Company were concerned, they were desirous of having the hearing at the earliest possible moment. The earliest time, however, when they could satisfactorily put their case before the Court was about the last week in October. The Metropolitan Company were, of course, dependent on Messrs. Ganz and Co. When the matter came to be thoroughly thrashed out the full scientific position would be brought before the tribunal, but at present it was purely a question of when the enquiry could be commenced. As he had already stated, the Metropolitan Company were quite willing to begin their case at the earliest possible time they conveniently could.

Mr. FLETCHER MOULTON (for the District Company) thought the arbitration should go on at once—not that day, but some time this week. He would remind the Court that according to the statute the enquiry should take place "forthwith."

The ARBITRATOR: The words of the statute are "the Board of Trade shall forthwith appoint the tribunal." I see nothing in the Act that the enquiry should be held "forthwith."

Mr. MOULTON said that in Section 9 it was enacted that unless within one month of the passing of the Act the District Company or the Metropolitan Company "shall have agreed to adopt the same system of electric traction, either company may refer the question to the Board of Trade," so that, he submitted, the Act contemplated that the question should be decided "forthwith"—that the enquiry should be held as soon as possible after the passing of the Act. On July 31, continued the learned counsel, the secretary of the Metropolitan Company wrote a letter to the District Company to the effect that his directors considered that the two companies could now proceed to settle the system of electric traction to be adopted, and that, with a view to ascertaining whether the two companies could agree, he was instructed to say that representatives of the Metropolitan Company were prepared to meet representatives of the District Company, and asking for an appointment. The letter went on to state that in the event of the two companies not agreeing, it would, of course, be necessary to refer the matter to the Board of Trade, and that the directors of the Metropolitan Company were desirous that notice be given to the Board of Trade at once, so that the matter might be referred immediately any difference between the two companies should arise. This letter, Mr. Moulton thought, showed conclusively that on July 31 last both parties were agreed that the matter should be proceeded with at once. The Royal assent to the Act was given on Aug. 9, and as a matter of fact the month following was occupied in negotiations between the two companies. But as early as July 31 both parties were ready to go to arbitration, and this was shown by a letter from the District Company to the Metropolitan Company in reply to the above communication, wherein it was stated that the District Company would not agree to the Ganz system, and were quite ready to arbitrate. The tender of Messrs. Ganz—which was really the beginning of all this trouble—was referred to by Colonel Mellor (the chairman of the Metropolitan Company) in his evidence before the Parliamentary Committees at the end of last year, so that the proposals of Messrs. Ganz had been before the Metropolitan Company for eight or nine months now. The question which system was to be adopted was a question to be decided, no doubt, with the evidence of experts before the tribunal, but surely there was no reason why there should be any long preparation for it. The District Company were perfectly willing to begin at once. It was on Dec. 19 that the first report of the two electricians, Sir Wm. Preece and Mr. Parker, was made, and ——

Mr. CRIPPS: They recommended the Ganz system.

Mr. MOULTON: Yes; so that the case of your clients was in preparation at that time. Continuing, the learned counsel reminded the arbitrator that the Law Courts reopened on the 24th, and he urged that the days between now and that date should not be wasted. He did not know that the Metropolitan Company gave any reason for delay.

The ARBITRATOR: Apart from the correspondence, which shows a very proper desire to get on, I must look at the actual rights of the parties. The Royal assent to the Act was given on Aug. 9 last. If they have 30 days from that time, that brings them to Sept. 9. I did not receive my appointment as arbitrator till Sept. 22, and one of my

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colleagues was out of the country at the time, so that the expedition shown in getting this tribunal together within a fortnight is somewhat remarkable.

Mr. MOULTON: It seems to me it is such a remarkable effort that it should not be wasted.

The ARBITRATOR: Mr. Cripps gives no details, but he says that his experts cannot conveniently be here before Oct. 15 at least.

Mr. CRIPPS said he was instructed that his experts could not be here till early in November, but if the other side wished it, he could arrange to begin the arbitration, say, on the 22nd and 23rd of the present month.

The ARBITRATOR said he was going to suggest that they should make some progress next week with the case for the District Company.

Mr. MOULTON agreed that if the other side were ready to cross-examine, this case could be commenced next week.

Further discussion elicited the fact that counsel engaged in the arbitration could not be present next week, and ultimately it was agreed that the arbitration should be formally opened on Tuesday, the 29th inst. We understand that the case for the Metropolitan District Company will be gone into first, and that the expert evidence it is intended to call on their behalf will occupy at least two days. The sittings of the Court, it is arranged, shall be continuous in order to finish the enquiry with all speed.

THE TENERIFFE ELECTRIC RAILWAY.

Some time ago (see the *Electrical Engineer*, vol. xxvi., p. 701) mention was made of this electric tramway as being then in course of construction by the Sociedad Anonima de los Tramvias Electricos de Teneriffe, or the Electric Tramway Company, Limited, of Teneriffe, at a capital cost of £60,000. It is entirely a Belgian enterprise, the King of the Belgians being, it is said, the principal shareholder. It is intended by this line to connect Santa Cruz, the capital of the Teneriffe Island of the Canary Group, with Laguna, a small town in the interior, and then with Oratava, on the far side of the island, a favourite health resort of Englishmen. So far only the first part, or from Santa Cruz to Laguna, is in working order, but the remainder is expected to be finished shortly, as by now the line has been surveyed and the materials ordered.

The portion constructed has a length of 10 km., or 6¼ miles. As will be seen from Fig. 1, which gives a general view of the town of Santa Cruz, the country is very hilly, the consequence being that the line is all grade and curve, the mean grade being as steep as 7 to 8 per 100, or about 1 in 13, which is not far from the maximum possible for traction on ordinary rails. The difference of level between the present termini is 560m., or over 1,800ft. The gauge adopted is 1m., or 3ft. 3⅜in., the same as the Belgian light railways. The rail is of the Vignoles type, weighing 50lb. per yard and resting on oak sleepers. The generating station (Fig. 2) is placed half-way up the grade. The plant includes two engines of 300 h.p. each, able to do the whole work at present. A battery of 260 Tudor accumulators has also been installed. The carriages are of the ordinary

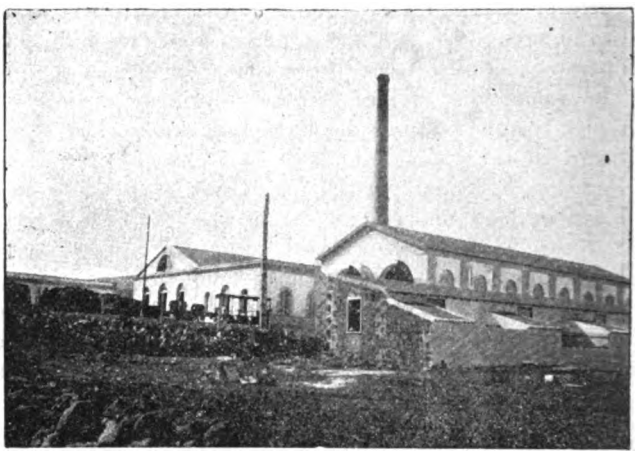

FIG. 2. The Generating Station of the Teneriffe Electric Tramways.

Belgian type, painted naturally a canary yellow, and each provided with two Thomson-Houston motors of 50 h.p., one for each axle. The accommodation is divided again, according to Belgian fashion, into two classes—the first class for the accommodation of the numerous tourists and visitors who avail themselves of this mode of locomotion to view the fine scenery, and the second class for the peasants of Laguna, who have soon learnt that for a comparatively small sum a tiring journey of three hours' climbing is saved. With the trail car a train can accommodate 100 passengers and run at a minimum speed of 10 miles an hour on the upward grade. The line is single track, the trains, one an hour in each direction, crossing each other at determined places. Each train is composed of two carriages on weekdays and three on Sundays. The receipts have already reached 1,000 pesetas (at par £40) a day, but this amount is expected to be more than doubled when the company carries merchandise, which will become, it is anticipated, the principal source of income. The working expenses are at present 27 per cent. of the receipts. MM. Tichefet frères, of Brussels, are the contractors, the work having been executed in 10 months. The writer, who has had the pleasure of travelling several

FIG. 1.—General View of Santa Cruz de Teneriffe, showing the Electric Tramway in the Foreground.

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times on this line, has always found the cars full of the two classes of passengers above mentioned. The view obtained at the summit is marvellous, steamers 15 miles at sea

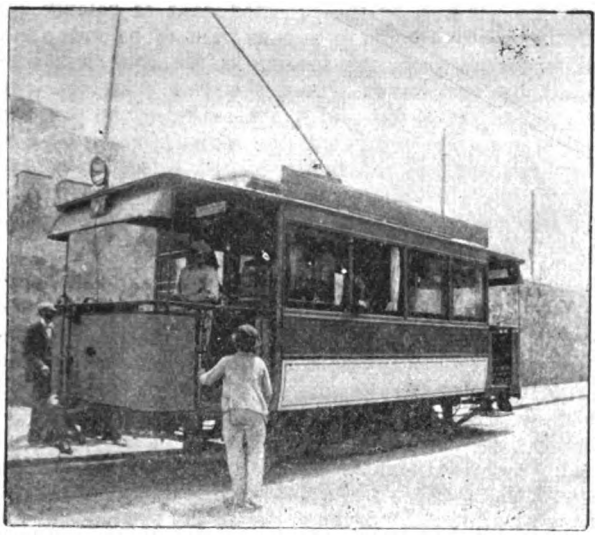

FIG. 3.—Car at the Teneriffe Terminus.

being clearly visible, while the land scenery all round is good. The "conductor" at the time the writer

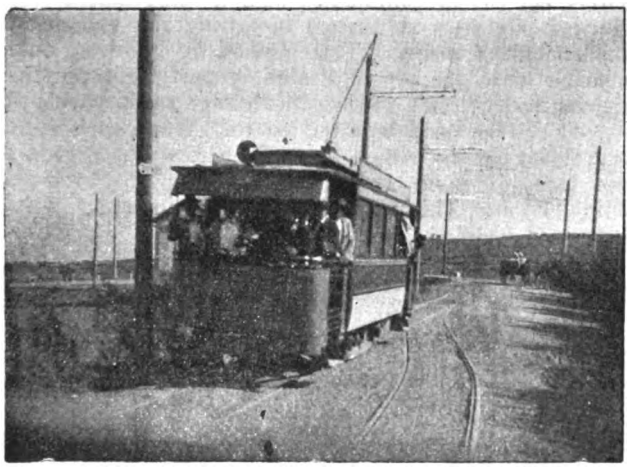

FIG. 4.—Electric Car on the Descent.

visited the line was not accustomed to his work, and was certainly not as brisk as his London *confrère*;

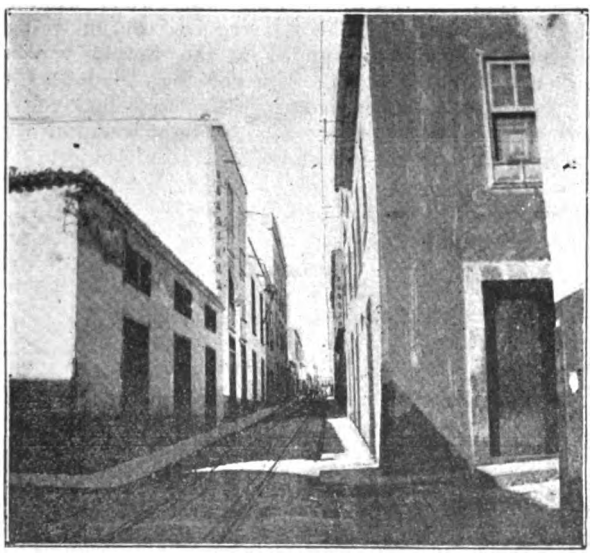

FIG. 5.—The Teneriffe Electric Tramway in Narrow Street.

for being given a five pesata piece it took him a good five minutes to calculate the price of three tickets and the change to be given, which he did at the back of a ticket with the inevitable blue pencil of the Brussels tram conductor. The tickets, one of which is illustrated, are a bit complicated. The same ticket does duty for any portion of the journey, each fare being marked in rotation. The conductor has to tear off all up to the place to which the passenger has paid, what is left of the ticket remaining attached to the counterfoil as a check. Another item of interest is that each train is accompanied by not one but two *gensdarmes* (or whatever the man in blue is

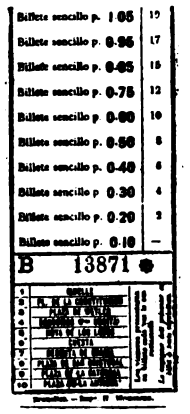

FIG. 6.—One of the Teneriffe Tram Tickets.

called in Spanish), who watch on the fore platform that no man or animal runs the risk of getting run over. From the view given of the line in a narrow street it will be seen that this risk is by no means confined to the country. In fine weather a policeman's life in Teneriffe must be a happy one. For facilities and information the writer is indebted to M. Uttini, of Brussels, one of the directors.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

419. State clearly the way you would start if asked to design a choking coil of the ring type and open-coil pattern. The space is limited—that for the ring 4in. by 3in., and the coil 5¼in. by 3in. The choker is required to impede 30 volts with seven amperes at 50 ~. Give working example of each type.—T. H. A.

420. I wish to measure the "slip" of a 5-h.p. single-phase induction motor. What will be the best method to do this accurately? What is "slip?"—E. B. W.

ANSWERS.

Question No. 413.—How is regulation best effected in a three-wire alternating-current system of distribution fed by high-tension mains from a distant power station?

Best Answer to No. 413 (*awarded* 10*s.*).—To fully answer this question it is necessary to consider two points: (1) how to keep the outers of the low-pressure system at a constant voltage; (2) how to equalise the two sides of this system. It will be shown later that it is only necessary to run a two-wire feeder to each point, and each feeder will have a panel on the switchboard carrying voltmeter, ammeter, switch, fuse, and hand-wheel for working the regulating apparatus. The voltmeter must be arranged to show the voltage of the outers at the feeding point, either by compounding—*i.e.*, adding a series winding carrying the

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feeder current acting in opposition to the shunt winding—or by being connected direct through pilot wires. The latter method is more expensive, but more usual, the pilot wires being useful for testing purposes. To control the voltage as shown on this voltmeter, a regulating booster is a very convenient piece of apparatus. These were first used by Mr. Rider at Bolton. Its construction is shown diagrammatically in **Fig. 1.** The primary winding is wound

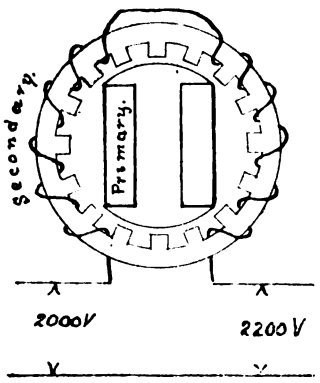

FIG. 1.

on a shuttle of iron stampings, which can be rotated through a right angle, the secondary winding being wound on a Gramme ring, which is fixed and concentric with the shuttle. When the shuttle is vertical, all the turns of the secondary winding act in the same direction, producing a maximum voltage; when it is horizontal, those portions of the secondary winding above the horizontal diameter act in opposition to those below it, and the resultant voltage is zero. The transformer must be wound to give a maximum voltage equivalent to the loss in the feeder and in the transformer at the distant end, this voltage being added to the generated voltage, as shown in the figure.

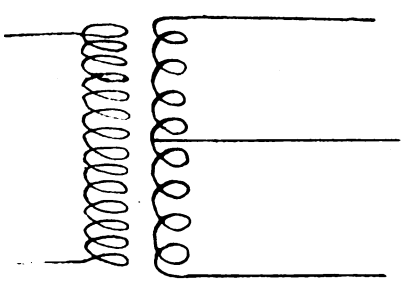

FIG. 2.

Another method of regulating the voltage is to raise the station voltage sufficiently to allow for the drop in the longest feeder, and then insert choking coils to reduce the voltage on the shorter feeders. In this case the regulating hand-wheel on the board withdraws or inserts the iron core. The only thing against the regulating transformer is its high price, but it has the advantage that it can be applied to any existing system, whereas it may be difficult to raise the station sufficiently to allow for the use of chokers.

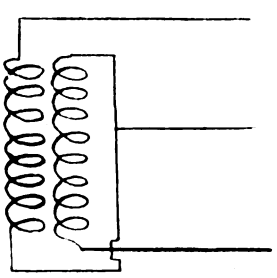

FIG. 3.

We now come to the second point. In order to balance the three-wire system at the feeding points, it is only necessary to connect the middle wire to the middle point of the secondary winding of the step-down transformer (see Fig. 2). A transformer even of small size can easily be built with a total drop of volts of only 2 per cent.—1 per cent. in the primary and 1 per cent. in the secondary—so that if one side of the system is fully loaded while the other side has no load, there can only be a difference of voltage of 1 per cent. The secondary winding of the transformer should have a capacity greater than that of the primary winding by the expected want of balance, or, say, 25 per cent. Should a serious want of balance occur at points distant from the feeding points, this should be remedied by connecting across the two sides the two windings of a transformer with a 1 : 1 ratio, the capacity of such transformer being half the want of balance. The winding connected to the lightly-loaded side then acts as primary, while the other acts as secondary, relieving the middle wire and restoring the balance to within 2 per cent. or less. This is shown in Fig. 3.—J. W.

Answer to No. 413 (*awarded* 5*s.*).—Practically the only point to be considered is, how to keep the supply voltage on the primary side of the distributing transformers constant, for the secondary pressures will then also remain very nearly constant (within about 2 per cent.) between full load and no load, and even when the distribution of the load on the two sides of the system is unequal. The effect of changes of load, or unbalancing of the load, on the voltage, whether the two sides of the three-wire system are fed from separate transformers or from the two sides of the secondary of the same transformer, is, in fact, of very little importance, especially on non-inductive loads, because of the close regulation obtainable in modern transformers.

The simplest way of maintaining constant primary supply voltage is, of course, hand regulation of the alternator exciting current in conjunction with a compensated voltmeter (or pilot wire voltmeter) indicating the voltage at the distributing mains. This method is, however, only applicable when the power station is used for supplying only one feeder circuit, so that the voltage requirements of only one district need be attended to. When, as is more usual, this is not the case, it becomes necessary to introduce some form of hand regulation into each high-tension feeding circuit. **This may be effected by inserting** either

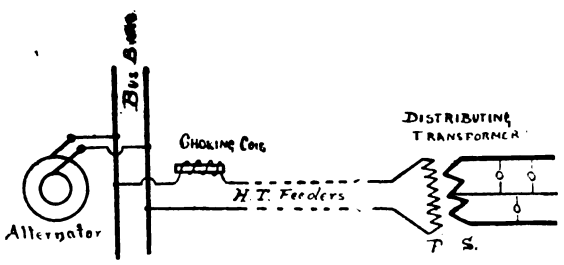

FIG. 1.

variable choking coils, or, better, adjustable reversible boosting transformers, into each circuit. If choking coils are used (Fig. 1), the distributing transformer windings must be arranged to give the full required output voltage when fully loaded and supplied at the lowest primary voltage ever likely to occur. The choking coils must then be of sufficient capacity to reduce the secondary voltage to this same value when working on light load and with the highest likely primary voltage. The only objection to

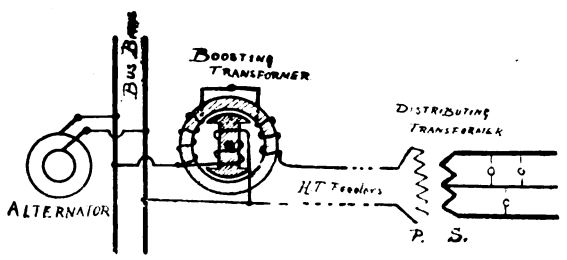

FIG. 2.

choking coils is their effect in lowering the power factor of the system, and on this account boosting transformers, though more expensive, are to be preferred, especially if any considerable line loss has to be allowed for in the regulating device.

The usual form of these boosters as made by Messrs. Cowan and Still is shown diagrammatically in Fig. 2.

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They consist of an external stationary laminated core slotted on the inner periphery and wound with a secondary winding (connected in series with the high-tension feeders) arranged to form two poles at opposite ends of a diameter, and a central core wound with a primary winding (connected across the feeders), and capable of being moved through an angle of 180deg. by hand. The secondary voltage depends on the position of the primary core relatively to the secondary poles, and can be varied perfectly gradually from full voltage in one direction (helping the feeder voltage), through zero, to full voltage in the opposite direction (opposing the feeder voltage).—Q.

Answer to No. 413 (*awarded* 5*s.*).—The transforming down to distribution pressure from the transmitting pressure is usually done by means of two transformers—the primaries in parallel connected across the H T mains; the secondaries in series. The two outers for the distribution are connected to the extreme ends of the secondary winding of the transformer. The "middle" wire is connected to say, a six-stud switch, the connection being made on the axle (permanent). Three studs are connected to one transformer and three to another; each stud to a coil according to the size of the transformer, or about 1·5 volts. It will be seen that the above arrangement is not automatic, and although a three-wire system of continuous currents using balancers is not ideal, the three-wire alternating is

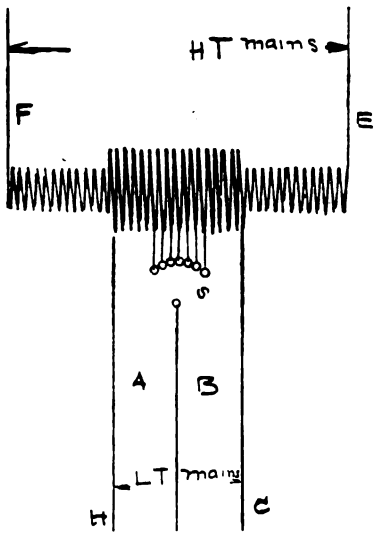


FIG. 1.

much inferior from an automatic regulation of voltage point of view. Many methods have been suggested, but it has been found in practice that they are either too expensive, or consume too much energy. One arrangement is an ordinary

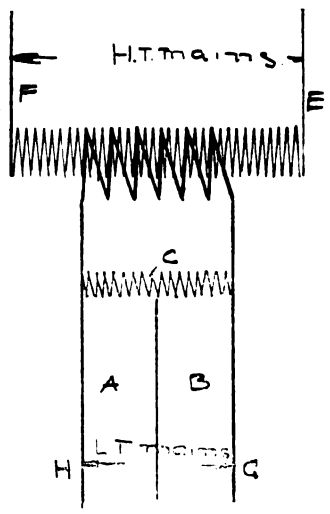


FIG. 2.

regulating switch, and worked by means of a rotating disc driven by clockwork or a motor, a coil with an iron core, the coil being connected to an outer, and the middle wire makes it correspond to the voltage, the core working a reversible clutch which works between the switch, and a revolving disc turns the switch over until a balance is arrived at.

The method shown in Fig. 1 only employs one transformer. The arrangement acts upon the principle of the well-known "economy coil." I do not think it has been applied to three-wire distribution, the objection being that an earth shield cannot be employed between the primary and secondary. Fig. 2 shows an arrangement which is an attempt at being automatic. The coil, C, is a transformer with one winding. If A has a large current, then B C acts as a transformer, B side acting as primary, and A side as secondary. In practice, however, a regulating switch would improve the arrangement.—T. W. S. H.

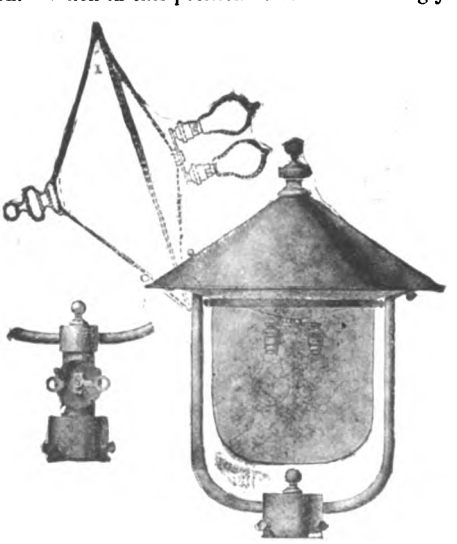
Question No. 414.—Explain how the winding speed is varied, and starting and stopping arranged, on a mine shaft winding engine driven by a polyphase motor.

Best Answer to No. 414 (*awarded* 10*s.*).—In an electrical winding engine driven by a polyphase motor the winding speed is regulated by the insertion of resistance coils in the winding of the rotary armature and as the resistances are cut out or not, so the rotation of the magnetic field is retarded, of course at the expense of efficiency. For the starting the motors are furnished with collector rings, and in the circuit of the rotating portion a so-called starting resistance is inserted when the strength of the current on the motor begins to work, and can be kept within limits, and, on the other hand, the initial power becomes very much increased.

In the stopping and controlling, which is the most important part, it is desirable that, so long as the brake is on, it shall not be possible to start the motor, and likewise that the brake ean only be put into operation when the lever is at zero. One method of doing this is by a device by means of which the double-cranked starting lever is connected by one of its arms with the brake, while the other moves through a slot in such a manner that the lever in its forward motion effects an alteration of its level, which causes the brake to be lifted gradually, and then moves in the slot right and left, where it is coupled with another lever, which by degrees switches the current on or cuts out the resistance. Another brake acting upon the winding drum is fitted up as a foot-brake, but locked in such a way that it can only be laid on when the current is interrupted.—R. E. P.

INCANDESCENT STREET-LIGHTING.

We illustrate herewith a new device for supporting incandescent lamps for street-lighting which is being manufactured by the General Electric Company. It will be seen from the illustration that the lamps and reflectors are securely fixed to the hood of the lantern. This hood is made to hinge on one of the supports in such a way that it can be swung back easily into the dotted portion indicated in the illustration. When in this position it is an exceedingly easy matter



to clean the reflectors and the lamps. At the same time the lamp-trimmer can clean the lamp globe without trouble. The electrical connections of the lamp are so arranged that they are not liable to be broken by the repeated opening of the lantern in the way indicated. The device seems to have a good future before it.

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TUNBRIDGE WELLS ELECTRICITY WORKS.

The following are the reports of the chairman of the Electricity Committee (Mr. E. Elvy Robb) and the borough electrical engineer (Mr. H. Boot) on the fifth completed year's working of the electricity undertaking. Abstracts of the accounts are appended:

Chairman's Report.

In presenting the accounts, I desire to draw attention to one or two special features which they involve. It will be observed that for the first time since the undertaking was started there is a loss upon the year's working. This loss amounts to £82, and although this fact is in itself unsatisfactory, yet, having regard to the great disadvantages under which we have laboured during the 12 months covered by the accounts, I think it is a matter of surprise that the deficit should be so small. There can be no doubt whatever that the principal cause of the deficit is the increase in the coal bill. Under this head alone the increased cost has been £1,380, coal having risen from 20s. 9d. to 36s. 6d. per ton. The year's accounts also include a payment of £488 towards interest and sinking fund on the last capital raised, which capital has not yet been earning income, as the machinery is even now not working. I would also draw attention to the excessive amount, as I consider it, which is charged against this undertaking for office accommodation, services of the town clerk, and borough accountant. This charge amounts altogether to £308, and in my opinion is out of all proportion to the services which the undertaking receives in return. It has recently been decided to increase the same, which is most unfair. I find by enquiry that in many large towns throughout the country, including such places as Belfast, Bolton, Bradford, Hanley, Lancaster, Manchester, Newport, Oldham, Portsmouth, and a number of others, no charge whatever is made under this head. I agree, however, that strictly some charge should be made, as the undertaking is a trading concern, and should be self-supporting. What I object to is that the undertaking should be penalised in order to support other departments of the Corporation which are not profit-producing. By way of demonstrating the heaviness of the charge which is made in this town, I would point out that in a town like Nottingham the corresponding charge is only £50 per annum. At St. Helens, with a population of 80,000, it is £50, including office accommodation. Fortunately, the deficit on the current year's trading will not fall upon the ratepayers, as we possess a reserve fund of £2,039, which has been built up out of the profits of previous years. Even, however, had this deficit fallen upon the general rates, it would scarcely have been considered a hardship in such an such an exceptional year as this, particularly as the rates have up to the present time received no less than £2,750 out of the profits of the undertaking. I would also point out that the ratepayers have the advantage of having the public lighting supplied at a cost which will compare favourably with charges in any other town of the United Kingdom. As far as I can ascertain, there is no other town where the public lighting is carried out at so low a rate as Tunbridge Wells. Consumers are still coming on rapidly, and with the improved and more economical plant which we now possess, I look forward with considerable confidence to the result of the present year's working of the undertaking, particularly if, as is to be hoped, coal remains at a more reasonable price. I would point out that in spite of the large increase in our coal bill, no addition has been made in the price of energy supplied to the consumers, nor should I advise any such increase only under most exceptional circumstances.

Engineer's Report.

I do not propose to deal with the extensions in this report (amounting to some £34,000 expenditure) which are now being carried out under my advice, as you are familiar with what is being done at the electricity works, the previous reports having contained full details. The works, mains, and sub-stations have been maintained in a high state of efficiency. I have continued the old policy of keeping everything in perfect order and repair, irrespective of the expense that is entailed in so doing, as it is important that all the machinery should be ready to take its fair share of work when called upon. It must be borne in mind when criticising the accounts for the year (which are not so favourable as hitherto) that in all trading concerns years of prosperity and depression are experienced; the last year to us has been one of "depression," owing to numerous causes outside our control, as enumerated below: (*a*) The high price paid for fuel, coal costing 36s. 6d. a ton, as against 20s. 9d. for the same the previous year. Allowing for the increased consumption, had coal been the same price, the money saved thereon would represent £1,380. (*b*) On account of the corrosive properties of the water, I have thought it advisable to have the boilers retubed, costing the sum of £250. (*c*) This year includes the payment of £488 towards interest and sinking fund on the additional capital, which capital has not been available for earning revenue, as the machinery, although partly paid for, has not yet been completed, and, therefore, no advantage has been gained thereby. Deducting £482—*i.e.*, the net deficit—leaves a net profit of £1,636, or more than double the net profit of last year, although the units have been sold at a lower price. The average price obtained from private consumers is 4·46d. per unit, as against an average price of 4·8d. last year. Again, the average price for public lighting per unit (after deducting the cost of repairs, carbons, trimmers' wages, etc.) this year is 1·03d., whereas last year it was 1·19d., showing a reduction in each case. However, you thought it advisable to maintain, as far as possible, the low price we were selling electric energy at, and draw on the surplus in hand to meet any possible deficit. The price per unit charged for public lighting should be increased, as we are selling it under cost price, and I would suggest that the prices charged for side street-lighting should be the same as that of the gas company. There is a considerable increase in the rates; now they are £369, whereas last year they were £299, and comparing the amount charged with other towns, it will be seen that we are paying more than they do. Deducting the deficit from the amount brought forward, there is still a net surplus of £1,544 in hand to carry forward. I am still of the opinion that it would be advantageous to the undertaking if the Corporation supplied lamps to the consumers at cost price. The number of consumers on the register is 600, being an increase for the year of 135, and the number of lamps connected to the mains is 35,260, being an increase of 6,658. With regard to the extension of our area, the larger the area the better chance there is of making the undertaking a financial success.

Revenue Account.

Dr. Expenditure.	£	s.	d.
Generation of Electricity.			
Coal and other fuel £4,230 18 3			
Oil, waste, water, and stores 214 15 1			
Wages at generating station 603 5 6			
Repairs to machinery, etc. 316 8 10			
	5,365	7	8
Distribution of Electricity.			
Repairing mains, meters, etc. 37 17 10			
Meter inspector 56 17 6			
	94	15	4
Public Lamps.			
Wages of workmen 224 6 2			
Carbons 42 8 1			
Globes, fittings, repairs, etc. 28 16 4			
	295	10	7
Rents, rates, and taxes	369	6	5
Management expenses	1,133	8	0
Insurance	31	18	3
Miscellaneous—sundry expenses	38	0	3
	7,328	6	6
Gross profit transferred to net revenue account	2,362	17	9
	£9,691	4	3

Cr. Income.	£	s.	d.
Sale of electricity—private consumers at 6d. per B.T.U.	5,777	2	0
Private consumers at 4d. per B.T.U.	1	0	4
Private consumers at 3d. per B.T.U.	1,814	10	9
Public lamps	1,518	5	6
	9,110	18	7
Meter rents	315	7	6
Sale of ashes	14	8	6
Fees for extra tests	3	3	0
Miscellaneous	271	9	0
	9,715	6	7
Less allowance and bad debts	24	2	4
	£9,691	4	3

Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Tunbridge Wells Corporation stock	21,137	1	1
Mortgage debt—Lloyd's Bank, Limited	30,000	0	0
Sundry creditors	1,926	6	10
Profit appropriation account—surplus at date	1,544	16	3
Premiums on stock issued	247	10	5
Redemption of loans	4,875	18	0
Capital account—borough treasurer, overdrawn	732	16	6
Free wiring account—amount due to company	22	7	10
	£60,486	16	11

Cr. Capital Outlay and Assets.	£	s.	d.
Buildings	9,772	7	6
Machinery	19,831	17	10
Mains and services	16,473	5	6
Transformers	2,074	5	4
Transformer chambers	567	14	9
Meters	2,848	5	9
Instruments	169	9	4
Public lamps	3,003	4	4
Engineer's commission	1,002	10	0
Furniture	98	0	5
General expenses	171	12	6
	56,012	13	3
Cash—revenue account	696	12	1
Coal, oil, waste, carbons, etc., in hand	250	8	6
Sundry debtors for current supplied	3,328	1	5
Insurance account—premiums paid in advance	15	15	0
Sinking fund account—amount invested	154	11	8
Deposit account	28	15	0
	£60,486	16	11

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units		702,574
Quantity sold { Public lamps ..... 190,607 } { Private consumers by meters ... 374,220 }		564,827
Quantity used on works		9,087
Total quantity accounted for		573,914
Quantity used in distribution		128 660
Number of lamps		35 260
Total maximum supply demanded (kilowatts)		470

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COMPANIES' MEETINGS AND REPORTS.

ST. HELENS AND DISTRICT TRAMWAYS.

In their report for the year ended June 30, the directors state that the negotiations between the Company and the Corporation for a modification of some of the terms of the lease were not concluded until the 4th ult., when the concessions recommended by the Electric Supply and Tramways Committee were rejected by the Town Council. The directors regret this decision. The lease, however, provides for a revision in five years from the date of its commencement. In the meantime the directors regret that the accounts do not admit of the payment of the dividend on the preference shares for six months. The accounts show a net profit of £272 after paying the preference dividend and interest due upon calls paid in advance. A reference to the profit and loss account shows that out of a total of £26,301 from traffic receipts £15,368 had to be paid to the Corporation, equal to 5·01d. per car mile. It will be possible in future to effect substantial reductions in the cost of working by curtailing the frequency of the service and otherwise. The action of the Corporation may render this course imperative, and it may also be necessary for the same reason to revise the fares, which are now below the scheduled rates. A steady increase in the traffic receipts is also reported.

NORWICH ELECTRIC TRAMWAYS.

Presiding at the first ordinary meeting of the shareholders in this Company on the 3rd inst., **Baron E. B. d'Erlanger** said the total earnings amounted to £35,665, to which had to be added a sum of £700 for interest on moneys deposited. Against this their expenses had amounted to £22,497, so that the tramways had been worked, in round figures, at just under 61 per cent. of the gross receipts. They were of opinion that the earnings should increase steadily over the past year's figures, but the expenses of operation should remain nearly the same; the increase would, therefore, practically be additional net profit. On the item of coal alone there ought to be a saving in this year's operations. They had run 924,789 miles, transported 7,816,222 passengers, their average receipts per car mile had been 9·25d., their average cost per car mile had been 5·83d. Their present profit and loss account showed that, after allowing for debenture interest, there was a distributable balance of £11,566. 2s. 5d., out of which they proposed that a dividend at the rate of 4½ per cent. upon the paid-up capital for the time being be declared, absorbing £10,864. 1s., and that the balance of £704. 1s. 5d. be carried forward. In conclusion, he moved the adoption of the report and accounts

The motion was seconded, and carried unanimously.

BROCKIE-PELL ARC LAMP.

Directors: Right Hon. Lord Suffield, K.C.B. (chairman); Sir F. D. Dixon-Hartland, Bart., M.P. (vice-chairman); Hon. R. Brougham; H. W. Maynard, Esq. Secretary and manager: W. J. G. FitzGibbon.

First annual report of the directors, to be presented at the ordinary general meeting of the Company to be held at the Company's premises, 60, Worship-street, Finsbury, E.C., on Oct. 15, 1901, at 12 noon:

The directors have pleasure in submitting the accompanying profit and loss account and balance-sheet for the period ending June 30, 1901, showing that, after writing off the sum of £435. 17s. 11d. for depreciation on plant, machinery and tools, etc., there remains a net profit of £2,465. 8s. 7d. The increase in the Company's business during the year has been most encouraging, the orders received for lamps being greatly in excess of those in previous years. At the present time 1,000 lamps are in course of construction at the Company's works, over 800 of which are for orders already received. The Company has been entrusted by the authorities at Glasgow with the important task of lighting the buildings and grounds of the present exhibition with Brockie-Pell arc lamps, which work has employed for the time being a large amount of the Company's capital. The directors are informed that these lamps have given every satisfaction, and their superiority has been acknowledged by those interested in electric lighting who have visited the exhibition. It may be mentioned that nearly 1,100 lamps are in use nightly for this work, and they form the largest installation of arc lamps in the United Kingdom. The directors have demonstrated that a substantial profit can be made, and under ordinary circumstances a dividend could be paid to the shareholders, but it is utterly impossible for them to do this out of the profits for this year and yet leave a sufficient amount of working capital for the increased needs of the Company. They therefore very much regret that they are unable to recommend on this occasion the payment of a dividend, and accordingly propose that the whole of the amount be carried forward. The directors have carried out their promise to spare no exertion to turn the Company into a dividend-paying business, but they cannot do impossibilities, and it is therefore necessary that the shareholders should acquiesce in an arrangement which will enable the Company to extend their trade so that the fixed charges will bear a much smaller proportion to the gross profits than has hitherto been the case. In order to attain this result, the directors find it necessary to call up the balance of the capital, but in accordance with the Board's circular of June 9, 1900, they are making a call of only 6d. per share at present, the remaining 6d. to be called up at the expiration of three months from now. Should any shareholders desire to pay up both calls (1s. per share) at the date when the present call is due, interest at the rate of 6 per cent. per annum will be allowed upon the amount paid in advance. It is with the deepest regret that the directors have to record the death (in January last) by an accident of their late managing director, Mr. William Shrimpton, whose ability and untiring energy were steadfastly devoted to the Company's interests. They are, however, glad to state that they have found in Mr. FitzGibbon a successor in every way competent to take up his work, and have appointed him to the post of manager in addition to his former work as secretary. The duties of both these offices have, since his appointment, been carried out to their entire satisfaction. Under the articles of association the auditors, Messrs. Mellors, Basden, and Co., retire, and, being eligible, offer themselves for re-election.

ABSTRACT OF BALANCE-SHEET.

Dr. Capital and Liabilities.	£	s.	d.
Capital authorised—80,000 shares of £1 each	80,000	0	0
Capital issued—less calls in arrear	75,656	0	0
Calls paid in advance	10	0	0
Loan secured on first mortgage debenture	2,000	0	0
Sundry creditors	9,653	6	11
Profit and loss account	2,465	8	7
	£89,784	15	6

Assets.	£	s.	d.
Patent rights and goodwill	58,951	7	8
Cash at bank and in hand	354	8	8
Sundry debtors, after making provision for doubtful debts	8,261	7	4
Stock-in-trade and work in progress	16,097	12	1
Machinery and plant	3,651	16	3
Tools and loose plant	442	13	5
Furniture and fixtures	1,031	0	1
Patterns	650	0	0
Balance of reconstruction expenses	344	10	0
	£89,784	15	6

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Patent fees, etc.	192	4	10
Directors' fees	438	12	2
Legal expenses and accountancy charges	161	5	10
Depreciation of plant, tools, fixtures, and patterns	435	17	11
Interest on debenture	27	10	8
Balance carried to balance-sheet	2,465	8	7
	£3,721	0	0

Cr.	£	s.	d.
Balance from trading account	3,407	17	6
Transfer fees	2	7	6
Royalties	310	15	0
	£3,721	0	0

APPOINTMENTS VACANT.

Resident Electrical Engineer, Bootle Corporation, £350 per annum, Oct. 14. Full particulars in our advertisement columns.

Chief Mains Assistant, accustomed to armoured and solid system, £2 per week. Full particulars in our advertisement columns.

Assistant, to take charge of mains laying, fault localising, etc., electricity department, Bristol; £2. 15s. per week, Oct. 23. Full particulars in our advertisement columns.

Chief Assistant Engineer, Bexhill Urban District Council, £125 per annum, Oct. 17. Full particulars in our advertisement columns.

Engineer's Clerk, Bexhill Urban District Council, 25s. per week, shorthand, typist, accustomed to wages analysis, stores, etc., Oct. 17. Full particulars in our advertisement columns.

Lecturer and Demonstrator in electrical engineering and general physical laboratory work, City of Norwich Technical Institute, £150 per annum. Full particulars in our advertisement columns.

Estimators.—Two experienced men used to estimating for switchboard work, good salaries. Full particulars in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

East London.—Tenders are invited for the supply of a 50-kw. alternator and engine. Tenders by Nov. 26. Details in our advertisement columns.

Stepney.—The Electrical Committee invite tenders for arc lamp columns, lamps, fittings, switchboard, etc., by Oct. 17. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of main switchboard. Tenders by Oct. 14. Details in our advertisement columns.

London County Council.—Tenders are invited for wiring and fittings for the electric lighting of fire brigade stations at Homerton, West Hampstead, East Greenwich, and Perry Vale. Tenders by Oct. 31.

Leyton.—The Electric Lighting Committee invite tenders for the supply of a multipolar dynamo of about 450 kw. capacity, and a balancer. Tenders by 26th inst. Details in our advertisement columns.

Blackpool.—The Corporation invite tenders for poles, plinths, etc., cables, etc., overhead materials, trolley wire, and bonds, 20 electrical car equipments. Tenders by Oct. 21. Details in our advertisement columns.

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Dundee.—The Gas Commissioners invite tenders for electric motors. Specifications, etc., may be obtained from the Electrical Engineer, Dudhope-crescent-road. Tenders by Oct. 18.

London, W.—The Directors of the Great Western Railway invite tenders for the supply of the various stores from Dec. 1 next to Nov. 30, 1902. Tenders by Oct. 21. Details in our advertisement columns.

Chesham.—The Urban District Council invite tenders for the transfer of their provisional order enabling them to supply electricity within the Chesham urban district, by Nov. 16. Full particulars in our advertisement columns.

Woolwich.—The Electricity Committee invite tenders for free or assisted wiring. General conditions, &c., may be obtained from Mr. J. B. Mitchell, borough electrical engineer, Council's Offices, Maxey-road, Plumstead. Tenders by Oct. 15.

Luton.—The School Board invite tenders for the supply and erection of fittings and apparatus for using the electric light in the Board's offices and in other buildings in Waller-street, Luton. Specifications may be seen at the Offices, Waller-street, Luton. Tenders by Oct. 15.

Ilford.—The Urban District Council invite tenders for the supply and erection of a water-tube boiler, with fittings, pipework, etc.; one 550-kw. steam dynamo (vertical enclosed high-speed engine); main switchboard and connections. Tenders by Oct. 29. Details in our advertisement columns.

Madrid.—The Department of Agriculture invite tenders for the installation and working of an electric tramway for not more than 60 years. The route is from Linares to the mines of San Rogue and Tortilla. The deposit is 11,105 pesetas provisional, and 55,526 pesetas finally. Tenders by Oct. 17.

Newport (Mon.).—The Corporation invite tenders for the supply and erection of winches, cables, overhead construction, complete electric motorcar, and repair shop equipment. Specifications, etc., can be had on application to Mr. H. F. Parshall, consulting engineer, 8, Princes-street, Bank, London, E.C. Tenders by Oct. 21.

Boulder City (Western Australia).—The Boulder City Council invite tenders for construction of about 3½ miles of electric tramway, with all necessary plant complete according to specifications, and the right to construct and run tramways within the municipality. Tenders by Nov. 23. Details in our advertisement columns.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station and sub-stations of two 6,000-h.p. triple-expansion engines, two 3,750-kw. three-phase alternators, 48 motor-generators for sub-stations. Tenders by Nov. 6. Details in our advertisement columns.

Leeds.—The Corporation invite tenders for supply of 50 electric motorcars. Specification, etc., may be had from Mr. Thomas Hewson, M.I.C.E., city engineer, Municipal Buildings, Leeds; or from Messrs. Hopkinsons and Talbot, consulting engineers, 26, Victoria-street, London, S.W., and 29, Princess-street, Manchester. Tenders by Oct. 15.

Darlaston.—The British Electric Traction Company invite tenders for the construction and reconstruction of about eight miles of tramways in the district between Wolverhampton and Darlaston, in the county of Stafford. Specification, etc., can be obtained on application to the Chief Engineer of the Company, Donington House, Norfolk-street, London, W.C. Tenders by Oct. 18.

Whitby.—The Urban District Council invite tenders for the wiring of the electricity works, Church-street, the sub-station under the Council's offices, the Council's offices, Flowergate, and the public shelters, conveniences, and bandstand, Pier-road. Specifications, etc., can be obtained from the electrical engineer, Mr. C. W. Kennaway, Council Offices, Whitby. Tenders by Oct. 18.

Batley.—The Corporation invite tenders for: (a) three Lancashire boilers, one economiser, two jet condensers, one electrically-driven feed pump, injectors, steam, exhaust, feed, and condenser pipes, and accessories, and (b) travelling crane. Specification, etc., may be obtained from the engineers, Messrs. Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by Oct. 18.

Stourbridge.—The British Electric Traction Company invite tenders for the construction of about 2½ miles of tramways in the neighbourhood of Stourbridge, in the county of Worcester. The electrical equipment of the tramways is not included in the contract. Specifications, etc., can be obtained on application to the Chief Engineer of the Company, Donington House, Norfolk-street, London, W.C. Tenders by Oct. 18.

General Post Office.—Tenders are invited for the purchase of about 40 tons of guttapercha, 100 tons of old copper wire, plates, etc., 100 tons of iron, a quantity of other metals (brass, zinc, and lead), indiarubber-covered copper wire, tools, raw and limed hide pieces, electric light wire, fittings, glow lamp tops, accumulators, dry battery cells, tarpaulin, felt, jute serving, etc., the whole being arranged in convenient lots. A form of tender, containing all particulars, can be obtained on application, by letter, to the undersigned. Tenders will be received until 10 a.m. on Wednesday, Oct. 16, 1901.

RESULTS OF TENDERS.

Nelson.—The Corporation have accepted the tender of D. Bruce Peebles and Co. for the 200-kw. set, at £2,189.

Bristol.—The City Council have accepted the tender of Messrs. Buchanan and Curwen for wiring the Avonmouth electrical works for lighting purposes.

York.—The Corporation have accepted the tender of Callender and Co. for the work in connection with the extensions to the mains, and the Tudor Accumulator Company, Limited, for the extension of the battery.

Maidenhead.—The following tenders have been received:

Steam dynamos.

Contractors.	Engines.	£	s.	d
Crompton and Co.	Belliss	2,450	0	0
Ditto	Allen	2,138	0	0
Ditto	Reavell 500 r.p.m.	2,014	0	0
Ditto	Reavell 550 r.p.m.	1,976	0	0
W. H. Allen, Sons, and Co., Limited	own	2,251	0	0
Rhodes and Webster	Browett-Lindley	2,268	0	0
British Schuckert Electric Company	Allen	2,044	12	0
Ditto	Reavell	1,873	12	0
Ditto	Alley-Maclellan	2,079	12	0
F. Suter and Co.	Allen	2,086	0	0
Ditto	Browett-Lindley	2,236	0	0
Ditto	Alley-Maclellan	2,122	0	0
B. Thomas	Willans	2,484	0	0
Ditto	Belliss	2,591	0	0
Ditto	Allen	2,234	0	0
Ditto	Reavell	2,061	0	0
Ditto	Browett-Lindley	2,387	0	0
Ditto	Alley-Maclellan	2,270	0	0
India Rubber, etc., Company	Willans	2,579	0	0
Ditto	Belliss	2,602	0	0
Ditto	Allen	2,328	0	0
J. H. Holmes and Co.	Willans	2,584	10	0
Ditto	Belliss	2,516	10	0
Ditto	Allen	2,255	10	0
Thames Engineering Works	Allen	2,018	0	0
Ditto	Reavell	1,854	0	0
Johnson-Lundell Electric Company	Allen	1,697	18	0
Ditto	Robey	1,577	16	0
Siemens Bros. and Co., Limited	Willans	2,560	0	0
Ditto	Belliss	2,590	0	0
Ditto	Allen	2.315	0	0
Rosling, Appleby, and Fynn	Willans	2,637	4	0
Ditto	Belliss	2,649	4	0
Ditto	Allen	2,350	4	0
Ditto	Browett-Lindley	2,498	4	0
Lahmeyer Electrical Company	Belliss	2,444	0	0
Ditto	Allen	2,170	0	0
Westminster Engineering Company	Willans	2,644	0	0
Ditto	Belliss	2,615	0	0
Ditto	Robey	2,280	0	0
Armstrong, Whitworth, and Co.	own	2,348	0	0
T. Parker, Limited	Willans	2,521	0	0
Ditto	Belliss	2,484	0	0
Ditto	Allen	2,184	0	0
Ditto	Reavell	2,144	0	0
Ditto	Browett-Lindley	2,361	0	0
Ditto	Alley-Maclellan	2,241	0	0
Ditto	Davey-Paxman	2,425	0	0
Clayton Engineering Company (accepted)	own	1,736	0	0
Bergtheil and Young	Willans	2,325	0	0
Ditto	Belliss	2,331	0	0
Ditto	Allen	1,987	0	0
Witting Bros.	Reavell	1,875	0	0
Electrical Construction Company	Willans	2,715	10	0
Ditto	Belliss	2,641	10	0
Ditto	Allen	2,311	10	0
Brush Electrical Engineering Company	Willans	2,553	0	0
Ditto	Belliss	2,625	0	0
Ditto	Allen	2,319	0	0
P. R. Jackson and Co.	Willans	2,700	0	0
Ditto	Belliss	2,720	0	0
Morley Electrical Engineering Company	Robey	2,010	0	0
Newton Electrical Works, Limited	Willans	2,519	0	0
Ditto	Belliss	2,443	0	0
Ditto	Allen	2,160	0	0
Mavor and Coulson, Limited	Willans	2,293	0	0
Ditto	Belliss	2,316	0	0
Ditto	Allen	1,992	0	0
Ditto	Browett-Lindley	2,198	0	0
Lancashire Dynamo and Motor Company	Willans	2,500	0	0
Ditto	Belliss	2,530	0	0
Ditto	Allen	2,150	0	0
Ditto	Reavell	1,990	0	0
Ditto	Browett-Lindley	2,407	0	0
Ditto	Alley-Maclellan	2,290	0	0
Ditto	own	2,325	0	0
Johnson and Phillips	Belliss	2,280	0	0
Ditto	Clayton Co.	2,014	0	0
Ditto	Vauxhall Ironworks	2,195	0	0
International Electrical Engineering Company	Willans	2,290	6	0
Ditto	Belliss	2,395	0	0
Ditto	Allen	1,970	0	0
Ditto	Browett-Lindley	2,195	0	0
Ditto	Alley-Maclellan	2,080	0	0
Ditto	Clayton Co.	1,770	0	0
Ditto	Vauxhall Ironworks	1,975	0	0
J. Fowler and Co., Limited	Belliss	2,647	0	0
Ditto	Allen	2,381	0	0
Ditto	Reavell	2,207	0	0
General Electric Company	Willans	2,560	0	0
Ditto	Allen	2,310	0	0
Mather and Platt, Limited	Willans	2,430	0	0
Ditto	Belliss	2,510	0	0
Ditto	Allen	2,220	0	0
Ditto	Browett-Lindley	2,320	0	0
Ditto	Alley-Maclellan	2,275	0	0
Ditto	Paxman	2,350	0	0

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W. Whiteley and Sons	Willans	3,122	0	0
Geipel and Lange	Browett-Lindley	3,065	0	0
J. and H. Gwynne, Limited	Willans	2,513	0	0
E. Scott and Mountain, Limited	own	2,420	0	0
Sunderland Forge Company	Willans	2,479	0	0
Ditto	Belliss	2,506	0	0
Ditto	Allen	2,083	0	0
Laurence, Scott, and Co., Limited	Willans	2,434	0	0
Ditto	Belliss	2,456	0	0
Ditto	Allen	2,030	0	0
Ditto	Reavell	1,866	0	0
Ditto	Browett-Lindley	2,341	0	0
Ditto	Alley-Maclellan	2,230	0	0
Ditto	Paxman	2,256	0	0
Veritys, Limited	Willans	2,716	0	0
Ditto	Allen	2,401	0	0
C. A. Parsons and Co.	turbines	2,535	0	0
Dick, Kerr, and Co., Limited	Willans	2,506	0	0
Ditto	Belliss	2,529	0	0
Ditto	Allen	2,254	0	0
A. G. Inrig	Willans	2,650	0	0
Ditto	Browett-Lindley	2,550	0	0
Ditto	Alley-Maclellan	2,470	0	0
D. Bruce Peebles and Co.	Willans	2,440	0	0
Ditto	Belliss	2,464	0	0
Ditto	Allen	2,113	0	0
Ditto	Browett-Lindley	2,345	0	0
High-Speed Engine Company	own	1,790	0	0
Contractors.	Dynamos.			
Davey, Paxman, and Co.	T. Parker, Limited	2,348	0	0
Ditto	Siemens Bros. and Co.	2,365	10	0
Ditto	Electric Construction Company	2,672	0	0
Ditto	J. H. Holmes and Co.	2,394	0	0
Ditto	Crompton and Co.	2,330	0	0
Ditto	Lancashire Dynamo and Motor Company	2,248	0	0
Ditto	General Electric Company	2,213	0	0
Alley and Maclellan	Bruce Peebles and Co.	2,296	0	0
Ditto	Crompton and Co.	2,270	0	0
Ditto	T. Parker, Limited	2,268	0	0
Hatley Engine Company	Morley Electrical Co.	2,325	0	0
Ditto	Bruce Peebles and Co.	2,365	0	0
Ditto	Laurence, Scott, and Co.	2,205	0	0
Willans and Robinson, Limited	T. Parker, Limited	2,493	0	0
Ditto	Bruce Peebles and Co.	2,484	0	0
Ditto	Crompton and Co.	2,485	0	0
Ditto	Siemens Bros. and Co.	2,571	0	0
Ditto	J. H. Holmes and Co.	2,625	0	0
Vauxhall Ironworks	British Schuckert Company	1,958	0	0
Ditto	International E. E. Company	1,985	0	0
Ditto	Crompton and Co.	2,099	0	0
Ditto	Johnson and Phillips	2,170	0	0
Ditto	Siemens Bros. and Co.	2,230	0	0
Ditto	Electric Construction Company	2,347	0	0
Reavell and Co., Limited	Bergtheil and Young	1,851	0	0
Ditto	Laurence, Scott, and Co.	1,877	0	0
Ditto	Thames Eng. Company	1,891	0	0
Ditto	British Schuckert Company	1,878	0	0
Ditto	J. P. Hall and Co.	1,932	0	0
Boilers.				
E. Danks and Co., Limited		1,162	0	0
W. Arnott and Co.		1,120	0	0
Dick, Kerr, and Co., Limited		1,129	0	0
J. Thompson		1,000	0	0
H. and T. Danks, Limited		1,090	0	0
Babcock and Wilcox (accepted)		930	0	0
Armstrong, Whitworth, and Co.		1,460	0	0
Holdsworth and Sons (no cross tubes)		1,045	0	0
Fraser and Fraser, Limited		1,190	0	0
A. Anderton and Sons		1,200	0	0
D. Adamson and Sons		1,150	0	0
Yates and Thom		1,061	0	0
Tinkers, Limited		1,150	0	0
Geipel and Lange		1,000	0	0
Economisers.				
Dick, Kerr, and Co., Limited (Green's type)		195	6	0
E. Green and Son, Limited (net)		185	5	0
J. Carter and Sons		207	0	0
Roberts Bros.		225	0	0
A. Lowcock, Limited (accepted)		173	0	0
Armstrong, Whitworth, and Co. (Green's type)		200	0	0
Clay Cross Company		195	0	0
H. and T. Danks, Limited		200	0	0
E. Danks and Co., Limited		225	0	0
J. Thompson		220	0	0
Babcock and Wilcox (Green's type)		200	0	0

Cheltenham.—The Town Council have accepted the tender of E. Green and Son for a new high-pressure economiser, at £614, less £100 for old small economiser taken in part payment.

Southport.—The Electricity Committee have accepted the tender of D. Bridge and Co. for the supply and erection of a bucket pump to lift the water from the condensers to the duct, at £275.

Worcester.—The Town Council have accepted the tender of Stokes Bros., Worcester, for the erection of an electricity generating station at the corner of Hylton-road and Tybridge-street, at £7,180.

Ilford.—The District Council have accepted the tender of Messrs. Macartney and McElroy, Glasgow, for the track and permanent way for the tramway undertaking, at about £66,000, and has to be completed in nine months.

Gravesend.—The Town Council have accepted the tender of Babcock and Wilcox, Limited, for steam-pipes, etc., at £2,226; and that of F. and E. Davey, Albert Works, Southend, for the erection of the electricity works, at £7,094.

Yarmouth.—The Tramways Committee have accepted the following tenders: Crompton, battery and booster, £1,606; A. Brunton, Hull, granite setts, 25s. 6d. per ton; Associated Portland Cement Company, cement, 31s. 6d. per ton; Graham, Newcastle, Jarrah blocks, £9. 17s. 6d. per 1,000.

Wigan.—The Corporation have accepted the following tenders for motors: Heyes and Co., 1-h.p.; Fuller, Wenstrom, and Co., 2, 4, 5, 10, and 15 h.p.; Bruce Peebles and Co., 3-h.p.; Greenwood and Batley, 6, 20, and 35 h.p.; Bergtheil and Young, 7, 8, and 15 h.p.; Laurence, Scott, and Co., 25-h.p.; and Newton and Co., Limited, 30, 40, and 50 h.p. motors.

Darlington.—The Corporation have accepted the following tenders for the supply and delivery of one Lancashire boiler (first extension), one 350-h.p. engine, coupled to a continuous-current dynamo (first extension), and extension to steam, drain, and feed pipes: R. Taylor and Sons, Marsden; Parker and Co., Wolverhampton; Babcock and Wilcox, London.

Colchester.—The tender of J. A. Kuner has been accepted for installing electric light in the officers' messes and quarters in the Sobraon and Goojerat Barracks, and also in the recreation establishment and commanding officer's quarters in the Goojerat Barracks. The installation provided is to be under the supervision of the military authorities' electrical engineer, at the following rates: Sobraon Barracks, £211. 10s. 4d.; Goojerat Barracks, £365. 19s. 8d.

Hammersmith.—The Borough Council have accepted the tender of the Sir Hiram Maxim Electrical and Engineering Company, Limited, for supplying and fixing the pipework and tanks required in connection with the condensing plant, at £1,881. The other tenders submitted were: Stephens, Smith, and Co., Limited, £2,879. 5s.; Fraser and Fraser, Limited, £2,746; Rosser and Russell, Limited, £2,199; Aiton and Co., £2,185; Korting Bros., £2,150.

Ilford.—The School Board have received the following tenders for electric lighting and gaswork at Downshall School:

Lighting Corporation, Limited	£448	7	6
Coley Electric Works	396	7	10
Electrical Contracting and Maintenance Company	360	17	6
Murrell Bros. (electric lighting only)	248	7	6
Beaven and Sons	431	5	0
J. T. Mayfield and Co.	395	0	0
T. H. Dennis	1,203	13	0
W. H. Tilley	306	12	6
W. Simmons	346	14	0
A. Fernhead	364	12	0
J. C. Christie (accepted)	285	15	0

BUSINESS NOTES.

TRACTION.

Burnley.—Considerable progress continues to be made with the tramway reconstruction at Burnley.

Chester.—The Corporation will enter into possession of the tramway company's undertaking on Jan. 1 next.

Hull.—Very shortly the Tramways Committee will consider the question of running the trams in the Old Town.

Doncaster.—The contract for the overhead equipment, standards, etc., of the municipal electric tramways has been placed.

Gomersal.—The British Electric Traction Company will shortly begin work on the proposed electric tramways in this district.

Dewsbury.—The Dewsbury Tramway Company have sold their undertaking to the British Electric Traction Company for £23,700.

Knaresborough.—The Urban District Council have resolved to promote a Bill in Parliament for powers to construct electric tramways in the district.

Greenock.—On Friday last that part of the new electric tramway system between Rue End-street and Ashton, Gourock, was opened for passenger traffic.

Brighton.—Experiments are at present being made with the "Wilson-Bennet" tramcar lifeguard, which has secured the approval of the Board of Trade.

Queensbury.—The District Council have obtained the consent of the Bradford Tramways Committee for the street lamps to be affixed to the tramway pillars.

West London Tramways.—The London United Tramway Company propose to substitute a double track for the existing interlacing lines in the High-street at Acton.

Thornhill.—The British Electric Traction Company have notified the District Council of their intention to commence breaking up the roads for the purpose of constructing the tramlines.

The Proposed Solent Tunnel.—Early in the New Year the inauguration of active operations in connection with the proposed Solent Tunnel at Freshwater is expected to take place.

Burslem.—The town clerk has received instructions to call the attention of the Board of Trade to the recent tramway accidents in the district, and the want of efficient lifeguards on the cars.

Ealing.—A Board of Trade enquiry has been demanded by the District Council in consequence of the numerous complaints received from the frontagers with reference to the noise and speed of the electric trams.

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Douglas.—By 16 votes to 5, the Town Council on Wednesday decided to purchase the horse and cable sections of the undertaking of the Isle of Man Tramways and Electric Power Company (in liquidation) for £50,000.

Grimsby.—Mr. Trotter, of the Board of Trade, has inspected the electrical equipment of the tramway to Cleethorpes. The work of carrying the lines across the railway on the Cleethorpe-road is now progressing rapidly.

Ilford.—The contract for the track and permanent way of the proposed electric tramways having now been let (as reported in another column), it is expected that a considerable part of the line will be completed within nine months.

Newcastle-on-Tyne.—The Finance Committee have negotiated a loan of £225,000 more for tramway purposes. Some 80 applications have been received for the managership of the tramways. They are now in the hands of a sub-committee.

Hoddlesden.—Work in connection with the electric tramway has now been practically completed, and the first electric car has been run along the new route. The formal opening of the line will probably take place at the end of the present week.

Salford.—As forecasted in these columns last week, the Higher Broughton tramways route was opened for public traffic on Friday last. The next route to be completed will be the Pendleton route, on which considerable progress has recently been made.

Wigan.—Negotiations are proceeding regarding the extension of the tramways to Crook and Poolstock. The Corporation have also submitted a proposal to the Wigan and District Tramways Company with a view to acquiring the lines they now hold under lease.

Darlington.—The draft of the light railways order, as provisionally settled by the Light Railways Commissioners, has been referred to the General Purposes Committee for consideration, and particularly for instructions as to what lines power should be sought to construct.

St. Marylebone.—The Housing and Improvement Committee of the Borough Council recommend the Council to inform the London County Council that they object to the proposed tramway in Edgware-road, notwithstanding the proposed widening of certain parts of the road.

Bury.—With reference to the proposal that the Parson's-lane route of tramways be adopted as an alternative route for Fleet-street, Rock-street, and Stanley-street, the Tramways Committee have been asked to publish a report before the public meeting is held to consider the question.

Aberdeen.—Speed on the Castle-street and Links tramway route very recently opened is restricted by the Board of Trade to eight miles an hour on the whole length with a few exceptions. As regards the proposed extension of tramways to Torry, consideration of the question has been deferred.

Longton.—The Town Council have protested against the proposed reduction in the service of cars on the tramways run by the Potteries Electric Tramways Company in the town. The Council consider that it would "render the service utterly inadequate to meet the requirements of the public."

Willesden.—Both the Middlesex and London County Councils' proposals to have tramways along Edgware-road, Marble Arch, to Cricklewood, are being opposed by the District Council, on the ground of already congested traffic and the Bill passed for the tube railway under the same route.

Southowram Light Railway.—The Light Railway Commissioners have decided to sanction the Holmfield and Southowram light railway scheme. At the enquiry last week, it will be remembered, the Elland-to-Southowram scheme was rejected in favour of the Holmfield route, which has now been formally sanctioned.

Dundee.—A reduction of fares on the tramways is proposed. Notice has been given of a motion that a uniform rate of 1d. be charged on the Perth-road route, outside and inside the cars, for the journey from High-street to Windsor-street and *vice versa*, and that the ½d. rate carry to Airlie-place instead of to Tay-street.

Warrington.—Messrs. Preece and Cardew having submitted an estimate of the cost of constructing and equipping tramways Nos. 4 and 5, tenders will be invited for this work forthwith. It is proposed to carry out alterations at the corner of Lower Bank-street and Mersey-street to effect an improved entrance to the proposed car-shed.

Tramways in Spain.—According to the *Financial News*, the Société Iberique Thomson-Houston has been formed at Madrid, with a capital of 10,000,000 pesetas. The new concern has acquired the patents for Spain and Portugal, as well as the tramway concession for Cadiz, from the Thomson-Houston de la Méditerranée Company.

Ravensthorpe.—With reference to the tramway scheme of the British Electric Traction Company in this district, the engineer to the company has promised to lay 6in. by 3in. setts outside the rails, and 5in. by 3in. setts inside the rails. All water-mains, manholes, etc., also will be altered by the company to the satisfaction of the Council.

West Riding.—A sub-committee of the County Council has been appointed to meet members of the Wakefield Corporation with regard to the widening of Kirkgate Bridge, which will be traversed by the tramways now in contemplation. The dispute with regard to this bridge is at present the chief obstacle to the carrying out of the scheme.

Whitworth.—A resolution has been unanimously passed by a ratepayers' meeting strongly condemning the action of the Urban District Council in taking up the tramlines before summoning a meeting of ratepayers to consider the question; and that "this meeting is unanimously in favour of a service of electric trams being run through the district."

Cardiff.—A meeting of the directors of the Provincial Tramways Company was held in London on Friday to consider the offer of the Cardiff Corporation of £40,000 for the lines at present held by the company in Cardiff. The proceedings were conducted in private, and no statement has yet been made public as to the decision come to by the directors.

Leamington and Warwick Tramways.—Presiding at the annual meeting of the Leamington and Warwick Tramways Company, the Chairman stated that everything was now in order for the conversion of the lines to electric traction. He hoped that before this time next year electric cars would be running between the boroughs of Warwick and Leamington.

Ayr.—In the first week's running of the Corporation electric tramways the total number of passengers carried was 42,280, and the drawings amounted to £164 odd. This result is stated to be beyond general expectation. It has been unanimously agreed to proceed with the completion of the tramway to Burns Monument, a distance of two miles, at a cost of £15,000.

Tottington and Ramsbottom Light Railway.—A statement was made at the monthly meeting of the Tottington Urban District Council with regard to the reported abandonment of the Turton, Tottington, Ramsbottom, and Rawtenstall light railway scheme. One of the councillors said he had good reasons for believing that the scheme was not finally and definitely abandoned.

Lytham.—It will be remembered that a week or two ago the Light Railway Commissioners refused to grant an application for the construction of a light railway between Lytham and Preston. In further reference to this matter it was stated at the last meeting of the Lytham Urban District Council, that another enquiry on similar lines might be expected within the next few months.

Norwich.—Much success has attended the first year's working of the 20 miles of electric tramways in Norwich and district. The cars ran 924,789 miles, carrying 7,816,000 passengers. The earnings were £35,665, and the expenses £22,497, and after allowing for debenture interest there was a distributable balance of £11,568, and the company have declared a dividend of 4½ per cent.

Scarborough.—The tramway company have agreed to the insertion of a clause in the Tramway Bill providing for the carriage of fish over the tramway from the West Pier to the North-Eastern Railway, so as to do away with the necessity of carting it through the streets. The company, we understand, are also willing to lay a line from their system along the carriageway to the Spa.

Southall.—Mr. Benjamin Harvey made an unsuccessful claim against the London United Tramway Company in the Brentford County Court last week to recover £62. 3s. for damages, as the result of a collision between the plaintiff's brake and one of the company's cars in High-street, Southall. The jury found there was negligence on both sides, and a verdict was given in the defendants' favour with costs.

Tunbridge Wells.—In consequence of local opinion being strongly opposed to an electric tramway system a service of motor 'buses has been established, which, we hear, is becoming very popular. The 'buses, which run in the principal thoroughfares of the town and to the suburbs and surrounding villages, are particularly appreciated by the working population, as the fares are low and the service frequent.

Electric Locomotive on Yorkshire Railway.—We hear that trials recently took place on sidings of the Lancashire and Yorkshire Railway Company at Castleton, Rochdale, with an electric locomotive constructed by Messrs. Tweedale and Smalley. The locomotive, the weight of which in running order is 22 tons, is mounted on two axles and four wheels, and in order to facilitate shunting operations can be controlled from either end.

Bolton.—The tramway receipts for September were £6,526. 15s. 3d., an increase of £453. 3s. 1d. upon the corresponding month of last year. From April to September the receipts reached £40,309. 4s. 8d., an increase of £4,759. 16s. 8d. The cars running in September last year numbered 44, and last month 52. We understand that the Council have let the tenders for their ironwork in connection with the tramways in Bolton at a considerable saving.

North Notts Light Railway.—Two more well-attended meetings were held at Clayworth and Clarborough on Monday night to consider the best steps to support the scheme for the proposed light railway for North Notts. It was unanimously resolved in both cases, "That in the opinion of this meeting the proposed light railway will be of material benefit to the district, and that it is worthy of every support from the landowners and the inhabitants."

Acton.—The District Council have received a copy of the memorial presented to the Light Railway Commissioners in opposition to the projected light railway through Bedford-park. The Council have deferred the matter for fuller enquiry before deciding to support the petition. A meeting of representatives from the Hammersmith, Acton, and Chiswick Councils will shortly be held to consider if any steps can be taken with reference to the noise from the electric trams.

Nottingham.—A recommendation of the Tramways Committe has been adopted for an extension of the tramlines from the bottom of King-street along the front of the exchange and South-parade to join the existing tramways across the Great Market-place, and two short curves constructed to connect the lines in the Great Market-place with the existing line in Market-street. Power to carry out the works will be sought in the Bill to be promoted in the next session of Parliament.

Sunderland.—Of the three candidates for the position of traffic manager of the Corporation tramways recommended by the sub-committee—viz., Mr. G. H. Andrews, Sunderland: Mr. H. England, Bolton; and Mr. R. Simpson, North Shields—the Tramways Committee have decided to recommend the appointment of Mr. England. On Wednesday it was formally agreed to make an application to the Board of Trade for a provisional order for power to construct new and additional tramways within the borough.

Wellingborough.—The Urban District Council are about to conclude a contract with Messrs. Simpson and Bibby for a motorcar and

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trailer for scavenging purposes, at a cost of £650. A conference has been arranged between members of the Council, representatives of the County Council, and the engineer for the Wellingborough and District tramway scheme, to consider the proposal of a grant from the authorities to the British Electric Traction Company in widening the main roads at several points in Wellingborough.

Stapleford.—The Rural District Council have asked the Nottingham Corporation to include an application in the Bill they intend to promote in the next session for power to extend the electric trams to within the district of the Council. Stapleford, with the adjoining parish of Sandiacre, is some six miles from Nottingham, and there is a large population in the immediate neighbourhood, and the request of the Council is based upon the convenient access to the city which would arise thereby, compared with the existing railway facilities.

Chiswick.—At the last meeting of the District Council the clerk said that the Board of Trade was proposing to make a by-law whereby tramcars on parallel lines should not stop within 10 or 15 yards of each other. The clerk reported that he had searched the various Acts of Parliament in connection with the tramways, and found no section giving companies preferential rights of user over the public highways. The Board of Trade were making regulations that the rate of speed, except in certain places, should not exceed 10 miles an hour.

Barrow.—It was complained at the meeting of the Town Council on Monday that the tramways as at present being worked were in a deplorable state. The cars and engines at present in use were unfit to run, and the company were committing breaches of the regulations every day. It was stated, in reply, that things were not so bad as was considered. With regard to the agreement with the British Electric Traction Company, the reason of the delay rested with the company, as the Corporation had agreed to the terms two months ago.

Manchester.—As a result of the agitation which the tramway men in the employ of the Corporation have been carrying on lately, Mr. M'Elroy, the general manager, recommends certain concessions. Applications for increased wages have been acceded to in some cases, and it is promised that when the whole of the tramway system comes into the hands of the Corporation the following questions will be considered: (1) the working hours of guards and other employés, and (2) the length of service before the maximum wages are attained.

Reading.—Sir Frederick Bramwell has made his award in regard to the purchase of the local tramway company's undertaking by the Corporation. The amount payable to the company by the Corporation is £11,394, and application has been made to the Board of Trade for their sanction to a loan of £11,883. Tenders have already been invited for the construction of new tramways, the reconstruction of the existing tramways, the electrical bonding of the rails, and the provision and laying of conduits for the underground work with drawing-in boxes; and the engineers have now prepared plans, etc., for the generating station.

Yorks Light Railways.—An enquiry has been held at South Shields into the application of the British Electric Traction Company for an order authorising the construction of the South Shields, Sunderland, and District light railway, by which it is proposed to link the South Shields tramways with those of Sunderland by way of the main road between the two towns. The enquiry was concluded on Wednesday. The chairman said that, having regard to the attitude of the Board of Trade, and the decisions of Commissioners at other enquiries, they were of opinion that it was a case which should be submitted to Parliament.

Electric Traction in Prussia.—A United States consular report states that work has been begun on the electric railway between Halle and Merseburg, permission for the construction of which was granted by the Prussian Government several months ago. It is expected that the Halle-Ammendorf section will be completed before the beginning of winter. The total length will be 10 miles. Power will be obtained from the River Saale. The report further states that the projected electric railroad between Leipzig and Halle has been abandoned, the Prussian and Saxon Governments having refused to grant the necessary franchises.

Bristol.—The Sanitary Committee have confirmed their resolution relating to the laying of new cables by the tramways company from their new power station to the east of Bristol. In accordance with instructions, the Watch Committee reported at Tuesday's meeting of the Corporation that there had been 142 accidents upon the tramways in the past six months, and that 68 persons were injured in them. A report is to be sent to the Board of Trade on the matter. The Council adopted a resolution to appoint a committee to consider the desirability and possibility of acquiring the tramway undertaking, and to report to the Council.

Halifax.—The Tramways Committee announce that they have directed the manager of the tramways to draw the attention of drivers to the excessive consumption of electric current caused by bad driving, with instructions that the cars be allowed to run without current whenever it is possible, and not to apply the brake except when necessary. No promotion or advance in wages will be allowed to any driver until he has proved his carefulness in this respect. The committee are about to double the line at the north end of North Bridge at an estimated cost of £200, and also to purchase six snow-ploughs for use in the tramways department.

Light Railways in Middlesex.—A conference of representatives of the Harrow, Wealdstone, and Wembley Urban District Councils, the Hendon Rural District Council, and the members of a sub-committee of the Light Railways and Tramways Committee of the Middlesex County Council was held at Westminster with a view to obtaining the ideas of the local authorities with regard to the light railway scheme proposed by the County Council in Middlesex. The conference was of a private character, but it is stated that the proceedings passed off in a most amicable manner, and that the committee seemed very anxious to meet the wishes of the local authorities as far as possible,

Wolverhampton.—It is reported that the British Electric Traction Company have made a further offer to the Tramways Committee to come to a compromise with the view of putting an end to the isolation of the borough from the outside towns, and on which the feeling of the tradesmen and townspeople runs very high. At present, however, it is said the Tramways Committee will not depart from the position they have taken up, nor offer any explanation of the very undesirable state of things existing. At the present time the work of laying the trial line in connection with the Lorain system of electric traction, which has been adopted by the Corporation of Wolverhampton, is in progress at the Bilston-road.

Hackney.—In recommending the payment of the parliamentary expenses incurred in opposing the City and North-East Suburban Electric Railway Bill last session, the Works Committee state that the main objects sought to be obtained by the opposition have been secured. Objection was taken by the Parliamentary Committee to the construction of a railway in embankment across Hackney Marshes, and the raising of Homerton-road. Amendments were subsequently agreed, to and consisted of the deletion of the clauses having reference to the railway across the Marshes, the line of the same being so altered as to admit of its construction in tube instead of embankment, without disturbing the surface of the Marshes, or the necessity of raising the above-mentioned road.

Stockport.—This place is now experimenting with the pneumatic slipper brake on the tramcars. Travelling at a speed of about 20 miles an hour down hill, the slipper brake is said to have given great satisfaction, bringing the car to a standstill within a few of its lengths. Four slipper brakes are fitted to each car, two on each side, each being worked by means of compressed air at a pressure of 40lb. per square inch. The surveyor reports that platelaying along Reddish-road, for a length of between 400 and 500 yards to the point where it is proposed to widen the road, is approaching completion, and the contractors will afterwards commence work on the Brinksway route. It is proposed to put a loop near the Wellington Hotel to act as a terminus for the Brinksway route.

Wednesbury.—Considerable indignation was expressed at the last meeting of the Town Council with reference to a recommendation that the consent of the Council be given to a renewal of the license to use steam power on the South Staffordshire tramways for 12 months. The town clerk, however, advised this course, and it was ultimately adopted. He stated that negotiations had been in progress with the company for a very long period, and in the last few weeks a decided step forward had been taken. He thought in all probability this would be the last time such an application would be made, as he hoped shortly to be able to report that satisfactory arrangements had been entered into for the purchase of the tramway undertaking in the borough and the granting of a lease to the existing company.

Bournemouth.—The town clerk has been authorised to take the necessary steps to apply for a provisional order for the construction of tramways down Parkwood-road at Pokesdown. A proposal to apply for powers to construct tramways in Bath-road from Lansdowne to the pier approach, and along Exeter-road to the Square, has been rejected. At the Town Council meeting last week the Mayor said there was no truth in a report appearing in several London papers to the effect that a Philadelphian firm had received a contract for constructing the proposed electric tramway for Bournemouth and for equipment. There had been no tender invited for equipment yet. The wood blocks would probably come from Norway, and the steel rails perhaps from Belgium, but the rest of the work was to be of English manufacture as far as he knew.

Durban's Electric Tramways.—The wisdom of the action of the Durban Corporation in acquiring the old horse tram system and converting it into an electric service has already been vindicated by the call for increased accommodation, which has induced the recent application of the Municipality to the Natal Parliament for further borrowing powers. The first vote on this account was for £250,000, of which £114,000 was for the purchase of the original tramway undertaking. The fresh outlay now projected will amount to £120,000, and is to provide for the addition of six miles to the existing network, making 23 miles in all. No finality in this extension is, however, considered to have been attained, and further large increases in the mileage will, therefore, have to be made within the next five years.—*The British and South African Export Gazette.*

Birkenhead.—The Tramways Committee recommend the Council to take a further step towards the completion of the whole tramway system in the extension of the Shrewsbury-road line along Shrewsbury-road North to Claughton Village and down Park-road North to the existing line in Laird-street, thus completing the first loop included in the scheme. The borough engineer reports that the work of laying the tracks is steadily proceeding in Park-road South and Beaufort-road, the latter being the Docks route. A memorial has been received from residents in Oxton and Claughton urging the extension of the tramways in those districts. The Corporation have refused to entertain an application for free tickets on the tramways for the use of the nurses of the District Nursing Society. The question of providing workmen's cars on the Higher Tranmere route is now under consideration.

Cheltenham.—The Corporation have adopted a report of the Tramways Committee on a proposal by the Cheltenham and District Light Railway Company for extending the light railway (which at present runs from the southern side of the town to the top of Cleeve Hill) from the western side through the High-street to Charlton Kings and Leckhampton. During the course of the discussion, it was urged that the Corporation themselves should undertake the extension of the tramways. It was, however, pointed out that while it was quite possible the Corporation could get an order for the construction of a tramway both inside and outside the municipal area, yet the Council must consider what prospect there was of embarking upon such an undertaking. If the light railway were to cover any area outside that

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for which the Corporation was responsible, it must be done by some combination or company, and could not reasonably be done by the Corporation.

The New York Rapid-Transit System.—The Westinghouse Company draw our attention to the fact that the work of building the tunnels for the New York Rapid-Transit Railway, the "Underground" of New York, is proceeding apace. The total length of the line will be 21 miles, and in all there will be 48 stations. The last contract to be placed by the Rapid Transit Company is that given to the Westinghouse Company for the electric power plant. The aggregate power of the plant is about 150,000 h.p. Although polyphase alternate apparatus will generate the power required for the railway, no three-phase or other alternate-current system of traction is to be used. The alternate current will be converted to direct current for feeding the railway line circuits, and the trains will operate on the standard direct-current third-rail system. It is of interest to note that this is practically the same system as that favoured by Mr. Yerkes for the London "Underground" railways.

Liverpool.—During the fortnight ending the 28th ult. 4,197,273 passengers were carried by the electric cars, an increase of 1,236,337 compared with the corresponding period of last year. In the same period the horse cars conveyed 26,668, a decrease of 743,307 passengers. The receipts from the electric cars were £19,378. 11s. 8d., an increase of £4,761. 11s. 4d., and from horse vehicles £150. 19s. 3d., as against £4,120. 16s. last year. Three hundred and forty-one electric and six horse cars were at work, and the mileage of the former during the past fortnight was 445,722 and of the latter 4,858. A new system of lighting the cars, it is promised, will shortly be introduced. The engineer is to be instructed to submit plans and estimates for the construction of the Edge-lane route to enable the committee to construct the route during the current year. The residents in Sefton Park East and West have presented a petition in favour of a tramway being established between Aigburth-road and Lodge-lane.

Wellington (N.Z.) Tramways.—We are pleased to note that an English engineer has been appointed to organise the electric tramways at Wellington (N.Z.). The gentleman selected is Mr. Wm. Ryle Wright, now electrical engineer to Bootle. After considerable experience with the Electric Construction Company and Messrs. Elwell-Parker, Limited, from 1888-1893, Mr. Wright became assistant to the Corporation electric lighting undertaking at Manchester. He then, in 1896, went to Burnley, and remained there till 1899, when he was appointed electrical engineer to Bootle. The good work done by Mr. Wright at Bootle fully justifies his selection for the important post of consulting and administrative engineer for the proposed electric tramways at Wellington. We are pleased to note that the salary—*i.e.*, £1,250 per annum—is in keeping with the responsibilities which Mr. Wright has undertaken. The estimated cost of converting the present horse tramways to electric traction is £250,000.

Proposed Tramway at Haslemere.—Much local sympathy is being shown with the proposal for the construction of an electric tramway between Haslemere and Farnham, in Surrey, to connect two branches of the London and South-Western Railway. The proposed line would also afford communication between Shotter Mill, Hindhead, Grayshott, Headley, and other populous and residential localities at present without any vehicular service. The tramway would give access to some of the most beautiful parts of what the late Prof. Tyndall termed the English Switzerland, and the proposal, we understand, has been received with favour by the local Press and others interested in the districts concerned. The military authorities at Aldershot, it is said, would welcome the tramway, as it could be made a connecting link, *via* Farnham, between Aldershot and the extensive new camps at Borden and Longmoor. The popularity of such a tramway, if constructed, cannot be doubted, and we should think there would not be much difficulty in promoting the scheme from a financial point of view.

East Ham.—A discussion took place at the last meeting of the Urban District Council on a report from the Works Committee, stating that they had received and considered the tenders for the construction of the permanent way (exclusive of the platelaying) for the tramway extensions to the City of London Cemetery gates and to Cyprus-place, together with a report thereon by the surveyor, and the committee recommended that the tender of the surveyor for the sum of £6,312 be accepted, and that the work be done by direct labour under the sole management and direction of the surveyor, and that he be empowered to make all the needful arrangements in regard to labour, staff, and plant. One councillor said that their tenders had been referred back to committee, and during that time their surveyor had written to Messrs. Dick-Kerr and the other contractors, stating that they had not charged enough. The reason why they were referred to committee was to see that everything was in order. He never heard of such a piece of impudence on the part of the surveyor as to write to the contractors. Another councillor stated that in looking over the tenders he found that Messrs. Dick-Kerr had not charged enough for certain items. He hoped the clause under discussion would be deleted, and that tenders be readvertised for. Yet another gave it as his opinion that the tender of Messrs. Griffiths and Co. was the only valid tender. The surveyor's tender was £57. 10s. above that of Messrs. Griffiths. The matter was eventually referred back to the committee.

London County Council.—The Council resumed its sittings at the County Hall, Spring-gardens, on Tuesday, when several matters relating to the Council's tramway schemes were dealt with. The Highways Committee were authorised to conduct the negotiations, and the arbitration (if any) with reference to the purchase by the Council of the undertakings of the South London Tramways Company and the Woolwich and South-East London Tramways Company. With regard to the application of the Council for powers to construct a light railway along the Archway-road, Highgate, this is to be withdrawn in view of the fact that the Light Railway Commissioners have already refused to sanction the construction of two other lines of light railways in the same district. On the question of the ventilation of the Central London Railway, the Council unanimously agreed that "in view of the extension of underground railways in London, it be an instruction to the Public Health Committee to report on the condition of the atmosphere in the 'tube' of the Central London Railway." Referring to the tramways question in his annual address, the chairman of the Council (Mr. A. W. Torrance) said the Highways Committee had vast schemes in progress and under consideration. It aimed at revolution; it would not rest content until every district in London was properly served with tramways. It was convinced that horse traction was doomed, that electricity must be the future power, and that the conduit system must be adopted. He would give one illustration, of a personal character, showing how the individual was served who wished to travel in London. To return last Saturday week from the ceremony of opening the new electric generating station at Lombard-road, Battersea, the following appeared to be the quickest route: a car from the station a certain distance, another to Chelsea Bridge, an omnibus to Victoria station, train to Mansion House, omnibus to Broad-street, train to Mildmay-park, and then car to Highbury, or seven conveyances to go about nine miles. The working men of London were handicapped by such a monstrous want of system more severely than in any other city. Surely, he concluded, that state of things needed alteration. We understand that Mr. Alfred Baker (the manager of the London County Council tramways), Mr. J. H. Rider (the Council's electrical engineer), and Mr. J. Allan Baker of the Council's Highway Committee) have just returned from the United States, where they have been studying the shallow underground electric tramway system now in operation in Boston and New York. The visit, it will be remembered, was made in connection with a proposal for the adoption of this system of electric traction under the new Holborn-Strand street, as well as from Westminster to Moorgate-street. We look forward to the publication of the report of these officials with interest.

LIGHTING AND GENERAL.

Whitehaven Loans.—The Town Council have received sanction to borrow £10,000 for electric lighting.

Carnarvon.—The Town Council have scheduled the streets to be included in their proposed electric lighting order.

Bacup.—The Lancashire Electric Power Company's draft agreement for supply of electrical energy is before the Town Council.

Rossie Island.—Both the electric light and gas will be considered by the Montrose Town Council for Rossie Island lighting.

Aspull.—The District Council have now received a King's printer's copy of the Act confirming the Aspull electric lighting order.

Kingstown.—We understand that the Urban District Council are reopening negotiations with the British Schuckert Company.

Witham.—Notice has been given of a motion to the effect that the Urban District Council apply for general powers for lighting purposes.

Exmouth.—The District Council intend to ask the Board of Trade to extend the time for carrying out the electric lighting scheme by two years.

Share Market.—During the past week business showed a disposition to look up, and was distinctly brisker than it has been in recent times.

Dewsbury.—Mr. Campion, in the employ of the Blackburn Corporation, has been appointed electrical engineer at a salary commencing at £300.

Sheffield.—The application to borrow £500,000 for electric lighting is not to be proceeded with until the matter has been before the Finance Committee.

Otley.—The District Council have passed a resolution in favour of an application to the Board of Trade for a provisional order to light Otley by electricity.

Stafford.—The electric cables in Newport-road, Rowley-avenue, Rowley-park, and Wolverhampton-road are to be extended at an estimated cost of £2,500.

Newcastle.—Application is to be made for sanction to the borrowing of £8,812, the estimated cost of carrying out the proposed works of electric lighting in the borough.

Stepney.—The draft contract proposed to be entered into between the Council and Mr. A. Wright has been referred to the Staff Committee for further consideration.

Cuba Submarine Telegraph Co.—The directors recommend a dividend on the ordinary shares for the half-year to June 30 at the rate of 4 per cent. per annum, tax free.

Direct United States Cable Co.—The directors have declared an interim dividend of 3s. per share, being at the rate of 3 per cent. per annum, for the quarter ended 30th ult.

Maidenhead.—The Town Council are obtaining from the Ecclesiastical Commission a loan of £25,000 for purposes of electric lighting. A list of tenders will be found in another column.

Denton.—Statutory notices of intention to transfer the undertaking authorised by the Denton Electric Lighting Order, 1897, to the Corporation of Manchester have been published.

Electric Railway Signalling.—The North-Eastern Railway Company are about to introduce the Westinghouse electric pneumatic signalling system at Tyne Dock in a cabin of 101 levers.

Worthing.—The Wardens of Christ Church propose to provide an electric motor at the church for working the organ machinery, and probably to adopt the electric light for lighting purposes.

Limerick.—The Corporation propose to ask for new tenders for electric lighting plant in consequence of the great reduction in the prices of coal, iron, and copper since the tenders were opened in 1900.

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Leyton.—An application for current, chiefly for motor power, at 1½d. per unit, subject to a minimum consumption of 25,000 units per annum being guaranteed, has been accepted by the Urban District Council.

Stock Exchange.—The Stock Exchange Committee have ordered New General Traction Company, Limited, £171,300 5 per cent. mortgage debentures of £100 each, Nos. 1 to 1,713 (registered) to be quoted in the official list.

Brierfield.—The Council are negotiating with the Nelson Corporation upon the terms upon which Nelson would undertake the superintendence of the electric lighting works proposed to be erected by the Brierfield Council.

Hull Telephones.—The Corporation on Wednesday appointed a sub-committee for the purpose of seeking the services of an expert engineer who could advise them as to the best means of establishing their telephone system.

Coventry.—Mr. E. A. Sandford Fawcett has held an enquiry into an application of the Coventry Corporation to borrow £23,200 for electric light extensions, £17,295 for street improvements and sewerage, and £2,350 for street improvements.

A Wrinkle.—Travellers to the Sandwich Islands say that there electric lamps are set in the masonry of the walls of dwelling-houses, thereby throwing a reflection both inside and on the lawns, where the residents spend most of their nights.

Branksome.—The General Works Committee having considered the regulations proposed to be made by the Board of Trade under the Poole and Branksome Electric Lighting Order, 1897, have recommended that no observations be made thereon.

Bury.—Mr. William Roberts has been appointed clerk of works. The electrical engineer is preparing plans, specifications, and estimates for the extension of plant for tramways purposes. Accumulators are to be used in conjunction with the steam plant.

Brockie-Pell Arc Lamp, Limited.—The meeting of this company will be held at the company's premises, 60, Worship-street, Finsbury, E.C., on Tuesday, Oct. 15, at noon. The transfer books will be closed from Oct. 10 to Oct. 23, both days inclusive.

Ilfracombe.—The articles of association in connection with the Edmundsons' Company having been forwarded by the Council (who have sold their order) to the Board of Trade, when the reply is received the electric lighting of the town will be commenced.

Italy.—Amongst the works just sanctioned by the Government we note the construction of a new telegraph line between Turin and Alexandria (Italy), and another from Novare to Varello, also extensions of the electric lighting works at Sampierdarena.

Taunton.—The connections to the mains during the past quarter have been equivalent to 938 8-c.p. lamps, in addition to which the tramways company are taking current at an average in excess of the minimum under their agreement with the Corporation.

Monmouth.—The price of electric current for motors used in the daytime only has been fixed at 3d. per unit. The estimated consumption of electricity for street lamps is 50,000 units, for which a charge of £400 per annum, equal to 1·84d. per unit, will be made.

Hull.—The minutes of the Electric Lighting Committee, which contained a proposal to borrow £42,000 for the purpose of carrying out the 1902 extensions in connection with the Corporation electric lighting system, were carried at the last meeting of the Town Council.

Mold.—The Highway Lighting and Watering Committee of the Urban District Council have received several letters from electrical engineers, with one of whom the surveyor has conferred, as to lighting the town by electricity, but the matter has been deferred for additional information.

Carnoustie.—The Town Council have approved of the application to be made by the Electric Corporation, Limited, London, nominees of Messrs. Crompton and Co., for a Board of Trade provisional order in the next ensuing session of Parliament for statutory powers to supply electricity in the burgh.

Johnson-Lundell System.—We have received the following illustrated pamphlets dealing with the Johnson-Lundell system as applied to (No. 51) traction motors, controllers, and regenerative braking; (No. 101) automobile and launch motors and controllers; (No. 157) surface contact electric traction.

Oriental Telephone and Electric Co.—The directors have declared an interim dividend of 2½ per cent. (being at the same rate as this time last year) on the paid-up capital of the company, free of income tax, payable to those shareholders whose names were on the register at Oct. 9. The warrants will be posted on 31st inst.

Woolwich.—At the meeting of the Borough Council on Friday it was stated that the electric light in Plumstead would be supplied as soon as it could be laid on. For private consumers the light would probably be supplied the next morning. For public street-lighting they would probably have to wait another month.

Nelson.—The following scale of charges has been adopted, to take effect from March 31, 1902: lighting—up to 1,000 units per annum, 4½d.; up to 3,000, 4¼d.; up to 5,000, 4d.; up to 8,000, 3¾d.; up to 10,000, 3½d.; over 10,000, 3d.; motive power—2½d. per unit. Meter rents will be reduced to a yearly sum equal to one-tenth the cost of the meter.

Bootle.—At the last meeting of the Town Council it was mentioned that the electrical engineer, whom the Council were paying £350 a year, had received an appointment in New Zealand at £1,250 a year, with £300 for expenses to go there. It would be a great loss to Bootle, but they could not help congratulating Mr. Wright on his appointment.

Luton.—With regard to the recent electric light failure, it is stated that this was not due to any deficiency in the plant or installation, but was caused by the negligence of an employé to carry out an instruction. The fuse boxes should have had attention in the morning, in the ordinary course of things, but through forgetfulness this duty was left undone.

Manchester.—A meeting of the City Council will be held to-day "to consider the proceedings of the Electricity Committee at a meeting held on Oct. 4 in relation to the acceptance of tenders for the construction of two chimneys and foundations for engine-beds at the Stuart-street generating station, and to approve or adopt resolutions in relation thereto."

Sleaford.—The Urban District Council have fixed the charge for the supply of electric light at 6d. per unit. Owing to the demands for extensions of the cables, application is to be made for power to raise a further loan of £1,000, the recent loan of £7,000 having been expended. It is now feared, as was predicted, that the plant will prove altogether inadequate.

Cheltenham.—The electrical engineer's last report states that 531 customers, with the equivalent of 32,900 8-c.p. lamps, are now connected to the mains. Extensions in Spa-buildings and Kensington-avenue are to be carried out, at costs of £50 and £85 respectively, and two additional trimming ladders obtained at a cost of £28 each to cope with the street-lighting extensions.

Sheffield Telephones.—At a meeting of the special committee appointed by the Corporation to consider the question of municipalising the telephone on Tuesday, Alderman R. Styring and Mr. W. C. Fenton were appointed to attend a conference which is to be convened by the municipal authorities of the West Riding to discuss the matter of the municipalisation of the telephone service.

Pianotype.—Mr. Robert Newman, of Queen's Hall, has invited inspection of a machine which is likely to be of service to conductors of theatre orchestras, and to all who add composition to performance. Mr. Neale's pianotype is an electrical instrument, which, attachable at will to a pianoforte, reproduces, on an endless roll of music-paper, every note and chord struck on the instrument.

Crook.—The electric lighting at Willington, Crook, Helmington Row, and Hunwick is being advocated. The Urban District Council are conferring with the Weardale Coal, Steel, and Coke Company with a view to lighting the streets of the Sunniside Ward with electricity, as the company are contemplating putting down an installation for their own private use at West Thornley Colliery.

Hamilton.—At a meeting of the Town Council on Thursday last week a motion was made, but not carried, proposing that, in view of the large sums required to provide electric lighting in the burgh, and the doubtful return for the expenditure of public money, the Council delay proceeding with the electric lighting scheme in the meantime, and that the Electric Lighting Committee be discharged.

Farnworth and Kearsley.—The Farnworth (Lancashire) District Council has decided to modernise its lighting arrangements by substituting electricity for gas into its streets, and as a commencement arc lamps have been ordered for two of the principal thoroughfares—*i.e.*, Bolton-road and Market-street. The Kearsley District Council is also proposing to introduce electric lighting into the township.

A. Reyrolle and Co.—Messrs. A. Reyrolle and Co., Limited, in order to extend their manufacturing capacity, have transferred their head office to Hebburn-on-Tyne, where they have erected large works. The speciality of the firm is the manufacturing of large distribution switchboards, many of which are already in use in London, Cork, Queenstown, Newcastle, Wallsend, Colombo, Woking, Northwich, etc.

Tunbridge Wells Telephones.—In spite of the fact that the National Telephone Company have reduced their rates to less than half, the municipal system is proving a great success, and there are now 650 subscribers, 150 having joined in the last two months. So popular is the system that the village of Uckfield, 15 miles away, has petitioned the Tunbridge Wells Corporation to include it in the telephone area.

Electrical Souvenir.—Under this title the proprietors of the *Scottish Electrician* have issued a reprint in book form of the special descriptions of the important electric exhibits of Glasgow International Exhibition which have appeared from time to time in the paper, and trust that it will be found useful as a work of reference. The book is confined to a technical description of the various electric exhibits and motive power.

Aberdeen.—On Tuesday a recommendation by the Council was agreed to that, in order to meet prospective expenditure in connection with the gas and electric lighting departments, authority should be asked by the Council in the first Bill or provisional order for which application may be made to Parliament to borrow on mortgage the additional sum of £200,000, £80,000 of which is for the requirements of the electricity department.

Nairn.—At a special meeting of the Town Council to be held on Oct. 30, the following resolution will be proposed: "That the Local Authority of the burgh of Nairn make application to the Board of Trade, under the Electric Lighting Acts, 1882 and 1888, for a provisional order authorising them to supply electricity for any public or private purposes within the burgh of Nairn or such larger area as may by said resolution be defined."

South Shields Telephones.—The Corporation are debating the question of municipal telephones. Nothing definite is yet proposed, but the opinion of the Council seems to be that, having regard to the costly and incomplete telephone service in the town, the time has arrived when they should consider the desirability either of applying for a license for a municipal telephone, or making arrangements for a competing company to come into the borough.

Edinburgh.—At the last meeting of the Electricity Committee of the Town Council the subject of supplying electric light to the North British Railway was under discussion. This matter has been before the committee on more than one occasion, and an arrangement has

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now been made under which the railway company are to be supplied at special rates. The new applications for electric current during the past fortnight have been equal to 3,300 8-c.p. lamps.

Todmorden Telephones.—A conference of local authorities in the Burnley district was held on Thursday last week to discuss the advisability of establishing a municipal telephone system for the district. The Town Councils of Burnley, Nelson, Colne, Todmorden, and the rural district councils, and other local bodies were represented. The proposal was favourably received, and it was decided to consult an expert and obtain full information on the subject to be submitted to another conference.

Lower Bebington.—In reference to the formal notice by the Lower Bebington Urban District Council of their intention to apply to the Local Government Board for a provisional order enabling them to supply electric light to the parish of Poulton-cum-Spital, that Council adhere to their former resolution to the effect that they would not object to their having powers providing that Bebington would undertake to supply the electric light to Poulton-cum-Spital upon the same terms as they supplied their own district.

Post Office Telephones.—The National Telephone Company's exchanges in the western district were on Saturday inspected by several Post Office officials, and it is expected that cables will be laid between one of these exchanges and the Post Office exchange in Cromwell-road. The National Telephone Company's exchange at Kensington is a new building and well adapted for the requirements, and a considerable number of the company's employés in the western district are under a week's notice to leave.

Croydon.—The Board of Trade have approved of the additional continuous-current direct-supply system being adopted for the supply of energy under the Corporation Electric Lighting Order, 1891, subject to the regulations for securing the safety of the public and ensuring a proper and sufficient supply of energy which were previously imposed by the Board. The Department have also given their formal approval, with the concurrence of the Postmaster-General, of the connection of certain parts of the electrical circuits with earth.

West Bromwich.—The following scale of charges has been adopted: for one hour's use per day, 4½d. per unit; for two hours, 3d. per unit; for three hours, 2½d. per unit; for four hours, 2¼d. per unit; and for five hours, 2·1d. per unit; or 4½d. per unit for maximum demand of 91 hours per quarter, and 1½d. per unit for all energy consumed above that number of hours; further, that a flat rate be charged for churches and chapels of 3½d. per unit all the year round, and for power purposes that a uniform rate of 1d. per unit be charged.

Benwell.—At a recent open-air meeting held to protest against the handing over of the provisional order which the Benwell and Fenham Urban District Council has been granted under the Electric Lighting Acts of 1882 and 1888 to any private electrical company, a resolution was declared carried protesting against the action of the local authority in inviting the electric supply companies to tender for the lighting of the district and expressing the opinion that the best interests of the district would be served by the Council working the provisional order themselves.

New Firm.—Having resigned his position with the Edison and Swan Company as representative for the South Coast and West of England, Mr. Blower has joined Mr. E. Roberts in partnership, under the style of Ernest Roberts and Blower, manufacturing electrical engineers, at 6, Holborn-place, W.C. The new firm has been appointed agents for Jandus Arc Lamp Company for the South Coast and West of England. Mr. Blower has been with the Edison and Swan Company for upwards of 11 years, part of which he had opportunity to gain practical experience at the works.

Cambridge.—At a quarterly court held at Addenbrooke's Hospital on Monday, it was stated, with regard to the question of the electric light installation, that the cost was originally estimated at about £400. When the tender for the work was sent in by the electric supply company the amount was £524, and the committee, being a small body, naturally hesitated, and took steps to fortify themselves with the opinion of the Advisory Council. The latter gave it as their opinion that the Lighting Committee would be justified under the powers conferred upon them in accepting the tender of £524. This action of the Advisory Council was approved.

Tunbridge Wells.—The Council have decided to increase the salary of the engineer and manager of the electricity department, Mr. H. L. P. Boot, by £150 per annum. The engineer has reported that on Sept. 10 a superheater attached to boiler No. 6 exploded during a trial or testing run, such explosion doing considerable damage. Four men were more or less injured by steam and falling glass. The engineer also reported that the accident and damage arose during the performance, and as a consequence of, the work of the contractors. Each of the injured men was paid at once the sum of 30s., and the engineer was authorised to do whatever was necessary to meet their present needs.

Accidents.—We regret to learn that Mr. James Gray, in the employ of the Chatham, Rochester, and District Electric Lighting Company, was killed a few days ago in a sub-station, where by some means he came into contact with the live current, and was killed instantly. At the subsequent inquest it was pointed out that deceased had a glove on the right hand, while the left hand was burnt.—William Moore, a man employed at Exhall Colliery, Warwickshire, was killed last week while roof repairing, a heavy steel bar breaking the guard protecting the electric wires.—Explosions occurred on Tuesday in Highbury and on Wednesday at Ludgate-hill; in the first case an escape of gas and the second fusion of wires being the apparent cause.

American Pacific Cable.—The *Daily Telegraph's* Washington correspondent wired on Oct. 3: "The Cabinet will decide to-morrow whether to accept Mr. Mackay's offer to construct a trans-Pacific cable. Objections to the scheme come largely from those who want the Government to lay the cable itself, and the President before stating his position has asked for an opinion from the Attorney-General whether or not there are any constitutional objections to Government ownership. The Mackay Company offers to carry Government messages at a substantial reduction from the ordinary charges, but there is a strong belief that it will be more economical in the end for the Federal authorities to lay the cable and to send their own messages free."

Persian Telegraphs.—Russia has been roused into activity by the recent Anglo-Persian convention conferring upon an English company the right to construct a new telegraph line in Persia, from Kuchan, along the principal trade routes of central and southern Persia, to Ispahan and Beluchistan. The Muscovite Government has decided to arrange a line of communication between Astara, on the Russian frontier, the seaport Enseli, Teheran, and Ispahan. The proposed line will run from Astara through Enseli, Kasvin, Teheran, Kum, and Kuchan, to Ispahan. All these towns are Persian commercial centres. The Russian Government is persuaded that the concession will be as easily obtained as the English one, especially as the sympathies of ruling circles in Persia are, at the present moment, on the side of Russia.—*Daily Telegraph.*

Beckenham.—The conveyance of land at South-hill Park for a transformer station has been completed, and the work of constructing such transformer station is in hand. A guarantee has been given by the wiring contractors and the British Insulated Wire Company, Limited, which will protect the Council in case the building is required for railway purposes during the next 10 years. An application for the extension of the cable to Venner-road to supply one house has been submitted. The estimated cost is £60. Further information as to other consumers in the same neighbourhood is to be obtained. A cable is to be laid in Mackenzie-road for the convenience of several intended consumers, at an estimated cost of £40. The British Insulated Wire Company, Limited, have declined to reduce the price of current to private schools.

Germany.—At Malsbenden the River Oleff joins another called the Urft, and the joint stream falls into the Roehr. At some seasons the flow of water is only a cubic yard or two per second, at others it is 400 or 500 cubic yards, and occasionally the rush of water has caused destructive floods. A dam is now constructed across the valley, by which a lake is formed capable of holding some 45,000,000 cubic yards of water, and the outflow of this water will be made to turn eight turbines of 1,280 h.p., which, coupled with dynamos, are expected to yield in all 8,000 h.p. in winter and 6,000 in summer, and together will supply Enskirchen, Düren, and Aachen (Aix-la-Chapelle) with electricity and cheap motor power. It is computed that 1 h.p. will cost about a farthing per hour, the whole cost of the installation not having exceeded £250,000 sterling.

Bolton.—The Electricity Committee of the Bolton Corporation at a recent meeting requested application to be made to the Local Government Board for sanction to borrow a further sum of £125,000 for the purposes of the electricity undertaking, which includes tramways and lighting. The Finance Committee received the resolution, but deferred it for further consideration, and at the Town Council meeting held on the 2nd inst. the Chairman of the Electricity Committee (Councillor Panton) expressed regret that the Finance Committee should have taken this course, as it was a matter of considerable importance to the electricity department. Councillor Walmsley, replying on behalf of the Finance Committee, said the scheme was one of considerable magnitude, and warranted more than passing consideration. The matter will be dealt with at a further meeting, and would not be endangered by being held a short time in abeyance.

Electrical Exhibition.—The preparations for the electrical exhibition at the Royal Aquarium, Westminster, are making rapid progress. We learn that, amongst others, the following have already engaged positions: Consolidated Telephone Construction and Manufacturing Company; Electric Lighting Boards (British Manufacturing Company), Limited, both fountains; Gardner Electric Drill and Hammer Company; Simplex Steel Conduit Company; New Century Arc Light Company; Renewable Electric Lamp Company; Crown Electric Heating Company; Ingersoll-Sergeant Drill Company; E. Green and Son, Limited (Manchester); Bastian Meter Company, Limited; Hedges, McKrell, and Co.; Foxcroft and Duncan; Pritchetts and Gold; Flather and Co. (Leeds); Harry Cox, Limited; Geipel and Lange; A. Vandam and Co.; Chas. Franklin; J. Starkie-Gardner, Esq.; J. Defries and Son, Limited, etc. Large audiences are still the order of the day at this popular place, and the excellent biograph pictures, already referred to in these columns, continue to be an attraction.

St. Annes-on-Sea.—With respect to the description of the electricity works at St. Annes-on-Sea which appeared in our last issue, we now learn from the engineer, Mr. P. J. S. Tiddeman, that the number of equivalent 8-c.p. lamps is already 4,609, while the largest observed load is 73 kw. The load curve which we have received for Sept. 14 shows a fairly even load, from 7 to 11 per cent. This is due to the private house consumers, who represent the bulk of the supply. The private houses in St. Annes are mostly inhabited by Manchester merchants, who are keen on having electric light in their homes. The engineer informs us that he is receiving a number of applications for electric motors, which will be charged for on the maximum demand system at 7d. and 2d. The wiring contractors in the district are helping matters on by their brisk canvassing. The electric lighting works propose to spend a further £7,230 on capital account, and Colonel C. H. Luard will hold an enquiry at the Council offices on Oct. 15. An installation of the electric light in the parish church has been carried out by Mr. Dewhurst, of Blackpool, at a total cost of £130. In the body of the church 15 five-light and five three-light electroliers are used, and there are 30 16-c.p. incandescent lamps in the chancel.

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Acton.—The District Council have an offer from the National Telephone Company of an agreement for a further period of five years at the reduced rate of £19. 10s. or continue under the present agreement at the annual rate of £22. 10s. They have agreed to continue at the annual rate, on the ground that when the Post Office telephone system was established the Council might want to take advantage of it. Messrs. Evershed and Vignoles have informed the Council that unless electric light was supplied in a reasonable time they would move the Board of Trade to cancel its grant of a provisional order to Acton. The Council's reply was that they are negotiating for a site for their electricity works.

Long-Distance Telephones.—Experiments are being made by the Post Office with a view of ascertaining how far it is possible to speak over the telephone. Conversation can now be carried on between Liverpool and Paris. Leeds subscribers, however, are not yet able to get through to Paris, the submarine telephone cables not having proved altogether satisfactory. The most distant town to which Leeds telephone subscribers can speak is Dublin, the wire crossing the narrow strip of sea at Stranraer, and reaching the Irish capital *viâ* Belfast. The fee is 4s. 6d. for three minutes' conversation, or 3s. 6d. to Belfast. It is said that the words are nearly as audible as if spoken by a person telephoning from across the street.

Hammersmith.—Since the last Council meeting eight additional consumers have been connected, representing a maximum of 436 8-c.p. lamps; these added to the number previously reported show a total of 959 consumers taking current from the mains. The engineer has reported that current for power purposes is required immediately at some flats which are being built at the corner of Queen-street and Sussex-place, and has submitted an estimate for fixing a transformer box at that corner, which would supply the above block when completed, and for picking up the pressure of the consumers around St. Paul's-crescent by laying connecting mains to same, at a total cost of £299. 11s. 1d. This work is to be carried out.

Congo Cable.—If the negotiations at present proceeding between the Congo Free State Administration and the French and German Governments come to a successful issue, Belgium will soon be connected by cable with the Congo and German South Africa. As the German Government has just completed a line of telegraph from Barés-Salaam to M'pua-M'pua, in its African colony, and as a French line already exists between Brazzaville, Loango, Libreville, Dahomey, Conakry, St. Louis, Teneriffe, and Cadiz, it will thus be seen that the construction of a line from M'pua-M'pua to Stanley Falls, Boma, and Brazzaville, as it is proposed, would complete the line of communication from Europe to the Congo and German South Africa.

Farnham.—The Urban District Council have received in reply to the advertisement *re* electric lighting of the town an offer from Edmundsons' Electric Corporation, Limited, proposing that the Council should arrange the necessary loan to carry out the works, after which the company would be prepared to enter into a contract to carry out the works at prices to be agreed upon, and to lease the works from the Council when completed for a period of 14 years, paying as rent a sum equivalent to the amount which the Council have each year to pay for interest and sinking fund upon their loan; the Council to have the option of terminating the lease at the end of seven years by six months' notice given in writing, but should this option be exercised, the Council should pay this company a sum equivalent to 15 per cent. on the capital which has then been expended.

Accrington.—According to the last report from the electrical engineer the supply continues to be satisfactorily maintained. There are now 83 consumers connected to the mains, with an equivalent of 5,760 8-c.p. lamps, and nine are about to be connected. The state of the extension plant is as follows: the two dynamos made by the Lancashire Dynamo Company are completed, and have been sent on to Messrs. Browett, Lindley, and Co. for connection and trial runs; the condensing plant, by Messrs. Ashton, Frost, and Co., is completed; the balancing motor-dynamo was started on Sept. 9; the external firegrate of No. 2 boiler has been replaced by internal (Whittaker's) firebars and fittings. The introduction of a few electrical incandescent lights for street-lighting near the town hall and market, utilising existing lamp-pillars, has been agreed to. These will cost about 50s. each. The engineer is making enquiries as to the terms upon which certain corporations undertake the wiring of consumers' premises.

Cowdenbeath.—Rapid progress is being made with the laying of the electric cable and relative works for the introduction of an electric light installation. Out of a total length of 11,000 yards, 6,000 yards of the cable have been laid in three weeks. The engine and dynamo house has been erected on a site adjoining No. 7 pit, and the fitting of the machinery is being proceeded with, while arrangements have been completed with the Fife Coal Company for a supply of steam from their boilers at No. 7 pit. With the additional lamp pillars that have been erected there are now altogether 200, each of which will carry two incandescent lights of 32 c.p. in the main thoroughfares and 16 c.p. in the side streets, brought up from the top of the pillar on the swan-neck principle. The cables are being laid at a depth of 2ft. from the surface of the roadway, and it is computed that the works will be completed by Nov. 10. The total cost of the works is estimated at £1,800, and the material is being supplied and fitted by Messrs. Hunter and Jack, electrical engineers, Glasgow, to whom great credit is due for the expeditious manner in which the work is being executed.

Spennymoor.—The Finance Committee of the Urban District Council are considering a letter from the Northern Counties Electricity Supply Company offering to supply current to sets of five arc lamps of 2,000 c.p. each lighted up to 11 p.m., and from that time until one hour before sunrise, to incandescent lamps. The incandescent lamps would be placed in pairs on the arc lamp-posts, and the company would supply current, attendance, and recarboning the arc lamps for the sum of £14 per lamp per annum. As the company would be laying out considerable capital in the work, they would prefer to make a contract for this work for a period of seven years, and at the end of that time a revision of prices could be agreed upon. If the Council are desirous of entering into any contract for incandescent electric light for the public lamps, the company would be prepared to connect those lamps within the area where it is proposed to lay cables on the following terms: for each 16-c.p. lamp lighted as above—namely, from Sept. 1 to April 30, from sunset to one hour before sunrise—for the sum of 39s. each. The Council would have to provide lamps, fittings, and posts, and the company would turn off and maintain the lamps; the Council to paint the posts and maintain them.

Colne.—Provision has now been made which will enable the electrical engineer to supply current to the buildings in the town which are now connected or shortly to be connected. The accumulator-house and offices, so far as the mason and joiner's work is concerned, are about completed. The chimney has reached a height of 74ft. above the ground level, and tenders for the setting of the boilers, revolving shutters for the coal bunkers, patent glazing required in the roof of the engine-house, weighing machine, and also the lightning conductor for the chimney, have been received. The electrical engineer's last report states that practically the whole of the cables are now drawn in, and nearly all the distributing mains are joined up, so that it will be possible to connect any consumer who requires the current. The switchboard is now erected, and, with the exception of a few details, is complete. The balancer booster is in position, and is ready for running as soon as the cables across the river are connected up. The turbine has been run up to speed, although the dynamo was not excited. Owing to the great delay in the completion of the accumulator-room, the battery is in a very backward state, and therefore it will be necessary to run the plant direct to supply the technical school, and he proposed to run the plant from dusk till 10 p.m. This arrangement would probably have to go on for two or three weeks, by which time he hoped that half of the battery would be ready for use, after which he would be able to run in the daytime to charge the battery and discharge from it at night, except such times as the motor at the technical school was required. To save inconvenience and disorganisation, he does not propose to use the refuse whilst running direct, as it would mean evening work and the refuse would take more handling, and there might also be some difficulty in keeping the steam pressure steady.

York.—The Council have authorised the Electric Lighting Committee to expend £50,000 on further extensions of the plant, etc. The supply was started in April, 1900, with a capacity of 320 h.p., capable of supplying current to 6,500 8-c.p. lamps. In December, 1900, a further boiler, engine, and dynamo of 360 h.p. were added in order to cope with the last winter's load. The machinery was capable of supplying current to 7,000 8-c.p. lamps, making the capacity for last winter 13,500 lamps. The extensions now in hand include the changing of the two 40-h.p. balancing sets for two of 130 h.p., the provision of a further engine and dynamo of 360 h.p., and the changing of the present battery for one of four times its capacity. With these extensions there will be a total horse-power in the station of approximately 1,400, which will supply 21,000 8-c.p. lamps. So great is the demand, however, that there is already connected or on application a total of 32,500 8-c.p. lamps, and the city electrical engineer estimates that by the end of March, 1903, there will be a total lamp connection of 44,000 8-c.p. lamps. The existing plant will therefore be quite unable to meet any increased demand for the winter of 1902-3. The present buildings are now utilised to their full extent, and new buildings will accordingly be required. The city electrical engineer's estimate for the extensions, including buildings and all other details necessary to provide an efficient supply for the winter 1902-3, is £50,000, as follows: two engines, £9,000; two dynamos, £5,000; four boilers, £6,000; four sets stokers, shafting, etc., £1,000; steam-pipes, feed-pipes, exhaust-pipes, valves, tank, two steam-pumps, £4,300; condenser, £1,100; economiser and motors, £3,200; switchboard and connections, £1,200; crane (20 tons), £500; buildings, including coal bunkers and sidings, £7,500; works wiring, £150; clerk of works, £120; draughtsman, £130; contingencies on the above, £800; allowance for coal-conveying machinery, fitting-up of the stores, a new workshop, also to provide for minor mains extensions, £10,000—£50,000.

Presentations.—On Saturday the staff and employés of the Woolwich District Electric Light Company, Limited, presented Mr. A. J. Fippard, the popular engineer and manager of the company, with a very handsome aneroid barometer, with clock and thermometer, in a polished hardwood case, together with two pipes in case, as a mark of their esteem, and in wishing him good-bye expressed the hope that every success would follow him in the work he was about to undertake. Mr. Fippard, who is leaving the company to take up consulting work with the well-known engineer, Mr. W. T. Pressland, of Broad Sanctuary-chambers, Westminster, joined the company in January, 1899. The number of lamps connected then, after the company had been supplying current for about five years, was less than 5,000 8 c.p. At the end of 1899 the number connected jumped to 9,610, and at the present time stands at considerably over 20,000. The income of the company naturally increased, and a loss was turned to a profit, the results being as follows: the units sold in 1898 numbered 98,517, in 1899 141,815, and in 1900 253,651. There was a deficit in 1898 of £264, in 1899 a net surplus, after providing £100 for depreciation, of £728, and in 1900 a net surplus, after providing £500 for depreciation, of £1,358. A movement is on foot amongst the consumers to present Mr. Fippard with some recognition of his efficient management.—Mr. E. S. Saunders, chief assistant engineer under the Bradford Corporation, who is about to take up an appointment in London with the British Westinghouse Electric Company, Limited, has been presented by the staff of the electricity department with a silver-mounted spirit case, a silver cigarette case, and a gold signet ring. The presentation took place in the presence of a numerous gathering at the Boar's Head Hotel, Market-street, and it was made on behalf of the subscribers by the city electrical engineer (Mr. R. A. Chattock),

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who testified to the ability Mr. Saunders had shown during his stay in Bradford, and congratulated him upon his new appointment.

South Africa.—A recent number of the *British and South African Export Gazette* contains quite a budget of electrical items, amongst which we note that in setting up the excellent electric light system which now serves the requirements of Durban, the City Fathers were minded to proceed cautiously, and the initial undertaking was laid down at a cost of £25,000. Public appreciation of the light was, however, such that further extensions were at once found necessary, with the result that the initial outlay has been threefolded. The call for more light is still as persistent as previously, and to the need for further expenditure are now to be added the requirements created by the installation of the electric tramways, for which, however, a separate account and disbursement are allocated. For a portion of the outlay involved by the two schemes a joint expenditure is contemplated in the creation of a combined lighting and power station, equipped with larger and more powerful engines and boilers, on which £45,000 is to be spent, a further sum of £30,000 being devoted to extensions of the electric lighting network. Alternative schemes for the provision of electric or acetylene gas lighting services are being considered by the Simonstown Municipal Council. The installation of electric lighting and tramway services at Paarl, Cape Colony, is mooted. The dynamo recently ordered for the electric lighting plant of the Natal Harbour Department has been delivered by the makers. Proposals for the extension of the private electric lighting of Kimberley, at an estimated cost of £10,000, are under the consideration of the Town Council. The public lighting of Wynberg, Cape Colony, by electricity has also been provided for by an arrangement with the Cape Peninsula Electric Lighting Company, Limited, which is now erecting a central station at Claremont for the services of the east and south-eastern suburbs. As stated in the last issue, Messrs. Reunert and Lenz have secured the contract for the machinery, etc. The first mine in Rhodesia to use water power for the generating of electricity to drive a mining plant is the Rezende, in the Umtali district. The plant operated comprised two 10-h.p. motors and one 50-h.p. engine, the latter driving the 10-stamp battery. It is now in contemplation to extend the plant in order to light the mine by electricity, as well as increase the number of stamps dropped.

Blackburn.—At the meeting of the Town Council on Thursday last week the report of the Electricity and Tramways Sub-Committee respecting the purchase of engines for the electricity works enlargement was presented. Two types of engines were tendered for—namely, (1) slow-speed Corliss, and (2) moderately high-speed. Of the 213 tenders for combined engines and dynamos, two of each type of engines were selected: tenders No. 32 (£25,069) and 44 (£23,383) first type, and 65 (£21,575) and 66 (£21,031) second type. The limit of revolutions fixed by the specification was 180 per minute, which the committee stated was only a moderately high speed. The sub-committee stated that they found that both types of engines were satisfactory in the towns they had visited, and said: "Neither type of engines of the size required (1,250 h.p.) has, however, been in use for electrical purposes for more than than three or four years in this country, but the makers of the high-speed engines and your own electrical and consulting engineers say there is no reason why the larger sizes, which have been (during the limited time they have been in use) found satisfactory, should not be as strong and lasting as those of the smaller sizes, all the parts being proportionately strengthened. The smaller sizes have been in use for 14 or 15 years. As to economy of steam, the figures guaranteed by the makers of the two types are practically similar. The purchase cost of the slow-speed engines with dynamos of German manufacture, as in tender No. 44, exceeds that of the high-speed engines with English-made dynamos by £2,350, and the slow-speed engines with English-made dynamos (tender 32) exceed that of the high-speed engines with English-made dynamos (tender 6A) by £4,038. To this difference in either case must also be added the extra cost of foundations and engine-house additions required for the slow-speed engines, estimated by our engineers at about £960. We are satisfied that either type of engine could be made suitable for the purposes required, but we do not feel justified in recommending the committee to incur the extra expense referred to in respect of slow-speed engines and dynamos. It has been explained by the engineers that the engines as shown in the detailed drawings of tenders 32 and 44 are not suitable for the purposes required, and cannot in their opinion be recommended, but they can recommend those of the engine in tender 66. Under all the circumstances we recommend the committee to accept tender No. 66 at the price of £21,031." The Electricity Committee recommended that the report of the sub-committee be adopted, and that the tender of Messrs. Dick, Kerr, and Co., Limited (tender No. 66), be accepted. After considerable discussion the report was allowed to go back to the committee.

London County Council.—The Council on Tuesday agreed to advance to the Hampstead Metropolitan Borough Council £9,525, repayable within 42 years, for the installation of the electric light, also £19,529, repayable as to £13,429 for the installation of the electric light within 42 years, and as to £6,100 for electric light meters, etc., within 10 years, and £7,078 for electric light installation, repayable within 42 years, and of £2,545 for the purchase of electric light meters, repayable within 10 years; and to the Stepney Metropolitan Borough Council £10,000, out of a sum of £26,507, repayable as to £24,570 within 42 years from the date of the borrowing, with three years postponement of commencement of repayment, and as to £1,937 within 20 years. The Council also approved of the plans submitted by Mr. C. S. Peach on behalf of the Central Electric Supply Company, Limited, for the erection of a chimney shaft and the permanent brick walls of a portion of a proposed electricity generating station on the east side of Grove-road, St. John's Wood, between the Regent's Canal and Lodge-place, and authorised the erection of the works, subject to the following conditions: that the brickwork, except that of the chimney shaft, be built in Portland cement mortar, composed of one part of Portland cement to three of clean sharp sand; that the whole of the work be executed to the satisfaction of the district surveyor; that the chimney shaft and permanent brick walls be otherwise erected and retained without any addition thereto and in exact accordance with the application for the approval and authorisation and the plans and particulars which accompanied such application; and that the chimney shaft and permanent brick walls hereby authorised be not, without the consent of the Council, used for any purposes other than those mentioned in the said application and plans. The Highways Committee submitted the following report: "Our attention was some time since called to the fact that a practice had been adopted by some of the electric lighting companies who test their own meters, of marking them in such a manner at might give the impression that they had been tested by an independent authority, and not by the companies selling the current. We brought the matter under the notice of the Board of Trade, and pointed out that the duty of testing electricity meters devolves, under the several orders, upon the Council; and the Board was asked to take such measures as it might see fit to prevent the continuance of the practice adopted by the companies referred to. At an interview in December, 1899, with Mr. Stewart, who was then clerk of the Council, the late Sir Courtenay Boyle, who was then secretary of the Board of Trade, expressed the view that the intention of the orders was that immediately the Board had classed any types of meter as appropriate, the duty was cast upon the Council of taking steps to test and certify all meters supplied by undertakers to consumers other than those who, under special arrangements between themselves and the undertakers, were excluded from the operation of the orders as regards supply by meter. It was, however, pointed out to Sir Courtenay that no penalty was provided in the orders in the case of failure of companies to have their meters tested, and he stated that the Board would consider whether some penalty should be provided for by further legislation. The matter has since been the subject of communication between us and the Board of Trade, and by our direction suggestions for legislation with regard thereto were submitted to the Board last June. The Board has had these suggestions under consideration, with the result that it has, under date July 24, 1901, intimated that while in sympathy with the object in view, it is of opinion, having regard to the small number of meters (meaning types of meters) which have as yet been approved by it, that the time has not yet arrived for compulsory legislation. The Board states, further, that as the question is one which affects electricity supply generally, and not London alone, the expediency of the Council taking action in the matter appears to the Board to be doubtful; and that with regard to future electric lighting orders, the Board as at present advised would not be prepared to insert any special provision requiring the use only of certified and approved meters. We report the facts for the information of the Council, and regret that the Board of Trade is unable to see its way, at any rate for the present, to take any action with regard to the matter." Owing to the great increase in the number of electricity meters submitted to the Council to be tested, it has been found necessary, as a temporary measure, to arrange for a room at the electricity generating station on the Victoria-embankment to be used for this work. Additional plant for the purpose has been obtained at a cost of £166, and the authority given to the Highways Committee on June 25, 1901, for the employment of a temporary assistant at the electricity-meter generating testing station is to be extended for a further period. Notices under Electric Lighting Acts and Orders were approved as follows: Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Order, 1897, to lay mains along Vanbrugh park and fields, and high-tension mains along a portion of Shooter's-hill-road, and to construct a transformer box in that thoroughfare; Brompton and Kensington Electricity Supply Company, under the House-to-House Order, 1889, to lay mains of high and low tension along a portion of Fopstone-road and along a portion of Abingdon-road; Charing Cross and Strand Electricity Supply Corporation, under the company's Further Powers Act, 1900, to lay extra high-tension mains along Bow-road; County of London and Brush Provincial Electric Lighting Company, under the Camberwell Order, 1896, to lay low-tension mains along both sides of, and across, Winterbrook-road, and under the County of London (North) Order, 1892, to lay low-tension mains along both sides of Woodbridge-street, and under the Holborn and St. Giles Order, 1898 (No. 1), to lay mains of high and low tension along Eagle-street into the Southampton-row subway, and to lay low-tension mains along Southampton-row and High Holborn, also under the Wandsworth Order, 1892, to lay low-tension mains along both sides of Brandlehow-road and Skeghill-road, to lay mains of high and low tension across High-street and along Chelverton-road, and to construct a transformer box in Chelverton-road; Kensington and Knightsbridge Electric Lighting Company, under the company's order and the Kensington and Knightsbridge Electric Lighting Act, 1893, to lay mains along Queen's-gate-mews, from Queen's-gate-terrace; Lewisham and District Electric Supply Company, under the Lewisham District Order, 1901, to lay mains across Lewis-grove to the boundary of the parish of Lee; Metropolitan Electric Supply Company, under the West London Order, 1889, to lay low-tension mains along a portion of Great Titchfield-street, and under the Paddington Order, 1890, to lay high-tension mains along portions of Croxley-road and Macroom-road and along portions of Carlton-vale and Rudolph-road; Notting Hill Electric Lighting Company, under the Notting Hill Orders, 1889 and 1895, to lay mains along and across Holland Park-avenue and along Royal-crescent and Holland-road; Woolwich District Electric Light Company, under the Woolwich Order, 1891, to lay mains along Globe-lane, High-street, Woolwich, Ropeyard-rails, Beresford-square, Plumstead-road, New-road, Brookhill-road, and Sandy-hill; St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, to lay mains along Fitzroy-place and Grafton-road, along Gordon House-road and Mansfield-road, and Savernake-road, and along College-place, Charrington-street, Ossulston-street, Euston-road, Mabledon-place, King's-road, Great

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College-street, Kentish Town-road, Highgate-road, and Prince of Wales's-road, and along St. Paul's road and terrace, and along Bayham street and place and Midland-road, and along portions of Outer Circle (Regent's Park) and Gloucester-terrace; Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Order, 1897, to lay low-tension mains along a portion of Blackheath-hill and along a portion of Lee-park; County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, 1892, to lay low-tension mains along both sides of, and across, Lessar-avenue, Clapham Common. London Electric Supply Corporation has given a notice under its order of 1889 to lay high and low tension distributing mains along Belgrave-square, Wilton-crescent, Grosvenor-crescent, Chapel-street, and Upper Eccleston-street, and to construct underground converter chambers and inspection boxes. The receipt of notices served under orders granted to local authorities, and under which the Council has no power of approval or disapproval of works, was reported as follows: (*a*) from Messrs. Kennedy and Jenkin, on behalf of the Battersea Borough Council, under the Battersea Order, 1896, to lay mains along Bush-hill-road, Bridge-road West, and Surrey-lane; (*b*) from the Hammersmith Borough Council, under the Hammersmith Order, 1893, to lay mains along St. Paul's-crescent, Sussex-place, and Queen-street; (*c*) from the Hampstead Borough Council, under the Hampstead Order, 1893, to lay mains along Belsize lane and crescent, Agincourt-road, Fleet-road, Nassington-road, and Upper-terrace; (*d*) from the Islington Borough Council, under the Islington Order, 1893, to lay mains along Park-street; (*e*) from the same Council, under the same order to lay mains along York-road; (*f*) from the Poplar Borough Council, under the Poplar District Order, 1893, to lay mains along Abbott-road and Portree-street; (*g*) from the same Council, under the same order, to lay mains along Glengall-road, Manchester-road, and Westferry-road; (*h*) from the South London Electric Supply Corporation, under the Lambeth Order, 1892, to lay mains of high and low tension along both sides of Church-road, Crownstone-road, Trelawn-road, and Morval-road; (*i*) from the Stepney Borough Council, under the Whitechapel Order, 1892, to lay mains along Fieldgate-road; (*j*) from the same Council, under the same order, to lay mains along New-road, Whitechapel; and (*k*) from the Woolwich Borough Council, under the Plumstead Order, 1899, to lay mains along Plumstead-road, High-street, Plumstead, White Hart-road, and Sandy-hill-road.

PROVISIONAL PATENTS, 1901.

SEPT. 30.

19440. Automatic cut-out device for overhead trolley wires as used for electrical traction. Walter Halliwell, 34, Palm-street, Longsight, Manchester.

19445. A new or improved electric light numbering machine. Frederick John Borland and Tom Gerald Morton, Sheepscar-grove Works, Leeds.

19461. Improvements in transmitting and receiving apparatus for Hertzian waves. Eugène Ducrétet, 72, Cannon-street, London. (Complete specification.)

19462. Improvements in electromagnets. Eugène Ducrétet, 72, Cannon-street, London. (Complete specification.)

19509. Improvements in electric cables. Karl Tomas Bennet and Johan Thure Johansson, 18, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 29, 1901, being date of application in Sweden.) (Complete specification.)

19510. Improvement in electric cables. Karl Tomas Bennet and Johan Thure Johansson, 18, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 29, 1901, being date of application in Sweden.) (Complete specification.)

OCT. 1.

19512. Improvements in trolley apparatus for use in connection with electric traction. Walter Joseph Bosley and Robert Henry Dyer, Grant and Maddison's Bank-buildings, Canute-road, Southampton.

19515. Improved means for actuating telephone exchange indicators. Edgar Thompson, 4, St. Ann's-square, Manchester.

19538. Hermetically-closed underground conduit for electric tramways and the like, with motor-driven collector. Franz Janecek, 21, Heumarkt, Cologne, Germany. (Complete specification.)

19546. An improvement in the fittings of connection boxes for single, concentric, and triple-concentric electric cables. Charles Beckingsale, Albert Villa, Church-road, Epsom, Surrey.

19554. Improvements in overhead electric fittings. Paul Traugott Julius Estler, 52, Chancery-lane, London.

19588. Improvements in differential arc lamps. John Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Société Industrielle des Téléphones, France.)

19590. Improvements in or connected with the generation of power and with the conductors for electrical distribution. Kenric James McMullen and John Alexander McMullen, 323, High Holborn, London.

19604. Improvements in collectors for electric railways and tramways on the overhead conductor system. James George Willcox Aldridge, 40, Chancery-lane, London.

OCT. 2.

19657. Improvements in mechanism or devices for communicating step-by-step motions, for controlling, and for encasing and mounting electric switches. William Kingsland, 33, Chancery-lane, London.

19660. Safety apparatus for use on top-seat tramcars worked on the trolley system. Sidney Howe Short, Clun House, Surrey-street, Strand, London.

19686. Improvements in electric arc rupturing devices. Sidney Howe Short, 18, Southampton-buildings, Chancery-lane, London.

OCT. 3.

19702. Improvements in electrical switches. Alfred Horswill Gibbings, 15, Water-street, Liverpool.

19748. Improvements relating to electric meters. César René Loubery and Charles François Baudry, 45, Southampton buildings, Chancery-lane London.

19757. A new or improved method of controlling electric arc lamps. Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

19761. Improvements relating to underground conductors for telephones, telegraphs, or the like. Count Victor Somssich, 18, Buckingham-street, Strand, London. (Complete specification.)

19764. Improvements in dynamo-electric machines. Henry Metcalf Hobart, Bush-lane House, Cannon-street, London.

19770. Improvements in electrical demand indicators. Edward Dubois, 18, Southampton-buildings, Chancery-lane, London.

19772. Improvements in telephone exchange systems. The Thomson-Davis Telephone System, Limited, and Arthur Thomas Milnor Thomson, 22, Southampton-buildings, Chancery lane, London.

OCT. 4.

19793. Improvements in electric switches. Charles Potts and Phillip Charles Potts, 64, Barton-arcade, Manchester.

19795. Improvements in trolley heads for electrical overhead traction. Arthur Eustace Rooke and George Spencer, 128, Hope-street, Glasgow.

19797. Electric light extinguisher. Claude Hamilton Verity, Brentwood, Roundhay, Leeds.

19811. Improvements in apparatus for testing the insulation of electric cables and the like. Ernest Alexander Claremont, 4, Bloomsbury-square, London.

19818. Electric heating apparatus. Amalia Marie Klitz, 8B, Morgan-mansions, Highbury, London.

19828. Improvements relating to the track construction of electric railways operated on the conduit system. William Chapman, Westinghouse-building, Norfolk-street, Strand, London.

19829. Improvements relating to the track construction of electric railways or tramways operated on the conduit system. William Chapman, Westinghouse-building, Norfolk-street, Strand, London.

19846. Improvements in or connected with electric traction. Thomas Irwin Newton, 55, Chancery-lane, London.

OCT. 5.

19864. Improvements in or connected with the trolley wheels used in overhead electrical traction. Robert Lighton Ross, 5, John Dalton-street, Manchester.

19878. Improvements in electric meters. Henry Stafford Hatfield, 17, Powis-road, Brighton.

19900. Trolley wheel guide for electric tramcars and the like Walter Crookell, 9, Douglas-street, Higher Broughton, Salford, Lancs.

19928. An automatic device for controlling the power of motors of vehicles propelled electrically. William Edward Evans, 27, Chancery-lane, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 26.

1900.

18031. Telephone systems. Kellogg.

18281. Control of electric motors and similar devices from several different points and means therefor. Leonard.

19071. Electric generator with governing arrangements for ignition purposes on motorcars, engines, or stationary gas and oil engines and other purposes. Reid and Shepherd.

19395. Anti-vibration base frame for motors, dynamos, and other machinery. Middleton.

20800. Manufacture of a primer for producing ignition by electricity. Kändler.

21617. Electrical fuse distribution or switchboards. Zimdars.

21644. Systems of electrical distribution. Kent. (Date applied for under International Convention, May 1, 1900.)

1901.

1193. Coin-freed delivery apparatus for electric current. Haensel.

11925. Apparatus for connecting the ends of electric cables and the like. Lake. (Stillman.)

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13300. Manufacture of electrode plates of secondary electric batteries. Nodon. (Date applied for under International Convention, Dec. 1, 1900.)

13367. Electric furnaces for dental and other purposes. Winter and Pappenheim.

15909. Electrodes of electrical accumulators. James. (Heilmann.)

17027. Locks for electric motor controller handles. British Thomson-Houston Company, Limited. (Linn.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	—	—	—		—	—
Birmingham Tramways	Oct. 5	5,101	4,569	+ 535	180,221	— *b*
Birkenhead Corporation	—	—	—		—	—
Blackburn Corporation	,, 4	587	476	+ 111	20,153	18,031*b*
Blackpool Corporation	,, 3	1,146	673	+ 473	33,745	25,146
Blackpool-Fleetwood Tramways	,, 5	664	408	+ 256	18,541	18,071*b*
Bolton Corporation	,, 6	1,466	1,348	+ 118	58,450	47,112*b*
Bradford Corporation	—	—	—		—	—
Bristol Tramways Company	,, 4	4,289	3,305	+ 984	—	—
Carlisle Tramways Company	,, 5	172	176	- 4	2,907*b*	2,827
Central London Railway	,, 5	6,152	5,103	+ 1,049	80,144	—
City and South London Railway	,, 6	2,031	1,616	+ 415	26,239	21,237
Cork E. T. and L. Company	,, 3	465	458	+ 7	18,803	16,625*b*
Darwen Corporation	,, 4	212	166	+ 46	7,485	6,080
Dover Corporation	,, 5	244	224	+ 20	8,914	8,458*b*
Dublin & Lucan Electric Railway	,, 6	106	102	+ 4	1,895	1,634
Dublin U. T., electric cars	,, 4	3,722	3,623	+ 99	—	—
Dublin S. District, Electric	,, 4	834	836	- 2	—	—
Dundee Tramways Company	—	—	—		—	—
Glasgow Corporation	,, 5	13,184	9,441	+ 3,743	—	—
Halifax Corporation*	—	—	—		—	—
Huddersfield Corporation	Sept. 21	958	653	+ 305	24,053	15,533
Hull Corporation, E. S.	Oct. 5	1,670	1,276	+ 394	24,109	18,510
Liverpool Corporation	Sept. 28	9,954	8,901	+ 1,053	349,854	306,166*b*
Liverpool Overhead Railway	Oct. 6	1,440	1,592	- 152	23,560	24,272
Oldham-Ashton-Hyde Tramways	—	—	—		—	— *b*
Portsmouth Corporation	,, 5	1,278	—		—	—
Potteries Tramways	—	—	—		—	—
St. Helens Tramways	—	—	—		—	—
Sheffield Corporation	,, 6	3,692	—		—	—
Southampton Corporation	,, 3	992	693	+ 299	—	—
Southport Corporation	—	—	—		— *d*	—
Swansea Tramways	—	—	—		—	—
Wolverhampton Corporation	—	—	—		—	—

* Fortnightly. *b* From Jan. 1. *d* From April 1. 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £157 decrease.
Barcelona Ensanche y Gracia, £29 decrease. Barcelona, £167 increase.
Brisbane, £419 decrease.
Buenos Ayres and Belgrano Electric, £624 increase; (month of Sept.) £1,870 increase.
Calcutta, £134 increase.
Cape Town (month of Aug.), receipts, £14,799; expenditure, £7,009.
Manchester Corporation (Sept. 21), £2,127.
Mexico Electric (month of Aug.), receipts, £17,900; expenditure, £10,800.
Perth Electric, £219 increase.
Port Elizabeth (month of Aug.), receipts, £3,151; expenditure, £1,844.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅞-¼
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	9 16-11/16
—— Ordinary, 1-125,000	1 ..	⅜-½
British Electric Works, Ordinary, 50,001-95,000	1 ..	1 15-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6¾
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4¾-5½
Brush Electrical Engineering, Ordinary	2 ..	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2½
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	15-16
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	3-3½
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	1-1½
—— 5 per cent. Debentures	5 ..	1½-2½
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84 89 xd
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	97-100 xd
W. T. Henley's Telegraph Works, Ordinary	5 ..	16¼-17½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	22-23
—— 4 per cent. Debentures	100 ..	100-103 xd
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref.	5 ..	5½-6½ xd
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	95-100 xd
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	7¾-8¼
—— 7 per cent. Preference	5 ..	8¼-8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7½-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14¼ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5½-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	5¼-5¾
—— 40,501-50,936	5 ..	5-5½ xd
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	11½-12½
—— 5 per cent. Debenture Stock	100 ..	122-124
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	104-107
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¾-6¼
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ltd., 6 p.c. Cm. Pf., 1-20,000	5 ..	4½-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7½-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	101-104 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1¾
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	112-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15½-16½
Oriental, 1879	1 ..	1¼-1¾
—— £5 Shares	5 ..	7¼-8¼
—— £4½ Shares, New	4½ ..	7-7½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5¼-6¼
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-102 xd
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11¼-12½
Electric Railways.—		
Central London, Ordinary	100 ..	101-104
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	98-101
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	51-54
—— Ordinary	10 ..	5-5¼ xd
—— 4 per cent. Debenture Stock	100 ..	113-118
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4-4¼ xd
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-128
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2½-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6-6¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	101-103 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14-15
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11¾-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	121-124 xd
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅛-2⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5¾ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5¾
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
—— Prov. Cert., all paid	100 ..	100-103
Cape Electric Tramways, Nos. 1-400,000	1 ..	1¼-1¾
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5¼-5¾
—— 4 per cent. 1st Mortgage Debentures	100 ..	103-106
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100 xd
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	105-107
New General Traction, Ordinary	5 ..	2¼-3½
—— 6 per cent. Cum. Pref.	10 ..	4-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11¼-12½
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-10¼
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £230,000 Ordinary	1 ..	1
—— £51,152 6 per cent. Preference	8s. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	4-4¼
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¾-5
—— 4 per cent. Deb. Stock, Red.	100 ..	96-99
—— 3½ per cent. Deb. Stock, Red.	100 ..	95-98
Oriental Telephone and Electric Company	1 ..	¾-1

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NOTES.

The Institution of Electrical Engineers.—We are informed that the opening meeting of the session for the presentation of premiums and the presidential address will be on Thursday, Nov. 21, instead of on Nov. 14.

The Osiris Prize.—The first award of the Osiris prize in 1903 will, we understand, be made by the French Institute. This prize is awarded to one who in the preceding three years accomplishes the most important work for science, industry, or literature, and is worth over £4,000.

Glasgow Local Section.—Mr. E. George Tidd, the local hon. secretary, informs us that at a committee meeting of this section of the Institution of Electrical Engineers, held on Friday last, it was decided that the section should meet on the second Tuesdays in the months from December to May in the coming winter session, but that the November meeting should be on the third Tuesday, so as not to clash with the closing days of the exhibition.

Mechanical Engineers.—Mr. Edgar Worthington, secretary of the Institution of Mechanical Engineers, informs us that the opening meeting of the coming session of the society will be held this (Friday) evening in the institution's house, Storey's-gate. The chair will be taken at eight o'clock, and after the routine business of the meeting has been disposed of, Prof. F. W. Burstall, Birmingham, will present a "Second Report to the Gas-Engine Research Committee" for discussion.

Electric Lighting in Simla.—Some time ago it was decided to establish works for electric lighting and power for Simla, in India, and several schemes were submitted for carrying this decision into effect. Mr. Mears an engineer of repute, was consulted, and he has recently issued his report, wherein he recommends that the Nautikhad scheme is the most promising. If economically worked, he thinks there should be a small profit ultimately. Within about 10 miles of the town water power is available sufficient to provide some 450 h.p., which Mr. Mears considers would be sufficient for the purposes indicated.

Technical Education in London.—The *London Technical Education Gazette* for September and October gives a list of the principal evening classes (other than the classes of the School Board for London) that are being conducted in London during the session 1901-2. We note that there are no less than 13 institutions in the Metropolis holding evening classes in electrical engineering, which in nine cases include laboratory work. For the study of chemistry evening classes are being held by 22 institutions in London, while for mechanical engineering students have the choice of 23 institutions, and for civil and municipal engineering only six.

The Proposed Brighton Electric Express.—We have received from Mr. F. H. Cheesewright, the engineer to the proposed electric railway from London to Brighton, a map which shows approximately the route of the line. The map, however, is of too small a scale to do more than generally indicate the proposed position of the line in relation to the present railway routes between the two places. We note that Mr. Cheesewright has not adopted the practice laid down by the American railway expert when drawing a map, of using only a ruler to draw a straight line and making all the curves in the surrounding country. Still, the curves which are shown would seem to be of a wide radius. We see that it is likely that the scheme will meet with great opposition when before Parliament, as is only to be expected, in view of the way it conflicts with existing railway interests.

Tests with the Ganz System.—Preliminary trials recently carried out on the Valtellina-Colico-Sondrio electric railway in Italy, which is equipped with the Ganz system, are reported to have given every satisfaction. The result of the tests, it is said, is to show that the installation is capable of driving a train of five cars at a speed of 44·7 miles an hour, and of maintaining this speed even on the up grades, which are fairly steep. It was also proved that the generators supplied their 21,000 volts without trouble. The starting of the train is gradual on the descent of inclines of 14 per cent., and the decrease of the load on the central station is very apparent. The practice is to partly close the gates which admit the water to the turbines until the motors are taking their normal current again.

Wireless Steering of Torpedoes.—Some further experiments concerning the steering of torpedoes without the use of wires are, we hear, shortly to be conducted with the Orling-Armstrong discoveries in low-tension electricity. From time to time practical demonstrations have been made in Sweden in connection with the inventions of Mr. Axel Orling and Mr. Tarbotton Armstrong, but up to the present we do not know that these have had any very gratifying results. It is anticipated, however, that the new experiments which are shortly to take place, will have important results on the subject of the wireless steering of torpedoes. With a view to its adoption on board ship, a demonstration of wireless transmission of sound by means of telephones and conduction currents through water on the Lindsay method will also be made at the same time.

Electric Cranes and Capstans.—We understand from our French contemporary *L'Electricien* that an exhibition of electric cranes and capstans is shortly to be held in Boulogne, in view of the adoption of such electrical accessories for the docks of that port. All persons who wish to take part in this question ought to write to Mr. Thanneur, at No. 3, Boulevard de Chatillon, Boulogne-sur-Mer. We think that our contemporary must be edited by an Irishman, in view of the fact that the information given above is taken from their issue of Oct. 12, while all applications are said to be due before Sept. 1, 1901. If this condition be absolute, it will be no use for our English readers to apply, but we should think there is a printer's error somewhere. The date at which the competition is to take place, and the conditions of the same, will be fixed after the number of exhibitors has been ascertained.

Rights of Rival Companies.—Of great importance to electrical companies and contractors going in for Canadian electrical undertakings is a decision recently handed down by Mr. Justice Andrews in the Superior Court of Quebec. The suit was brought by the Quebec Railway, Light, and Power Company against the Jacques Cartier Water Power Company to recover for damage to the former company's property and business from the defendants' poles and wires. The plaintiffs also asked for an injunction compelling the defendants to remove the same. The judgment, of which as yet we have only seen the briefest report, is in the plaintiffs' favour, and is based on the principle that they having been first established, the defendant company is not entitled to cross their wires at any place or height. In view of the far-reaching importance of this decision an appeal to a higher court has been lodged, and we should think that the appeal will be sustained.

Electricity and Gas Commission.—A technical commission has been appointed by the Prefect de la Seine in order to enquire into and report to the Municipal Council of Paris on the various questions which will be brought before it relative to the future control of gas and electricity

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in Paris. The names of the gentlemen forming this commission have now been published in our contemporary, *L'Industrie Electrique*. They are 19 in number, which seems to us to be rather a large commission. The names, however, are such as command respect, and include representatives of the largest gas and water companies in France, a good many professors, a number of municipal councillors, and, lastly, some expert inspectors. We fail, however, to find in the whole list the names of any representatives of the electric lighting undertakings of Paris. This seems to us to be a great mistake, in view of the fact that the gas companies have representatives on the commission. Perhaps this error will be rectified before the commission sits.

Sunderland Technical College.—This institution, which is still in its first year, having only very recently been established, is, we are pleased to note, proving very popular in the Sunderland district, so much so, indeed, that authority has just been given to the Technical Education Committee of the Corporation to incur more expenditure for additional equipment and staff, and to make certain necessary appointments in connection with the new college. It appears that the original estimate of working expenditure was based on the assumption that there would be 200 or 250 students during the first year. Already, however, there are as many as 650 students entered, and it has accordingly been found necessary to augment the equipment and staff of the college. In some sense, no doubt, this unforeseen influx of students may be attributed to novelty, but it is confidently expected by the officials of the college that a permanent establishment of 400 to 500 students may be relied upon. In this case, therefore, the proposed additional expenditure is fully warranted.

Awards for Civil Engineers.—The council of the Institution of Civil Engineers have, we are informed, in addition to the medals and prizes given for communications discussed at the meetings of the institution in the last session, made the following awards in respect of other papers dealt with in 1900-1901: a Telford medal and a Telford premium to Reginald Pelham Bolton (New York); a Watt medal and a Telford premium to J. Emerson Dowson (London); a George Stephenson medal and a Telford premium to W. T. C. Beckett (Calcutta); a Manby premium to E. K. Scott (London); a Trevithick premium to T. A. Hearson, R.N. (London); a Telford premium to J. A. W. Peacock (Tantah, Lower Egypt). For students' papers the awards are: a Miller scholarship (tenable for three years) and the "James Forrest" medal to E. V. Clark, B.Sc. (London); Miller prizes to C. E. Inglis, B.A. (London), H. E. Wimperis, B.A. (Cambridge), J. L. Cridlan (London), F. K. Peach (London), G. H. Whigham (Glasgow), F. Taylor, B.A. (Manchester), A. C. Walsh (Newcastle-on-Tyne), and H. O. Jones (Manchester).

A Marconi Rival.—What are claimed to be two distinct improvements upon the Marconi system of wireless telegraphy are the inventions of Mr. F. J. Gross, of the Wireless Telegraphy Company of Honolulu, H.I The inventor, indeed, goes so far as to assert that his improvements will result in a virtual transformation of the Marconi system. We understand from the *Western Electrician* that the first of these devices consists of an attachment for automatically transferring the received electrical impulses to an ordinary telegraph wire and conveying them to a Morse instrument. An apparatus of this kind is now in operation between the Waialu telegraph station and Honolulu, thus doing away with the necessity of telegraphing or telephoning the messages received at the station to the city. The other improvement referred to relates to the arrangement and operation of the coherers. The inventor claims to have perfected an automatic device for de-cohering the metal filings in a better way than that adopted by Mr. Marconi in his system of wireless telegraphy. Seeing the big things claimed for Mr. Gross's inventions, it would be instructive to consider the details, but up to the present it seems he has not thought fit to make them public. Nor is it stated in the note in our contemporary whether or not the inventions are protected by letters patent.

Manchester Engineers.—We learn that from an electrical engineer's point of view the winter meetings of the Manchester Association of Engineers, the first of which was held on Saturday last, are likely to prove of considerable interest. The syllabus for the new session includes several papers on electrical matters, which are expected to arouse some instructive discussions. Among the most important of these may be mentioned "Efficiencies of Electric Cranes," by Mr. R. Matthews, which is expected to furnish some valuable information with regard to a branch of workshop equipment that has of late years come so prominently to the front. Other papers include "American *v.* English Methods of Conducting Engineering Establishments," by Mr. Edward Wood; "Electric Welding," by Mr. T. T. Heaton; and "Workshop Management," by Mr. A. P. Loscher. It is arranged that the president of the association shall deliver his inaugural address on Jan. 10, and the annual dinner is fixed for the 25th of that month. On the occasion of the opening meeting of the winter session on Saturday, visits to the works of Messrs. Ferranti, Limited, Hollinwood, and the electric light station of the Manchester Corporation were made in the afternoon. This was followed by tea at the Grand Hotel, after which the subject of "Engines for Driving Large Dynamos" was ably dealt with in a paper by Mr. Chas. Day.

Railway Locomotive Headlights.—So far the use of electricity for the headlights of the locomotives on our steam railways has not been seriously undertaken in this country, although the question has received considerable attention in the States. The necessity for a better headlight than that obtained from oil has evolved the electric and acetylene lamp. It appears from a report just published in America by the committee of the Travelling Engineers' Association that the arc light is commonly used over there on some of the railway systems. The committee are unable to give any accurate data as to comparative figures of the cost of maintenance as between oil and other types of improved lights, but admitting that the first cost and maintenance of the improved light to be most expensive, they believe that it is still the most economical, owing to the additional safety provided. With the electric headlight, the most trouble experienced has been due to short-circuits in the armature. In regard to the brilliancy of the electric headlights, photometer tests made by two different technical schools give the electric 125 times stronger than the oil headlight. The actual measurements showed that a newspaper can be plainly read by a person three-quarters of a mile from the headlight, and a milepost, telegraph pole, or crossing fence can be plainly seen from 20 to 28 poles ahead by the enginemen. A number of locomotives are now also being equipped with incandescent lamps for various purposes inside the cab.

Development of Wireless Telegraphy.—In its "Science Notes" for the 14th inst. the *Daily Telegraph* makes the brief announcement that Mr. Marconi has now succeeded in transmitting readable signals nearly 350 miles, including 100 miles overland, with wireless telegraphy. It is a pity that no details of this feat are given, for, if true, it is decidedly the record distance yet attained. We suspect that the "100 miles overland" were by ordinary

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telegraphs, and that the remaining 250 miles were bridged by wireless telegraphy between an Atlantic liner fitted with the Marconi system and the station on Nantucket Island, off the American coast. But it can only be hoped to achieve even this distance under the most favourable conditions. It is also recorded that on Tuesday night last week the liners "Lucania" and "Campania" were in wireless communication in mid-ocean, when over 140 miles apart. This is believed to be the record in mid-ocean communication. The *Daily Telegraph* further reports that an arrangement has been completed with Lloyd's which will make all their stations receiving and transmitting agencies, and as the great steamship lines are adopting the new system, the passengers on some of the longest routes—to India and Australia, for example—will hardly ever be out of touch of land. Again, we gather that a number of wireless telegraphy companies are being organised in America, where there is no State or other monopoly in telegraphs to hinder them competing with the existing lines.

Selective Signalling on Telephone Lines.—In the current number of the *American Electrician* we notice an illustrated description of the selective signalling system for telephone party lines, which the Metropolitan Telephone and Electric Company of Chicago have adopted. The illustrations show how four subscribers, all using the same pair of speaking-line wires, can be individually rung up without disturbing the other three subscribers. All four subscribers are first of all split up into two groups by using earth as the return for the ringing circuit—*i.e.*, two subscribers are connected to each of the speaking-line wires. The distinction in ringing between the two subscribers on any one line wire is made by altering the frequency of the current used in signalling. The bells and the ringing circuits are so designed that while a 26-cycle current will ring one bell, it will not ring the other, and the reverse takes place if a 16-cycle current is used. The principle used in obtaining this result is the employment of two circuits on each of the bell magnets. Condensers are used in series with the one circuit, and the adjustment is so made that in the second bell, for instance, the current is divided equally between the two windings if it is of 26 frequency. As the result, the bell does not ring with this frequency of current. The balancing of the capacity and inductance is, however, altered if the frequency is dropped to 16 cycles, and at that frequency the bell rings freely owing to the current in one circuit predominating. We gather from our contemporary that the apparatus is actually working in practice and with success.

Three-Phase Railways.—We notice in *L'Industrie Electrique* an interesting letter from the well-known firm of Messrs. Brown, Boveri, and Co., of Baden, as to the dates on which three-phase tramways and railways were first used on the Continent. The correspondence arises out of a statement in an article of our contemporary, that the Jungfrau was the first line to be worked by means of three-phase currents. The list, which is well worthy of reproduction, reads as follows: The three-phase equipment for the tramways of Lugano was ordered from the firm in February, 1895, and the line was opened on June 1, 1896. The Zermatt-Gornergrat railway, which is of the rack type and about 5½ miles long, was ordered in April, 1896, and opened on Aug. 28, 1898. The Stanstad-Engelberg railway which is partly rack and partly ordinary rail, was ordered in January, 1897, and opened on Oct. 5, 1898. This line is 13 miles long. The Jungfrau line, which was the one referred to by our contemporary in its article, had its first section inaugurated on Sept. 20, 1898, the equipment having been ordered in April, 1897. The firm also mention the Berthoud-Thoune, which is an ordinary railway 25 miles in length. The equipment for this line was ordered in April, 1897, and the railway was opened on July 22, 1899. As Messrs. Brown and Boveri point out, the use of three-phase equipment on the Jungfrau railway was influenced by the example of the Gornergrat line. The directors of the company working this latter railway looked most thoroughly into the various systems, and accepted the firm's proposals for the use of three-phase currents, although all the other firms tendering for the work suggested the employment of continuous currents.

Street Excavations.—In a recent issue of the *Times* a letter appeared which complains of the way in which the Charing Cross and City Electric Company's mains are being laid, and of the great inconvenience which the laying of these mains is causing in all parts of the City. The writer of the article does not sign his name, and evidently is not an an engineer. Also he does not understand the subject on which he writes, as he suggests that the company are only laying one main down each street, whereas in all the streets we have seen they have opened up both sides of the street for their distributing mains. In consequence of this it will not be necessary to reopen the whole width of the street every time a consumer has to be connected. It is much too late to look to the Corporation of London to prevent the inconvenience complained of. When the negotiations on the question of the admission of a new company into the City were under weigh, we repeatedly warned the Corporation of the enormous damage that would be done if a new system of mains were laid under the already crowded footways. The direct loss of time caused is worth much more than the cost of the work actually done, and we are sure that if at that time the Corporation had taken the bold course of acquiring the undertaking of the City of London Electric Lighting Company, and hence avoiding the present complication, it would have been a wise step financially for all concerned. As regards the position of the new company's mains, there is unfortunately no choice. The footways are already completely occupied in most of the London streets, and the space near the kerb line seems to be the only available ground in which to lay the new cables. This, of course, causes great inconvenience, but is quite unavoidable.

Small Screw Gauges.—The British Association's report of the Screw Gauge Committee working under Section G was duly issued for last year to the Glasgow meeting. The committee have not advanced matters to any extent since the Bradford report, in which the following alterations in screw gauges for instrument makers were suggested. These were that for screws the designating numbers, pitches, outside diameters, and the common angle of 47½deg. remain unchanged; but that the top and bottom of the thread shall be cylindrical, showing flats in section, and that the depth of the thread shall be increased by one-tenth of the pitch, the diameter of the solid core being in consequence diminished by one-fifth of the pitch; and that for nuts the designating numbers, the pitches, the diameters of the clear holes, and the common angle of 47½deg. remain unchanged, but that the top and bottom of the thread shall be cylindrical, showing flats in section, and that the depth of the thread shall be increased by one-tenth of the pitch. The committee learn that one firm of manufacturers of screws in England is occupied in producing screw gauges for their own use, which may ultimately be submitted to the committee. As the result of correspondence between the committee and Dr. R. T. Glazebrook, the director of the National Physical Laboratory, arrangements have been made that all screw gauges submitted by the British

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Association will be examined and reported upon in that laboratory. The committee have accordingly used the grant of £45 made at Bradford for the purchase of apparatus for the National Physical Laboratory, and have appointed Mr. C. V. Boys, Lieut.-Colonel Crompton, Dr. R. T. Glazebrook, Mr. W. A. Price, and Colonel Watkin to be a sub-committee for the expenditure of the grant. The other new members of the committee are Mr. O. P. Clements and Mr. W. Taylor.

Tramways in India.—The Bombay Corporation have scored a complete success over the local tramways company as to the purchase of the undertaking. The controversy, it may be recollected, arose out of the objection of the company to the Corporation transferring the administration of the tramways to a third party after purchase. Judge Fulton, of the Bombay High Court, however, has decided the point in favour of the Municipality, and also the second count as to whether the interest paid by the company in respect of debentures ought to be deducted from the gross receipts in arriving at the average profits. While on this subject we may refer to a leading article in our contemporary *Indian Engineering*, in which the editor reviews the situation in India in relation to electric traction. We gather from this that Messrs. Dick, Kerr, and Co. and the English Electrical Manufacturing Company have been entrusted with the construction of the new electrical system of Calcutta, and that these firms have also secured a concession at Hong Kong for the construction of electric tramways in the port. At present the Municipal Corporation of Singapore have before them an application from the same firms for a similar concession. The concessionaires ask for a 50 years' lease, in return for which they undertake to build the tramway and maintain it without any pecuniary assistance from the Municipality. Our contemporary winds up its leading article with the assertion that the East is not yet prepared to adopt the principle of municipal control as regards electric tramways, for this reason: In India and in the Crown Colonies, the European population, from which would be drawn the technical talent required to work a concern like an electric tramway, is migratory. Europeans have not yet begun to settle and colonise these places in any large numbers, and without a strong European element always available and well equipped with local knowledge and influence, no Oriental municipality could be trusted to run such a concern as a tramway, at least not with any confidence of success. A well-considered concession to a thoroughly good firm, who are above the suspicion of mere speculative exploitation, seems therefore to be the simplest and wisest course to adopt.

Electric Interlocking in the States. — An important electric interlocking installation, which was recently introduced at the crossing of several railway tracks in Chicago, is described in the *Railway and Engineering Review*. The importance of the new arrangement may be gathered from the fact that the plant controls the movement of about 850 regular trains daily. A remarkable feature of the installation is the unusual distance between the limits of the interlocking, the same being 6,200ft. between the farthest distant signals operated from the interlocking tower. In this system both the switches and signals are operated by electric motors, which are worked on 110-volt circuits supplied from storage batteries, of which there are two sets of 55 cells each, having a capacity of 150 ampere-hours each. From these batteries is also obtained current for the electric signal lamps, each lamp being lighted by a 4-c.p. incandescent globe. The batteries are located in the first storey of the interlocking tower, and are charged by two 2-kw. dynamos in a small building near the tower. A 5-h.p. gasoline engine drives each dynamo. The capacity of each engine and dynamo is sufficient to furnish all the current required to charge the batteries and light the signal and switch lamps, and the switchboard is so wired that either of the generators may be put in connection for charging either of the batteries, or either of the generators may be put in connection with the interlocking machine for the operation of the switch and signal motors direct. The charging of the plant requires but little attention, and is run and looked after by the tower man or signal repair man. Our contemporary goes on to describe the manner of connecting the circuits of the switch and signal motors with the interlocking machine, together with details of the interlocking action, and the operation of the switch and signal motors of the Taylor electric interlocking system. Briefly, it may be stated that the interlocking machine consists of levers interlocked mechanically on a vertical board in the ordinary manner of cross-locking. Each lever is connected with a circuit closer for operating the switch or signal motor, as the case may be, and the movement of the lever is controlled by a latch operated by an electromagnet on the indication circuit. Each signal is operated by a motor of about 1 h.p. to 6 h.p. The signal is counterweighted to normal, and is brought to the clear position by a chain, which is wound up by the motor and made to lift the weighted end of the balance lever which pushes up the signal rod. The signal is returned to the danger position by de-energising the brake magnet, which permits the counterweight to act upon the blade by gravity. The conducting wires of the switch and signal circuits are carried in wooden trunking on stakes set about 8ft. apart just above the surface of the ground.

Electrical Gold-Mining Plant. — Prof. Wilber Colvin, LL.D., in the *Scientific American* describes a gold-mining plant which has just been put down by the Crown Mountain Gold-Mining Company, of Dahlonega, Ga., and in which electricity is the motive power throughout. The entire installation consists of the power plant for generating the electricity, and a pump station, a large stamp mill, and a mill fitted with Huntingdon mills, concentrators, Giant hydraulics, flume lines, tramcars and tracks, motors, and other appurtenances. The chief interest in the installation, which is very similar to other electrical gold-mining plants in America, lies in the manner of obtaining the water for washing the ore from the mountain side and for sluicing it down to the mills. Supply is obtained by elevating water from the Chestatee River through a 12in. iron pipe, 4,400ft. long, to a reservoir on the side of Crown Mountain, 560ft. above the river. The pump station is located on the bank of the Chestatee River. The pump is a large Deane triplex, and is operated by a Westinghouse 300-h.p. two-phase induction motor, constant speed, connected by steel cut gearing to the pump, the reduction being 20 to 1. From the reservoir on the mountain side the water is brought down to the mines through 6in. pipes to four Giant hydraulics with from 1¼in. to 2½in. nozzles. The above seems to us to be a somewhat unnecessary and roundabout arrangement for obtaining a supply of water from the river. Nothing is to be gained by first pumping the water up the mountain into a reservoir, unless, indeed, it be to keep a reserve. But for this we cannot see the need, and the more simple and less expensive course would have been to have pumped the water direct from the riverside to the nozzles. Several hundred feet of piping and the cost of the reservoir and maintenance would thus have been saved, and the same object achieved. Water power is used for driving the power plant, which is located on the Chestatee River, about 12 miles from the mills. The waters of three mountain

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streams are united by two canals, each about two miles long, but no dams are required. A fall of 97ft. is secured. From the bulkhead of the canal a wooden tube 5ft. in diameter conveys the water to the wheel—a Stillwell-Bierce, Victor type, capacity 800 h.p. The generator is a Westinghouse two-phase, 500-kw., 440 volts, direct connection on the water-wheel shaft, excited by a 7½-kw. 110-volt exciter. The speed of the wheel and dynamo is 514 revolutions per minute, delivering 568 amperes per phase. The current is generated at 440 volts, transformed to 12,000, three phase, and transmitted over three No. 6 wires 12 miles to the mills and 13 miles to the pumping station, and at both the mills and the pumping station it is again transformed to two phase, 400 volts, at which pressure it is used on all the motors. The entire plant is now in operation, and is working perfectly in every detail.

A Telegraph Veteran.—The current number of the *St. Martin's-le-Grand* —which, we find, is a very readable little magazine published quarterly contains some exceedingly interesting information relating to men and matters in connection with the postal and telegraph services of the United Kingdom. Thus the number opens with a lengthy article by Sir W. H. Preece on "Telegraphy in the Nineteenth Century," which treats thoroughly of the progress of the telegraph in this country in the last century. In another part of the periodical we see announced the death, at the great age of 83, of Mr. Richard Spelman Culley, one time engineer-in-chief to the Post Office. The deceased gentleman, who was probably the last remaining link between the very early telegraph days and the present time, died at Weston-super-Mare last month. He had been pensioned for nearly a quarter of a century, and his name must have dropped out of the recollection of all but a very few present-day telegraph men. The late Mr. Culley was, nevertheless, a man of considerable note in his day, and deserves to be remembered as the first engineer-in-chief of the Post Office telegraph system. Mr. Culley was born at Norwich in 1818, and after spending a short time in the service of the Midland Railway Company, and with Messrs. Cooke and Wheatstone, the co-inventors of the first electric telegraph, he entered the service of the late Electric Telegraph Company in 1846, the year in which the company was incorporated. He was first employed at Manchester under District Superintendent Barchard, and then transferred to the Scottish District, with headquarters at Edinburgh, in succession to Mr. Robert Rule, who shared the superintendence of the district with Mr. R. W. Davidson. This would be about 1856, and a few years later he was transferred to the Western District of England, with headquarters at Bristol. In or about 1865 he was further transferred to London as engineer of the company, in succession to Cromwell Fleetwood Varley, certainly the ablest electrician of his time; and in 1870, when the telegraphs were transferred to the State, he became engineer-in-chief to the Post Office, and a most valuable coadjutor of Mr. Scudamore in his reorganisation of the system. He was always a delicate man, and he was compelled through ill-health to retire from his great office in 1878, when he was succeeded by Mr. Edward Graves, who, however, pre-deceased him by several years. Mr. Culley was not exactly a scientist, but he was a most able, practical electrician, and his "Handbook of Practical Telegraphy," which has passed through many editions, and been translated into several languages, is worth a bushel of merely scientific treatises on the subject. He took a great interest in the development and improvement of the Wheatstone fast-speed apparatus, and with the assistance of Mr. David Lumsden, who followed him from Edinburgh to Bristol and from Bristol to London, he introduced many improvements in the system, which met with practical recognition at the hands of the distinguished inventor. He was a very reserved, retiring sort of man, which might have given the impression that he was not a vigorous administrator; but he had a mind of his own, and a very terse and emphatic way of expressing it, and he was always perfectly honest and sincere in everything he either said or did.

The Proposed American-Philippine Cable.—According to the latest dispatches from New York, no definite action has yet been taken by the United States Government with regard to the application of the Pacific Commercial Cable Company for authority to lay a cable between the United States and the Philippine Islands. The matter, it may be stated, is one which concerns England much more closely than is generally appreciated. As is well known, an English company holds to-day an exclusive franchise for cable connections with the Philippines which was granted by the Spanish Government in 1898. Mr. Knox, the American Attorney-General, has advised President Roosevelt that this franchise will not hold, and in support of his opinion he cited "the recent action of the Transvaal Concessions Commission, which held that concessions granted by the Boer Government in the Transvaal should not be recognised by Great Britain." To those who know anything at all about the matter, it must be apparent at once that this statement is incorrect. As a matter of fact, we believe we are correct in saying that the work of the Commission is still going on upon the basis that only concessions granted by the late Boer Government which are found to have been the result of bribery and corruption and to be prejudicial to British interests, will be declared void and inoperative. Taking, for instance, the gold and diamond mines in the Transvaal, where these have been operated under Boer concessions they have not been interfered with by us, and pending the final decision of the Concessions Commission, such franchises will receive due recognition by the British Government. The authority upon which Mr. Knox advised the President of the United States is, therefore, no authority at all, and in the case of the proposed Philippine cable, we think it would be most unfair if the United States Government grant the American cable company the concession asked for. Great Britain having been granted an exclusive franchise by Spain, it should be properly respected by the United States. Any competition at the present time with the English company would be most unjust, having regard to the fact that British capital has been sunk in it, and it requires that the line shall be in successful operation for some few years after its inception before it can be safely counted a profit-making concern. Before giving its decision with regard to the proposed American cable, the United States Government will, on the advice of the Attorney-General, sound the company as to their intentions after the completion of the cable to the Philippines. It is deemed desirable to know whether the company would extend its own line to China or make some arrangement with the English company, which already has a cable between Hong Kong and Manila. Mr. Knox, it is said, regarded it as very important that there should be a complete line from the United States to Asia *via* the Philippines, as in case of war it might be necessary for the United States not only to control a cable to the Philippines, but also one to China, or elsewhere in Asia. From the general tenor of the messages received from across the Atlantic, it seems that the United States Government are likely to grant the concession asked for. In such a case we should think some firm action on the part of our Government would be called for.

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LONGTON ELECTRICITY WORKS.

In the year 1877 the Longton Corporation bought up the gas undertaking, which at that time belonged to a private company, and although the investment has been profitable to the town, there is no doubt but that the price paid for it was abnormally high. In 1897 notices were received from two companies of their intention to apply for provisional orders authorising them to supply electricity within the borough of Longton. Upon receipt of these notices a sub-committee was appointed from the Council to consider the question of the provision of electric light and the promotion of a provisional order authorising the Council to supply the same. Mr. R. Hammond was consulted as to the desirability and cost of a plant suitable for the necessities of the town, and, reporting favourably on the prospects of the undertaking, he gave an estimate of cost, and suggested a site for the plant near the gasworks. For obvious reasons the Corporation at once determined not to allow another company to become purveyors of the light, but decided to apply to Parliament for a provisional order to enable them to provide their own electric lighting installation. The provisional order was accordingly granted in 1899, the compulsory area comprising Church-street, Market-street, Commerce-street, Stafford-street, Trentham-road (as far as the corner of Rosslyn-road), Rosslyn-road to Stone-road, and back to corner of Trentham-road. The usual powers were also granted for extensions beyond the compulsory area when demanded. The Gas Committee was henceforth constituted the Gas and Electric Lighting Committee, and it was thought desirable to select (if possible) a site for the new electric lighting station at the gasworks in order that the whole of the Corporation lighting undertakings might be under one committee and one engineer.

In designing an electric light works, a suitable site is of the utmost importance, not only as regards foundations, but also for adaptability to all future probable requirements. After making careful surveys, it was found that the site occupied by gas fittings, workshops, and stores (Fig. 1) would, by alteration, form a suitable building for generating and battery rooms, leaving ample space for extensions eastward, and that there was sufficient land adjoining northwards for the erection of a boiler-house and chimney shaft for steam requirements up to 1,000 h.p. This was the only available and convenient position for the electric light works, and the adoption of this site necessitated the building of new workshops and stores, a site for which was chosen at the north-west corner of the gasworks boundary. Plans and specifications were accordingly prepared and tenders invited for the buildings, and ultimately it was decided to accept the tender from Mr. R. Goodwin Longton for the building of workshops, and that of the late Mr. T. Bromage for chimney shaft and boiler-house. The latter building is 48ft. by 48ft., and is so designed that the floor of the boiler-house is about 8ft. below the engine-room floor and yard frontage, thus giving every facility for tipping coal into bunkers and minimising the evil of the boilers priming. The roof is of steel, and was made for the contractors by Messrs. Teggin, of Longton, and the work has been executed in a very creditable manner.

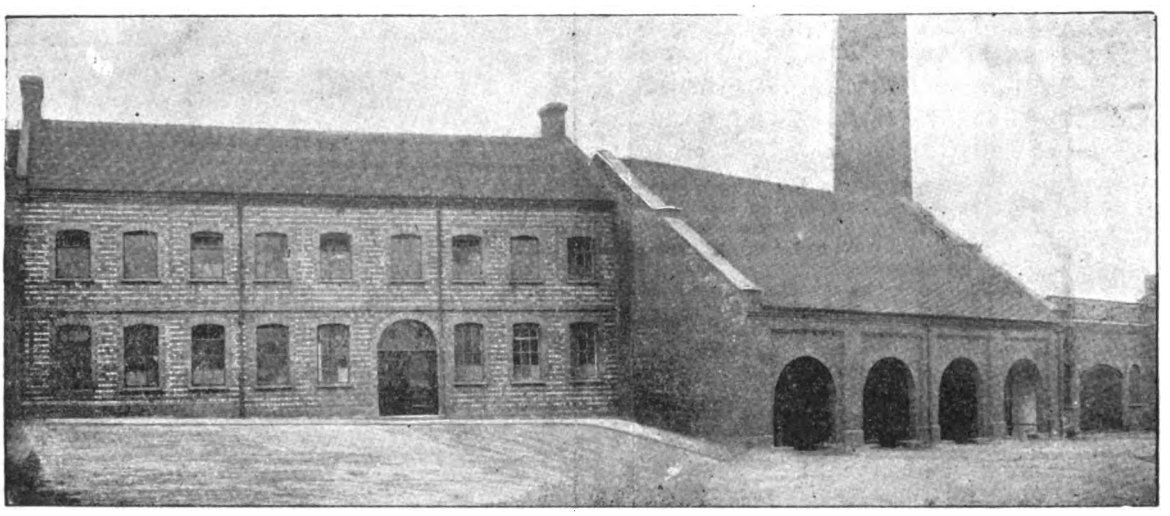

FIG. 1.—View of the Longton Electricity Works.

The height of chimney stack (Fig. 2) from the boiler firebars to the top is about 158ft., and the shaft internally is 6ft.

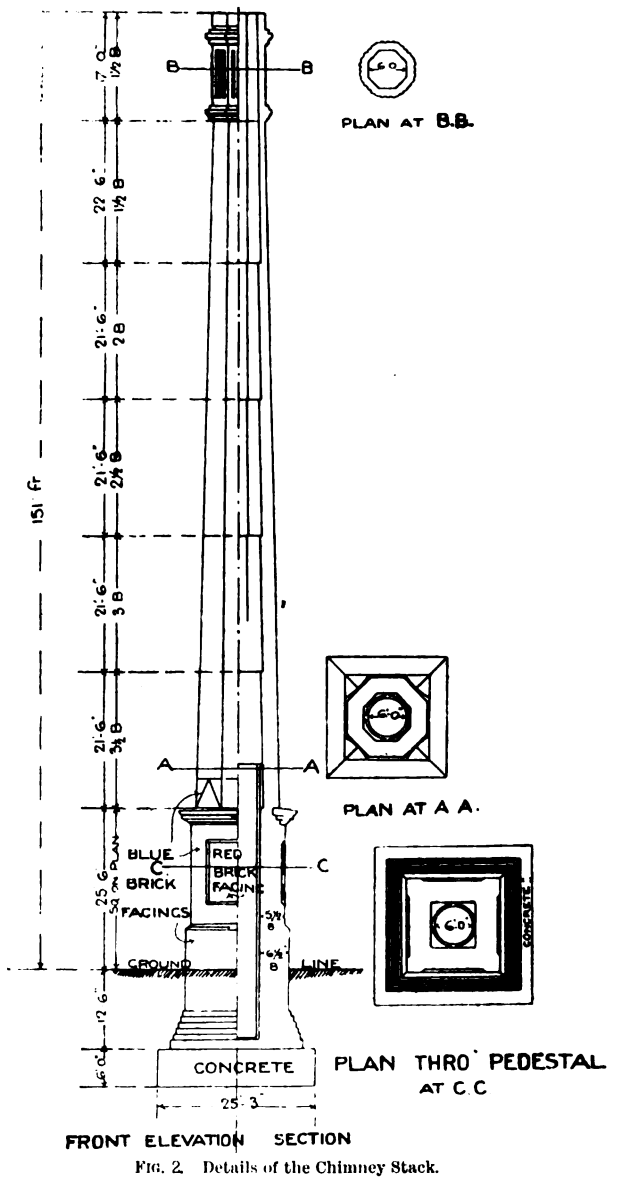

FIG. 2. Details of the Chimney Stack.

diameter. On account of the treacherous nature of the surrounding subsoil, every precaution was taken to ensure

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a good and solid foundation, the depth of which is about 18ft. below ground line. The foundation bed consists of cement concrete 25ft. square and 6ft. high; two layers of steel rails are embedded in the lower portion of this mass of concrete. The base of the chimney to the height of 23ft. is square, at which point is fixed a massive stone cornice, and from the top of the cornice the chimney is octagonal, tapering 1 in 30. Two bold cappings of blue bricks project from the upper part, and a cast-iron gripping trough is fixed on the top, bolted together in segments, the flanges being formed on the inside of shaft.

The transformation of the former workshops into engine and battery rooms has been accomplished without interfering with the outside form of the buildings, and the available inside space has been utilised to best advantage. The engine-room is 33½ft. by 28½ft., and contains two 150-kw. sets, with sufficient space left for a third generating set of the same power. The switchboard platform stands 3ft. 3in. above the floor level, at the back of which is the battery-room, 28ft. by 28ft.; immediately below the front of the switchboard platform is fixed the battery boosters and balancer. The inside of this room presents an attractive appearance. The ceiling is of pitch-pine, panelled and varnished. The windows towards the west are arched and fitted with tinted glass, whilst the north-west and south walls are very tastefully decorated with tiles supplied by Messrs. Minton, Hollins, and Co. The cast wall and windows have been left as before on account of their temporary character. All future extensions must be eastward as regards generating plant, consequently this wall of the building is left incomplete.

The steam required for these works is provided by two Babcock and Wilcox boilers, each having 1,619 square feet of heating surface, and constructed for a daily working pressure of 160lb. per square inch, the boilers having been tested hydraulically up to 240lb. per square inch since erection. The boilers are provided with the usual complement of fittings, including Turnbull's deadweight safety valves, Dewrance water-gauges, Turnbull's low-water alarm, and a flexible hose lance and cock for the purpose of cleaning the exterior of the tubes from soot is fitted to each boiler. The furnaces are constructed for burning coal, and swivel dampers are provided connected from the front by means of a lever and rod. The construction of the boilers includes the company's special Scotch furnace, which has been in successful use as an improvement for the combustion of bituminous coal, where the volatile gases are liberated at a comparatively low temperature, and coming in contact with the cool surfaces are quickly put out and their complete combustion hindered by means of the Scotch furnace. These gases are made to pass over incandescent surfaces, which effectually prevents the cooling effect, and with it excess of smoke. The whole of the brickwork of the boiler settings and main flues have been executed by the Corporation, and ample space is left in the boiler-house for future extensions. A Green's economiser has been fixed in the main flue, consisting of 96 tubes, so that the feed water is heated to boiling point before entering the boilers. The same firm has also supplied a double ram boiler feed pump of the Cameron type. Messrs. Babcock and Wilcox supplied and fixed the steam supply pipes and fittings.

The whole of the electric generating plant, consisting of engines, dynamos, boosters, balancers, and switch gear, has been installed by the Electric Construction Company, and consists of two Belliss-E.C.C. generators of a normal capacity of 145 kw. each, with provision for a third in the existing station. They are arranged side by side (Fig. 3), the engines being close to the boiler-house, and the generators in convenient proximity to the switchboard and regulating gear, the battery-room being at the back of the switchboard, the whole forming a compact and workable arrangement, readily lending itself to further extensions when required. A reasonable size of unit has been adopted, so that the cost of attendance and spares will be as low as possible. The engines are of the Belliss two-crank compound self-lubricating vertical type, running at a speed of 380 revolutions per minute, each capable of developing 220 b.h.p. for continuous running when supplied with a pressure of 120lb. per square inch, and exhausting into the atmosphere. The cranks are set opposite to each other, the steam being admitted simultaneously to the top of one cylinder and the bottom of the other, by which arrangement the reciprocating parts are to a great extent balanced, the strain on the bearings much reduced, and a high speed of revolution made possible without undue vibration. The arrangement of the slide valves is such that only one eccentric and rod is required. The governor is of the centrifugal type, driven direct from the crankshaft, and controls the speed of the engines within 3 per cent. when the load is suddenly thrown on or off. The engines are fitted with heavy flywheels. Forced lubrication is adopted at a pressure of from 10lb. to 20lb. per square inch, the action being quite automatic. The electric generators (Fig. 3) are of the E.C.C. standard inverted bipolar type. They are arranged to supply

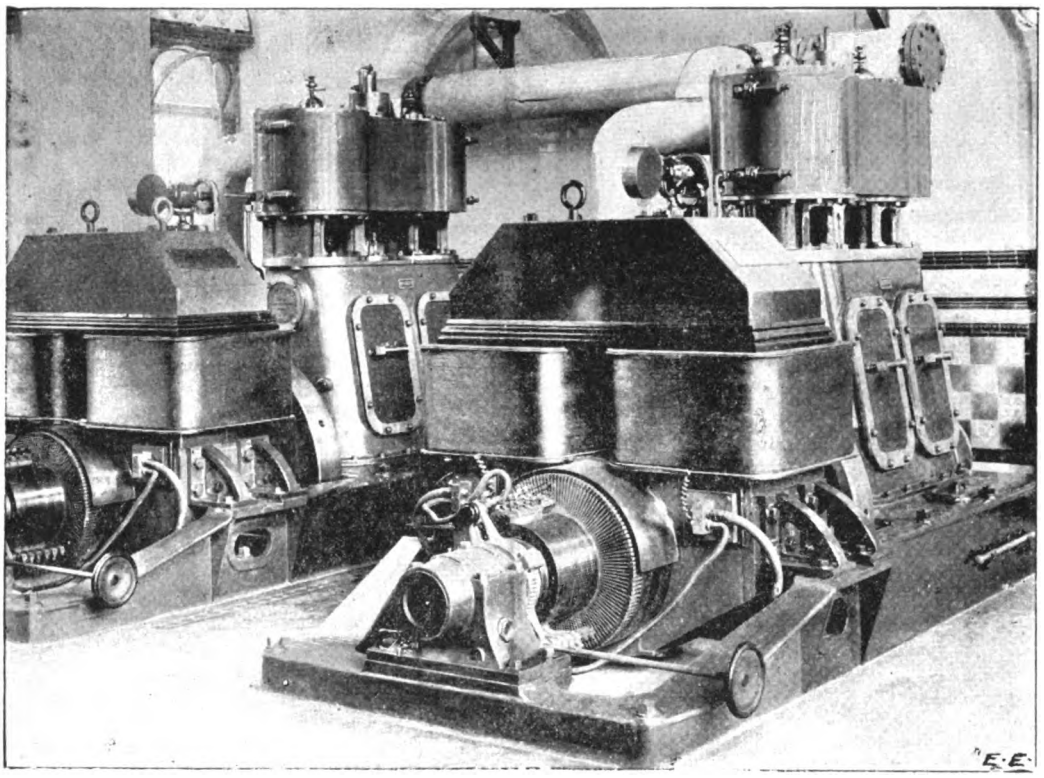

FIG. 3.—The Belliss-E.C.C. 145-kw. Steam Dynamos at Longton.

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energy to a three-wire system having 465 volts across the "outers." There are no balancing dynamos, any difference of load between the two limbs of the system being automatically compensated for by the balancer described hereafter. Each generator gives a normal output of 145 kw., and is shunt-wound, the necessary adjustment of potential being obtained by a rheostat in the shunt circuit. The armatures have former-wound interchangeable coils, on the Eickemyer system, and are of the usual E.C.C. construction, the armature core being formed of finely laminated charcoal iron discs, each not more than 15 mils in thickness, and suitably insulated for the elimination of eddy currents. The discs are in direct contact with, and securely keyed to, a very rigid steel shaft, which terminates in a half coupling bolted direct to the engine flywheel. No provision is made for internal core ventilation, the iron losses being so small that none is necessary. Carbon brush gear is employed, the commutation being sparkless under variation of load, with fixed brushes. The magnets are of the E.C.C. laminated type, the cores being of high permeability steel. They are carried by specially-shaped non-magnetic supports, which are mounted upon the usual combination bed-plate. The commutator end bearing is white metal lined, self-aligning, and self-lubricating. At the official trials of the set the combined efficiency of the engine and dynamo was shown to reach the high figure of more than 87½ per cent. The booster-balancer combination consists of two E.C.C. battery-charging boosters, direct coupled to and driven by an E.C.C. patent balancer. The function of the former is to augment or "boost" up the dynamo or line voltage by as much as is required to charge the accumulator cells. It consists of two E.C.C. bipolar dynamos, shunt-wound, and specially designed to work over a large range of E.M.F., which is adjustable by hand regulation in the usual way. The balancer is of an improved type, the function of which is to keep the voltage on the two sides of the system equal in case the load should be concentrated on one side or the other. The machine consists of a common field motor-generator, which is provided with an auxiliary magnet system, the intensity and direction of which is controlled by the out-of-balance current. It thus combines the efficiency of the single-magnet machine with the elasticity and range of the double-magnet type, but is much more compact than the latter. The set is capable of dealing with an out-of-balance current of 100 to 125 amperes, and on either side of the system, the regulation of E.M.F. being practically perfect, and entirely automatic, for any load from zero to the maximum on either side of the system. The total average variation of E.M.F. from a mean value obtained at the test was three-sixteenths of 1 per cent., and the maximum divergence at any moment one-third of 1 per cent. The machine is provided with carbon brush gear.

The main switchboard (Fig. 4) is situated on a raised platform at one end of the engine-room, from which an uninterrupted view of the whole plant can be obtained. It is designed to control at present two generators, three feeders, two batteries, one balancing transformer, and two battery boosters; but it is arranged so that panels for additional generators and feeders can readily be added. The board is divided into five panels, the extreme left and right hand panels carrying respectively the switches and instruments for the positive and negative connections of the generators and feeders. The intermediate left and right-hand panels carry respectively switches and instruments for the positive and negative batteries and boosters; they also carry the dynamo voltmeter. The centre panel is fitted with the middle wire and earthing ammeters, two large dial Lord Kelvin voltmeters for the feeders, and the balancing transformer switch gear. The panels are of polished slate and are mounted in an iron framework, the whole being surrounded with polished teak moulding and surmounted with an eight-day clock. In addition, field regulator switches for controlling and adjusting the voltage of the dynamos and boosters are fixed on the handrailing of the platform, in front of the board, the resistances for these being placed in a chamber below the platform. Meters for recording the energy generated by each dynamo are provided separately from the switchboard, and also for recording the charging and discharging currents of the battery.

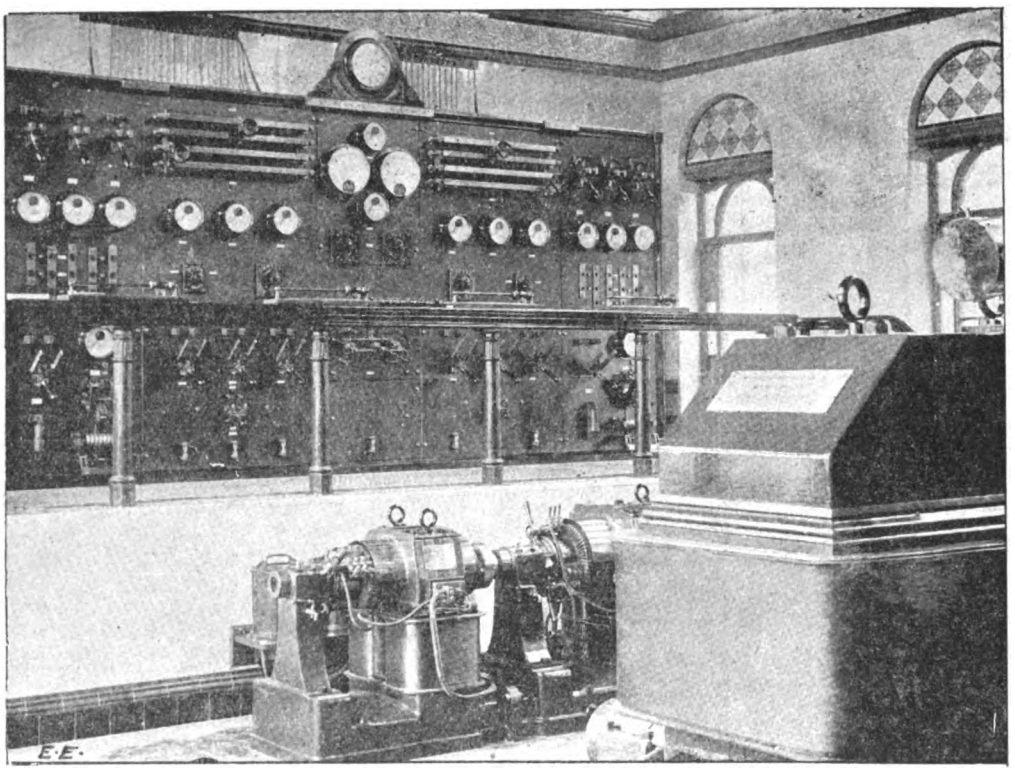

FIG. 4.—View of the Booster-Balancer and of the Switchboard.

The accumulators, which are of the well-known Chloride type manufactured by the Chloride Electrical Storage Syndicate, consist of 244 cells, divided into two batteries, 122 for each side of the system. There are 86 in each of the main batteries, and the remaining 36 cells are connected in pairs to the switchboard for regulating purposes. These connections are made with solid copper rod ⅜in. diameter. The containing boxes are constructed of sheet lead, so that there is no risk of breakage as is the case with glass boxes, nor of their being attacked with the acid, as is the case where wood boxes are used, and in these boxes the plates are suspended on glass hangers. The positive and negative plates of each cell respectively are burnt on

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to a common lead bar with those of opposite polarity in the adjoining cell. By this means the minimum of resistance is secured. The cells are carried on pitch-pine trays supported on glass oil insulators, and each cell is fitted with a curved glass cover to rest the spray when the cells are gassing. The stands, which are arranged in two tiers, are constructed of pitch pine coated with acid-proof varnish. The normal discharge rate of the battery is 40 kw. for a 10 hours' period, but in case of emergency the battery could be discharged at the rate of no less than 200 kw. for one hour.

The mains used in the town were supplied by Messrs. Callender and Co., and consist of high-conductivity copper cables insulated with Callender's vulcanised bitumen insulation. The distributing cables are laid in troughs filled in solid with pure bitumen, and are all single-conductor cables. The feeder cables are laid singly in stoneware troughs, and the distributor cables are laid three in a trough consisting of tarred red deal. All troughs are covered, after filling in, with hard blue tiles. At the three feeding points the cables are brought into a pillar, with links controlling each respective main. At the various branching points on the distributors, disconnecting boxes in pits with street covers are provided.

The scale of charges for electrical energy approved by the committee is, in our opinion, the correct one. It is the Brighton system, with 8d. per unit for the first hour's use of the maximum demand per day and 2d. per unit for all in excess. The charge of 8d. for the first hour is needed in small towns, and the low rate of 2d. for the rest of the supply encourages good consumers. The rate for energy for motors is 2½d. per unit. The supply when started was given to 20 consumers, and there are about the same number of applicants awaiting connection. The public buildings—such as the town hall and ante-rooms, the court house, the municipal offices, the Sutherland Technical Institute, the free library, and Longton High School—and the business houses are foremost in their applications, and appreciate the new illumination. The committee are hoping to obtain a decent day load in the near future, and are urging the manufacturers of pottery to adopt motors for their machinery. Some applications have already been made for motors, and these are being encouraged by the low rate of charge. To enable the ratepayers to see the works, these are being thrown open each Monday and Tuesday, and this tends to advertise the light.

We have to thank Mr. W. Langford, the energetic engineer and manager of both the electrical and gas plants at Longton, for the information from which the above is prepared. The result of the combined management shows so far that there has been no effort spared to make the new venture a success, both technically and financially.

MODERN COMMUTATING DYNAMO MACHINERY, WITH SPECIAL REFERENCE TO THE COMMUTATING LIMITS.*

BY H. M. HOBART, M.I.E.E.

(Concluded from page 521.)

It may be thought that the results of this collection of inductance tests point to the advisability of using throughout some 10 per cent. to 20 per cent. higher constants in estimating the reactance voltage. The writer would not be inclined to share this opinion. However, he attributes but little importance to any other than the *relative* values. If more satisfactory tests were at his disposal, pointing conclusively to higher values, corresponding to the actual conditions of practice, it would in no way affect his conclusions as to the relative merits of various machines, and he would merely scale up the numerical values of the reactance voltage and for the limiting safe values by 10 per cent., 20 per cent., or whatever still higher increase seemed justified right throughout the list. As to the relative influence of the "embedded" and "free length," the tests seem very conclusively to indicate the correctness of the ratio which the writer employs. Further data for revising the constants employed would be very welcome, since the writer fully realises the meagreness and lack of definiteness of the data here set forth. But the tests appear qualitatively to bear out very strikingly indeed the ideas underlying the method set forth, and the writer is of the opinion that where they conflict quantitatively it is due to the unavoidably rough character of factory tests, made, as they are, under conditions only permitting of taking a minimum number of measurements, and these with workshop instruments at moments when the exigencies of regular commercial testing permit. It was absolutely out of the question for the writer to give the tests any personal supervision further than to indicate in the first place the nature of the tests he required. This method of estimating the reactance voltage is based upon substantially the same principles as the method published two years ago by Mr. H. F. Parshall and the present writer. The novelty in the method, as then described by them, consisted chiefly in starting from the basis of representative values for the inductance as expressed in terms of the lines set up per ampere-turn per unit of length of laminations, and it led to substantially the same results as one obtains by the method in its present form, wherein the chief additional novelty consists, as has already been set forth, in allocating the components of the inductance in the "free" and "embedded" lengths respectively, in giving guiding values for estimating these components, and in supporting them by fairly thorough tests and by the results of experience gained in applying the method to a great variety of machines.

The "two-circuit" or "series" or "wave" winding is not so readily analysed in this way. The writer prefers to make the calculation precisely as if were a "multiple-circuit" winding—that is, ignoring the *actual* sequential connections of the face conductors, he treats the case just as if the connections were those described above, remembering, however, to derive the reactance voltage from the larger current which in such windings flows in each conductor. Furthermore, the writer's experience with these windings has been that it is desirable to keep within rather lower limits for the reactance voltage per segment. This is still more the case for "multiple" windings—*i.e.*, "double," "triple," etc.—including those of the multiple-circuit type, but more especially for the two-circuit multiple windings. In multiple-circuit multiple windings one must also remember that the frequency of commutation and the number of turns simultaneously short-circuited under the brushes have to be determined by remembering that for, say, a double winding, the intermediate commutator segment has to be considered as added to the width of the two bounding insulations. Hence in such windings, for a given width of brush, the frequency of commutation is much higher than for a single winding.

Having studied this method in connection with a good many machines, the writer finds that, with careful proportions in other respects, one may be very sure of excellent results with reactance voltages of not over three volts. Above three volts, except in the case of large slow-speed machines, one is liable to encounter trouble, which, however, if the value is not much in excess of three volts, is generally attributable to some other reason. Some of these reasons are: (1) high ratio of pole arc to pitch, which results in too narrow a commutating zone; (2) a number of commutator segments, for a multiple-circuit winding, not a multiple of the number of poles. With relatively large numbers of segments per pole this is not harmful, except that it prevents the use of equaliser rings, but with a small number of segments per pole it is to be avoided; (3) inequality in the air-gap; (4) inequality in the material of the magnetic circuit; (5) unsymmetrically assembled commutator segments; (6) unsymmetrically mounted brush gear; (7) unsuitable type of brush-holder; (8) incorrect brush tension; (9) inexact alignment of brushes; (10) insufficient brush surface; (11) brushes not suitably bedded; (12) unsuitable quality of carbon brush; (13) hard mica insulation between segments; (14) soft commutator segments; (15) insufficiently rigid machine foundations; (16) insufficiently rigid shaft; (17) insufficiently rigid commutator construction; (18) eccentricity in commutator; (19) insufficiently clean commutator surface; (20) inequality in angular speed of prime mover.

On large, slow-speed direct-connected machines the permissible limit for the reactance voltage increases considerably with the size of unit. Thus for speeds of from 80 to 120 revolutions per minute three to four volts may be used with perfect success for the range from 400 kw. to 800 kw., and the writer has occasionally seen machines of these rated outputs and speeds where the values went as high, at full rated load, as six volts. But they were not really excellent, and had not much margin of overload capacity, and the writer believes that it would be well throughout this range, and even to considerably beyond 1,000-kw. units, to not exceed 4·5 volts, or at the most 5 volts. It is, however, impossible in these large sizes, without departing widely from customary constructions, to have so low values as in smaller machines. The writer's own rule is simply to make the reactance voltage as low as considerations of economy and efficiency will permit. It is often practicable to obtain reactance voltages of from one to two volts, and where no other features are sacrificed by so doing, this is, of course, always very desirable. The commutation cannot be too good. As to why the larger sizes are rather less sensitive to high reactance voltages, the writer must freely confess that he has never yet found a satisfactory explanation. It would be an interesting field for investigation, and the results would be of great value to ascertain whether the three components of the reactance voltage—namely, the flux, the frequency, and the current—should all be given the same weight, and also whether some substitute for the method stated for estimating the frequency might not be more correct. The formula

$$\text{Reactance voltage} \quad 2\pi n I C$$

is, on account of the sine wave assumption involved, of course only remotely likely to be the most suitable, but it is used for want of knowledge of any suitable substitute.

The writer recently went through a very large number of machines, suggesting modifications and improvements, and at the same time adding to the system some new designs of both small and large machines. Especial attention was given to improvement in commutation; hence interest attaches to Table XIX., in which are set forth for 28 of them the normal ratings and some leading constants and dimensions. In the case of many of the small sizes they were only arranged with such modifications as it was practicable to make without too expensive changes, and hence the proportions are rarely such as one would select for new designs. Nevertheless, the table serves to indicate

* Paper read in Section IX. of the International Engineering Congress, Glasgow, 1901.

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TABLE XIX.

Reference number.	Number of poles.	Kilowatts output.	Speed—r.p.m.	Voltage.	Armature reaction in total ampere-turns per pole.	Reactance voltage.	Average volts per segment.	Number of slots.	Width of slot (mm.).	Depth of slot (mm.).	Number of commutator segments.	Turns per segment.	Type of winding 2-circuit or mult. circuit (single).	Depth of air-gap (mm.).	Commutator diameter (cm.).	Thickness of commutator segment at surface (mm.).	Diameter of armature (cm.).
1	4	5 h.p. Motors.	900	110	1,000	2·1	6·6	67	6·1	15	67	3	2-circ.	2·5	16	6·7	22
2	4	5 h.p. Motors.	900	220	1,000	2·8	10·9	27	11	18	81	5	2 ,,	2·5	16	5·4	22
3	4	7½ h.p. Motors.	850	110	1,300	1·8	7·2	61	7·6	19	61	3	2 ,,	2·5	19	9·0	25
4	4	15 h.p. Motors.	700	220	1,760	1·7	7·2	41	13	18	123	2	2 ,,	3·5	24	5·4	30
5	4	10	930	550	1,330	2·8	11·3	65	9·5	19	195	3	2 ,,	4	26·7	3·6	33
6	4	13½	1,400	550	1,200	2·5	11·3	65	10	15	195	2	2 ,,	4	26·7	3·6	33
7	4	14½	825	550	1,460	2·8	15·0	49	10·4	19·5	147	3	2 ,,	4	26·7	5·0	33
8	4	18½	770	550	1,930	2·5	14·4	51	11	22	153	3	2 ,,	4	27·9	5·0	41
9	4	30	600	115	3,880	1·4	3·9	119	7·5	17	119	1	2 ,,	5	45	11·1	52
10	4	27	715	550	2,320	2·4	11·6	63	12·6	18	189	2	2 ,,	4·5	32·5	4·7	46
11	4	40	600	115	3,780	1·7	5·3	87	8·5	20	87	1	2 ,,	5	35·6	12·1	52
12	4	30	600	230	2,890	1·1	5·2	59	15	15	177	1	2 ,,	5	45·0	7·2	52
13	4	35	975	230	2,450	1·7	7·1	43	15·2	17	129	1	2 ,,	4·5	38·1	8·5	46
14	4	33	660	550	2,680	1·5	6·2	119	8·0	20	357	1	2 ,,	5	45·0	3·2	52
15	4	33	1,100	550	2,000	2·0	8·2	89	7·2	17	267	1	2 ,,	4·5	38·1	3·7	44
16	4	38	1,070	550	2,150	1·7	8·8	83	8·6	19	249	1	2 ,,	4·5	38·1	4·0	46
17	4	50	1,020	550	2,700	1·6	9·3	79	9	18	237	1	2 ,,	5	38·1	4·3	52
18	4	60	960	550	3,230	2·1	9·3	79	10 5	18	237	1	2 ,,	5	38·1	4·3	52
19	4	45	925	230	3,000	1·8	7·6	121	5·9	21	121	1	2 ,,	5	38·1	9·1	52
20	6	40	240	110	3,800	1·9	1·8	125	9	27	125	1	2 ,,	5	38·1	8·8	68
21	6	75	500	600	3,340	2·2	11·3	160	7	33	320	1	2 ,,	5	48·2	4·8	67
22	6	130	500	110	3,800	2·2	5·7	116	9	26	116	1	6 ,,	6	63·5	16·4	85
23	8	80	750	115	3,500	2·0	2·9	84	12·1	27·5	336	1	8 ,,	5	48·0	3·7	68
24	8	250	100	550	7 800	2·2	4·0	364	9·6	29	1,092	1	8 ,,	9	165	4·7	187
25	8	300	375	550	5,000	2·9	7·7	192	10	29	576	1	8 ,,	8	95	5·2	150
26	8	400	100	550	9,000	2·8	5·6	264	12·5	33	792	1	8 ,,	10	165	6·6	230
27	16	1,000	90	500	9,000	3·9	7·7	384	13·4	32	1,152	1	16 ,,	10	270	7·4	350
28	22	1,600	84	550	8,000	3·8	9·2	440	14·0	34	1,320	1	22 ,,	10	350	7·6	450

what the writer regards as safe values from the commutating standpoint for the speeds, voltages, and outputs set forth. Before these small machines were rearranged the reactance voltages were in many cases several times as great, and they were decidedly poor as regards commutation. Many machines are now being produced by various firms in which similar conditions obtain, and in which rearrangement of the windings and commutators would permit of radical improvement in commutation. And in no feature of the design is it of greater importance to keep well on the safe side than with respect to commutation constants. Many of those quoted in the list are unnecessarily low, but so long as these low constants can be obtained without sacrifice in other directions, and (in the writer's opinion) even at slight sacrifice in other directions, it is to be recommended. For instance, in the last few designs in the list—namely, the large direct-connected machines—the efficiencies at full load and half load are some ½ per cent. lower than might have been obtained for a given cost of material, by going 25 per cent. or so higher with the reactance voltage.

In the specifications in Table XX. are given more complete data of the writer's designs for slow-speed direct-connected units of 400 kw., 1,000 kw., and 1,600 kw. The guarantee to which they comply is as follows: 25 per cent. overload during one half-hour, without harmful sparking or heating. Thermometrically measured temperature increase not over 50deg. C. above surrounding atmosphere during continuous operation at rated load. No harmful sparking or heating with momentary overloads of 50 per cent. Fixed brush position for all these conditions. Insulation of entire machine from copper circuits to iron, to withstand the application of a R.M.S. potential of 4,000 volts for one minute at 20deg. C.

TABLE XX.

Specification.	400 kw.	1,000 kw.	1,600 kw.
Number of poles	8	16	22
Kilowatts rated output	400	1,000	1,600
Speed, revolutions per minute	100	90	85
Full-load voltage	550	500	550
Full-load amperes	730	2,000	2,900
External diameter of the armature (cm.)	230	350	450
Length armature over winding (cm.)	95·0	80·0	72·0
Length over armature core (cm.)	40	35	33
Number of ventilating ducts	8	8	7
Width of each duct (mm.)	13	13	13
Effective length of laminations in armature core (cm.)	27	22·5	21
Internal diameter of armature laminations (mm.)	140	281	375
Diameter of commutator (cm.)	165	270	350
Length of commutator (cm.)	32	38	27
Width of segment at surface (excluding insulation) (mm.)	6·6	7·4	7·6
Thickness of insulation between segments	0·76	0·76	0·76
Total number of segments	702	1,152	1,320
Total number of slots	264	384	440
Segments per slot	3	3	3
Turns per segment	1	1	1
Width of slot (mm.)	12·3	13·4	14
Depth of slot (mm.)	33	32	34
Radial depth of air-cap (mm.)	9	10	10
Radial length of magnet core (cm.)	45	48	50
Diameter of magnet core (cm.)	45·5	38·0	38
Cross-section of magnet core (sq. cm.)	1,630	1,140	1,130
Pole-face dimensions (cm.)	40 × 61	35 × 49	33 × 47
Ratio of pole arc to pitch	0·67	0·71	0·72
External diameter of magnet yoke (cm.)	379	531	644
Width of magnet yoke (cm.)	66	70	90
Radial thickness of magnet yoke (cm.)	21	30	38
Width of armature conductor (mm.)	2·4	2·8	3·0
Height of armature conductor (mm.)	13	12·5	13·5
Current density in armature conductor (amps. per sq. cm.)	303	357	330
Thickness of armature slot insulation (copper to iron) (mm.)	1·6	1·6	1·6
"Space factor" in armature slot	0·46	0·49	0·51
Average voltage per commutator segment	5·6	7·7	9·2
Amperes per sq. cm. of brush contact	5·0	5·0	5·0
Total reaction in armature ampere-turns per pole	9,000	9,000	7,900
Type of winding	8-circ. single.	16-circ. single.	22-circ. single.
Paths through armature winding from positive to negative brushes	8	16	22
Amperes per path	91	125	132
Length of arc of brush contact (mm.)	23	20	33
Frequency of commutation, cycles per second	190	318	236
Mean length of armature turn (cm.)	300	240	220
Embedded length per turn (cm.)	54	45	42
Reactance voltage with full load amperes	2·8	3·9	3·7
Apparent tooth density (lines per sq. cm.)	21,000	22,700	23,000
Width of tooth at root (mm.)	14·3	14·7	17·6
Radial depth laminations below slots (cm.)	42	31	34
Density below slots (lines per sq. cm.)	10,300	10,700	10,400
Cycles per second for reversal of magnetisation in armature iron	6·7	12·0	15·6
Total armature flux at full load and rated terminal voltage (megalines)	21·7	14·9	15·1
Assumed factor for magnetic leakage	1·125	1·125	1·125
Flux in magnet cores (megalines)	24·4	16·8	17·0
Density in magnetic cores (lines per sq. cm.)	15,000	14,900	15,000
Density in magnetic yoke (lines per sq. cm.)	11,100	4,000	5,400
Pole-face density (lines per sq. cm.)	8,900	8,700	9,900
Ampere-turns on open circuit but full-load voltage	10,000	11,000	13,000
Ampere-turns at full-load amps. and volts.	13,500	14,000	16,000
Ampere-turns for overcoming armature reaction	3,500	3,000	3,000
Material of magnet yoke	c. steel	c. iron	c. iron
Material of magnet cores	c. steel	c. steel	c. steel
Material of magnet pole-faces	c. iron	c. iron	c. iron
Material of armature sheets	steel	steel	steel
Peripheral speed of armature (m. per second)	12·0	16·5	20·0
Peripheral speed of commutator (m. per sec.)	8·7	12·7	15·6
Centrifugal force at armature surface in kgs. per kg.	13·0	16·0	18·0
Centrifugal force at commutator surface in kgs. per kg.	9·0	12·0	14·0

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Losses and Efficiencies at 60deg. C.

Core loss	9,000	18,000	32,000
Armature copper loss	13,100	24,200	24,400
Commutator C^2R loss at brush contacts	16,000	4,400	5,800
Allowance for stray losses in commutator	100	200	300
Commutator brush friction loss	700	2,800	5,300
Loss in shunt winding	4,400	8,250	13,000
,, series ,,	1,600	2,250	3,000
,, shunt rheostat	650	1,250	2,000
,, series diverter rheostat	600	750	1,000
Total of constant losses	14,850	30,500	52,600
,, variable losses	16,900	31,600	34,200
,, all losses	31,750	62,100	86,800
Commercial efficiency at full load	92·6	94·1	94·9
,, ,, ,, ¾ ,,	92·5	94·0	94·4
,, ,, ,, ½ ,,	91·4	92·9	92·8
,, ,, ,, ¼ ,,	86·4	88·5	88·1

The commutator losses are figured on a brush resistance of 0·2 ohm per square centimetre, a brush pressure of 0·1 kg. per square centimetre, and on a friction coefficient of 0·3.

Watts per square decimetre of peripheral radia. surface of armature at 60deg. C.	31	48	57
Watts per square decimetre of peripheral radia. surface of commutator at 60deg. C.	17	25	43
Watts per square decimetre of exter. cylindrical radia. surface of field spools at 60deg. C.	9	9	9

Weights and Costs in Kilogrammes and Shillings.

Armature laminations	5,500	5,300	7,700
Armature copper	660	900	1,100
Commutator segments	730	1,700	1,700
Field copper	900	1,570	2,700
Pole-faces	700	1,000	1,200
Magnet cores	4,300	7,000	10,000
Total magnet yoke (including feet)	12,400	27,000	33,000

Taking for costs per kilogramme, the rough values of 2s. per kilogramme for copper, 0·31 for laminations, 0·38 for cast steel, and 0·25 for cast iron, the totals for the cost of "net effective material" are:

Total cost of net effective material in shillings	12,800	19,500	25,800
Total weight of complete machine exclusive of shaft (kilos.)	32,000	62,000	77,000
Cost of "net effective material" per kw. in shillings	32·0	19·5	16·1

There has lately been a good deal of discussion with regard to the practicability of obtaining good results as regards sparking in large high-speed dynamos for direct coupling to high-speed engines. In the writer's opinion this is purely a question of adopting sufficiently solid (and, consequently, expensive) mechanical construction throughout to permit of an absolutely true running commutator of high peripheral speed, both commutator and brush supports being completely free from vibration. Take, for instance, a large 500-volt unit, which would be the most difficult case for high speed. With a sufficiently large commutator diameter and sufficiently narrow segments there may be high armature strength per pole. The high speed, high armature strength per pole, together with a rather large number of poles, will result in requiring but a very small magnetic flux per circuit, and hence the machine will be very narrow. A narrow machine with many segments per pole, and consequently low average voltage per segment, will also, in spite of the high commutation frequency, be characterised by low reactance voltage, which, with the stable mechanical construction above set forth, will result in a machine with excellent commutating properties. Indeed, it occurs to the writer to point out here that probably one of the most characteristic novelties of his designs—if such slight departures from preceding designs may be termed novelties—consists in the employment of fairly many poles combined with high armature strength per pole. Heretofore designers resorting to many poles appear generally to have done so with a view, firstly, to securing economy in material, and, secondly, for the purpose of thereby minimising the armature ampere-turns per pole. The writer, in the interests of securing a low reactance voltage, is inclined to recommend a good many poles, and as many armature ampere-turns per pole as are consistent with suitable thickness of segment, available room on the armature surface, and permissible centrifugal stresses in armature and commutator. There appears to be a large field for such machines, which is developing as a result of the success which has been achieved with large high-speed engines. The possible economies may be judged by explaining that, for a given output, the factory cost for large 500-volt direct-connected dynamos decreases closely in proportion to the square root of the ratio of the speeds. This is no theoretical deduction, but the result of comparisons of the complete factory costs of a number of such machines. For lower-voltage dynamos the saving would not be quite so great as in this proportion, since the commutator must have a radiating surface and a brush-bearing surface practically as great for a high-speed as for a low-speed dynamo for a given output and voltage, since any increased advantage obtained at high speeds as regards ventilation is fully offset by the increased friction loss at the brushes. The amperes to be collected at the brushes, hence the brush contact C^2R losses, are independent of the speed. Since the lower the voltage the greater the percentage of the total cost which the cost of the commutator constitutes, the saving due to increased speed cannot be so marked in low-voltage as in high-voltage machines. This is analogous to the case of rotary converters, where the neutralising of the currents in the armature conductors shows its effect in decreased cost much more markedly in high-voltage than in low-voltage machines. Another tendency controlling the nature of the design selected for these high-speed dynamos is more of a commercial nature—namely, that the speeds are just about such as are very suitable for large 25-cycle rotary converters; and it is distinctly economical where, as often occurs, no especial advantage is thereby sacrificed, to develop both of these classes of apparatus from the same models. Thus a 25-cycle, 400-kw., 500-volt, 6-phase rotary converter works out very finely with eight poles and 375 revolutions per minute, and this speed, with shortened commutator, yields an excellent 300-kw. dynamo, although, if the rotary converter were not required, it is likely that six poles would be slightly preferable for a 500-volt, 300-kw. generator at 375 revolutions per minute. Similarly a 10-pole, 650-kw., 500-volt, 300 revolutions per minute, 6-phase rotary converter, with minor changes, yields an excellent design for a 500-kw. dynamo for the same voltage and speed. In such carefully-considered cases, the writer is by no means averse to making compromises in the interests of standardisation in manufacturing.

It is probably not generally realised what a stupendous programme of ratings requires to be standardised—in continuous-current machines alone—by every large electrical manufacturing concern. We may consider the case of a single line of very small high-speed machines of from 125 kg. weight up to 2,600 kg. weight. This may be provided for by some 12 distinct models, but when worked out to meet the demands of the market, with ratings as dynamos, motors, and all the subdivisions of these two classes, the list is found to comprise hundreds of ratings for which but few can, with any regard to the best results, be arranged to have precisely the same manufacturing specifications. The 12 models of the range of weights mentioned will, when rated as shunt motors with open frames, suffice for a range of outputs of from 2 h.p. to 65 h.p. for the lower of the customary range of speeds, and 3 h.p. to 75 h.p. for the highest customary speeds. But examining the different purposes for which the machines will be employed, there are found to be the following chief classifications, for each of which all the 12 models must be rated for three different voltages.

I.	Shunt-wound	dynamos—	low speed—	open type.
II.	,,	,,	high ,,	,,
III.	,,	motors	low ,,	,,
IV.	,,	,,	high ,,	,,
V.	,,	,,	low ,,	totally enclosed type.
VI.	,,	,,	high ,,	,,
VII.	Series-wound	,,	low ,,	open type.
VIII.	,,	,,	high ,,	,,
IX.	,,	,,	low ,,	totally enclosed type.
X.	,,	,,	high ,,	,,

These classifications alone make up $12 \times 3 \times 10 = 360$ different ratings, and yet it is a very incomplete list for the range of capacities concerned. Such machines would be required at a great number of speeds, differing from the two main groups designated above as low speed and high speed. There is also the rapidly-increasing demand for motors suitable for operation throughout wide ranges of speed by shunt regulation, for which more exacting requirement the standard constant-speed motor must be rated somewhat lower (in order to commutate satisfactorily with the weaker field excitation—*i.e.*, at the higher speeds), and must have special field windings. These remarks are merely intended to bring out more clearly the state of development at which the small motor industry has arrived, and it is scarcely to be wondered at that the large manufacturer, confronted with the task of standardisation, is inclined to demur at the multiplicity of patterns, drawings, dies, gauges, winding forms, insulation moulds, etc., required for securing the best results. He is painfully aware of the already huge accumulation (corresponding, moreover, in large measure to superseded types) already on hand, and is reluctant to admit that the manufacturing of a single line of little machines should assume the proportions of a great department. He has other departments to consider—for instance, induction motors, alternators, transformers, railway motors, railway generators, lighting generators, and very many more. Only a few years ago he got along very well with but a small equipment. The engineer who proposes to urge the further complications, from the standardising standpoint, which are required in conscientiously applying the knowledge of the subject nowadays at his disposal, calling for commutators and windings proportioned with due regard to the conditions which should be complied with, has no easy task, and the smaller the machines the more unwelcome are his proposals. While on the one hand it is true that, with small machines, considerable liberties with the design can be taken without great detriment to the performance of the machine, it is, on the other hand, precisely in the case of such small machines that it should be practicable to produce each different rating in considerable quantities, and hence it should be more economical to work out, with extreme care, such designs as shall, with a minimum of material and labour, yield the best result: and one is inclined to believe that production in quantity should be relied upon to ultimately render negligible the cost of special tools. The writer intends the above remarks to apply to machines of at least 2 h.p. output. For still smaller machines—*i.e.*, for fractions of a horse-power up to 1 h.p.—the cost is almost entirely a question of careful organisation of the manufacturing processes; almost any first-rate design of motor will serve equally well as a basis, the cost, especially of material, and to a considerable extent also of labour of workmen, disappearing to a far greater extent than in larger machines, in comparison with all the other charges involved before the machine is marketed.

In the other extreme case—namely, that of very large units—the contrary conditions prevail, and the engineer's task is a relatively easy one. For these machines he is encouraged to adopt such an arrangement of the material as shall bring about the most effective result per unit of value, and he readily obtains consent to incorporate, in each successive machine, such changes and improvements as he deems desirable, in spite of the consequently required modifications, and often even replacement of extremely expensive patterns, dies, etc.

Even when the manufacturer considers it expedient in machines of from 2 h.p. to 75 h.p. to evolve them, to the detriment of their tech

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nical properties, out of a minimum number of drawings, patterns, and dies, the necessities of the special unforeseen cases (which always have and always will continually arise, and which have to be provided for, since they must constitute a considerable percentage of the total business of every progressive concern) will compel the manufacturer, if he is to compete successfully, to depart gradually but inevitably from the original set of standardised designs, and accumulate an irregular, unsatisfactory, entirely haphazard assortment of deviating designs, most of which will be discreditable makeshifts. This result is in striking contrast to that to be obtained by boldly accepting the situation in the first place, making each machine correct for its rating, and, by the employment of all the technical knowledge of the subject available, to look for the profits from the skilful use of a minimum of material and labour in each case. Then, when the inevitable necessity arises of supplying special machines, these will be developed from whichever one of a very large variety of *correct* designs most nearly corresponds to the special requirement, and since the design from which the deviation is derived is itself correct, much greater satisfaction and economy will be secured in the special deviating machine. In fact, it will far more often occur that, the standard machine having been designed with strict regard to the specified performance, there will be very many special cases where the conditions to be met are considerably different, where the standard machines may be used without any change whatsoever.

These are not questions which can be easily decided. The writer realises a little that it would probably be impossible for him, in spite of the best intentions, to consider them from a thoroughly impartial standpoint. As to just in how far, he cannot know, but he inclines to the belief that at least a little more regard for technical excellence in the types of machinery treated of in this paper, may perhaps be consistent with the commercial success of the concerns engaged in their manufacture.

Indo-European Telegraph Co.—Payment is announced on the 1st prox. of an interim dividend at the rate of 5 per cent. per annum for the half-year ended June 30 last.

THE FERRANTI ENGINE.

On Saturday last Mr. Chas. Day read a paper before the Manchester Association of Engineers, entitled "Engines for Driving Large Dynamos." In the introduction to this paper the author refers to the lead English engineers have taken in the practice of direct coupling of engines and dynamos. He also rightly credits Mr. S. Z. de Ferranti as being the first to urge the advantages of large direct-coupled sets. Thus in 1887 the work on the Deptford station was started, and 1,500-h.p. engines of the Hick-Hargreave type have been at work there since 1888. Mr. Day adds that a perusal of the designs of the 10,000-h.p. sets, which were begun and never finished, shows that the engines would have differed but slightly from present-day practice. The author looks to the success of English builders of high-speed engines as one reason why more slow-speed engines for dynamo driving have not been made in this country. The advantages to be derived from increased speeds are classified by the author as: (*a*) less floor space, and consequently less cost of land and buildings; (*b*) cheaper dynamos and cheaper engines; (*c*) better turning moments. On the other hand, increase of speed introduces disadvantages, such as greater throwing about of oil, greater tendency to vibration, difficulty in securing automatic expansion, and necessity for more perfect lubrication. Owing to the limited time of the meeting, Mr. Day was unable to explain how these difficulties had been faced in Willans, Belliss, Browett-Lindley, and other high-speed engines, and confined himself to the engines made by Messrs. Ferranti, Limited.

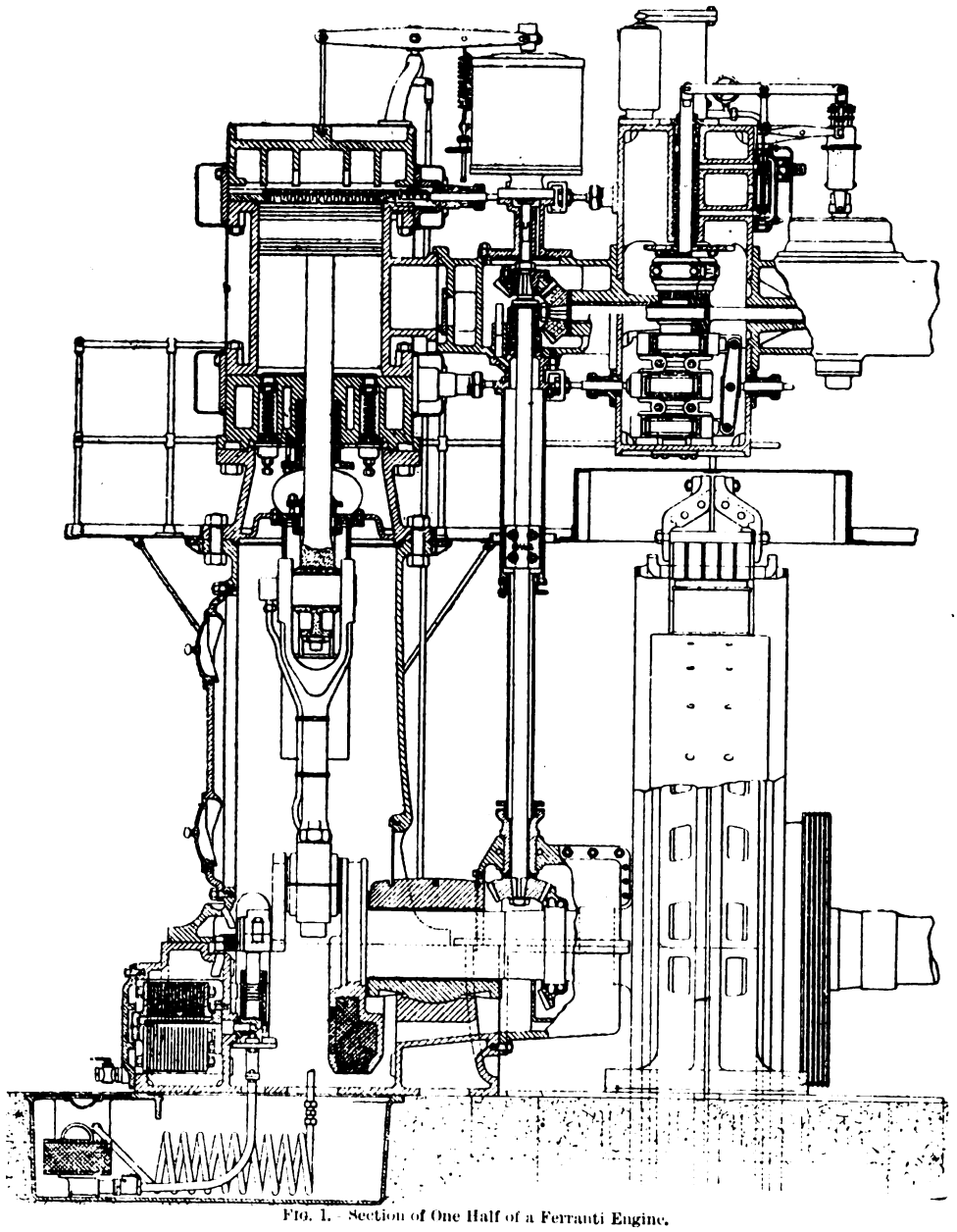

FIG. 1.—Section of One Half of a Ferranti Engine.

These engines (Fig. 1) are of the cross-compound vertical type, in which only two bearings are required, as the dynamo can be placed between the two cylinders. With superheated steam, and with varying loads, the author thought that the compound type had advantages over the triple-expansion engine. The splashing of oil has been avoided by completely enclosing the working parts, and forced lubrication is used on all the principal bearings. In Fig. 1, the filter used to cleanse the oil before it reaches the bearings is shown. The oil, which is apt to become heated in course of circulation, is cooled by a copper pipe with water circulating in it placed in the oil-tank.

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The method of lubricating the valve gear consists in surrounding the valve gear by a casing and filling this casing with oil.

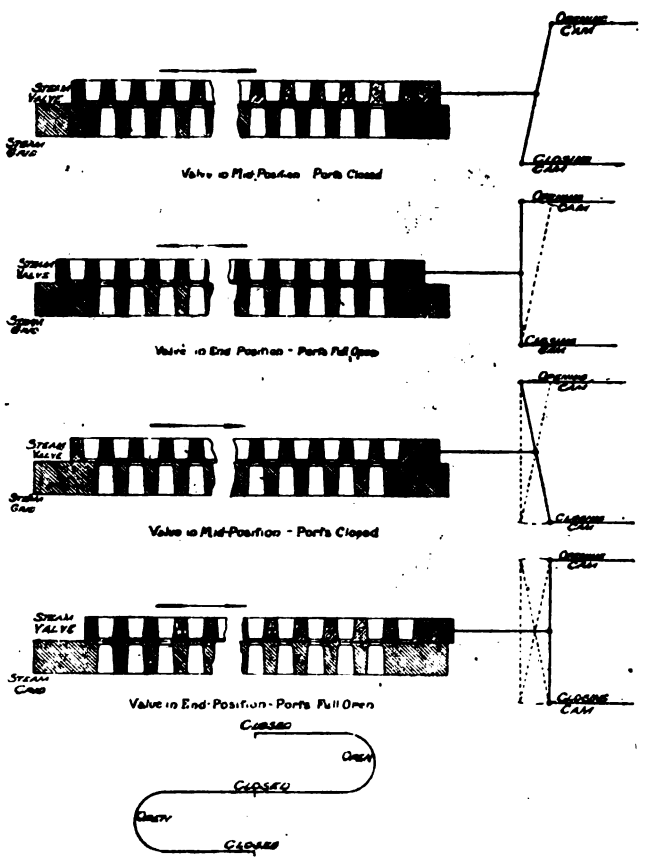

FIG. 2.—The Diagram at the bottom represents the Steam Valve Movements for One Revolution of Cam Shaft and for Two Revolutions of Engine.

Thus the whole of the valve gear works immersed in oil, rendering the engine attendant's oil-can quite superfluous. In order to secure the economy of the slow-speed Corliss engine four valves are used for each cylinder—*i.e.*, a steam and exhaust valve at each end. These valves are of the grid type, as illustrated in Figs. 2 and 3. The total movement of the high-pressure valve during one revolution of a 1,000-h.p. engine is 1¼in. At 214 revolutions per minute this give the low valve surface speed of 22ft. per minute,

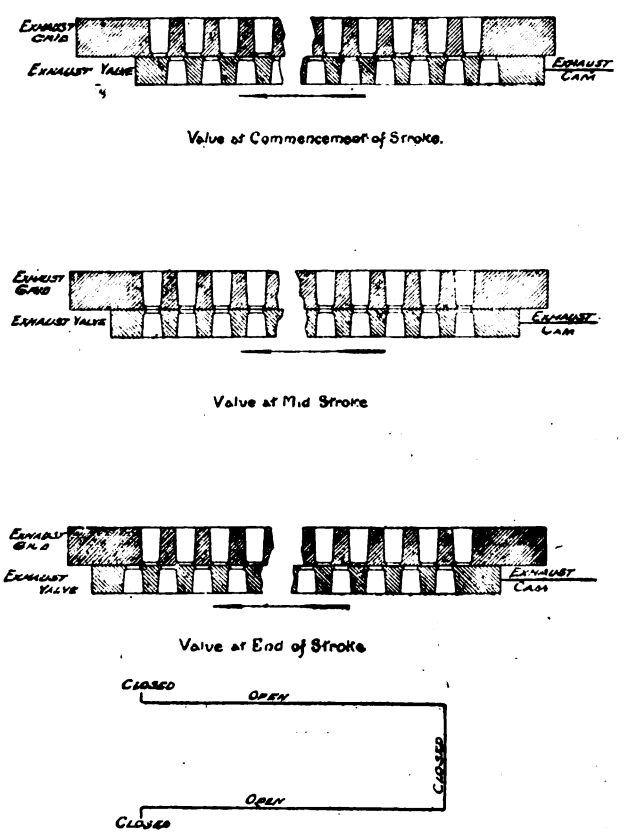

FIG. 3.—The Diagram at the bottom represents the Exhaust Valve Movements for One Revolution of Cam Shaft and for Two Revolutions of Engine.

which low surface speed should result in little wear. Another point in the design of these valves is their position in the covers,

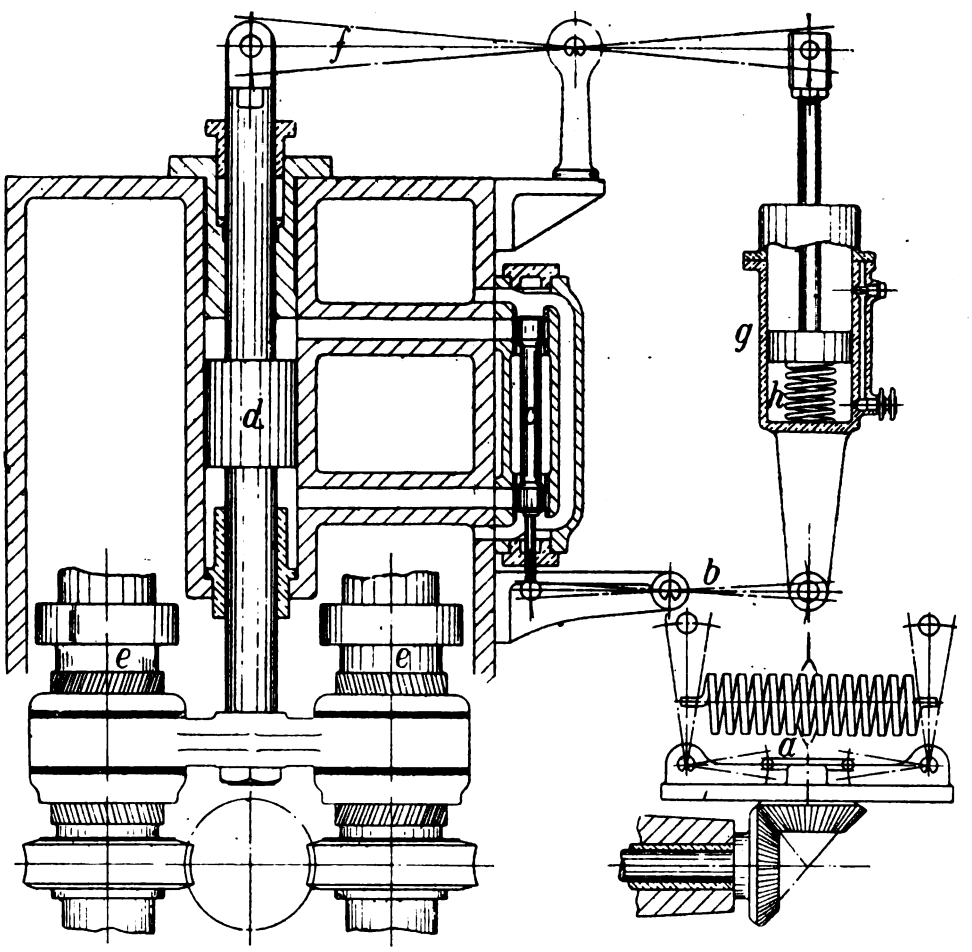

FIG. 4.—Details of Ferranti Governor.

which gives small clearance and very direct ports. The volumetric clearance can also be kept low, but the author is not in favour of carrying this step to an extreme. The valves are quite free to follow

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the wear, and hence the valve tightness improves with use. The author gives the following figures of steam consumption obtained on a 500-h.p. engine, after 18 months' work at the Cardiff electricity works: The steam consumption per indicated horse-power with a boiler pressure of 140lb. and a vacuum of 18·7in. was 15·6lb., and per kilowatt 24lb. The figure guaranteed was 26lb. per kilowatt, with a vacuum of 27in. On account of the deficient vacuum provided by the separate condensing plant a calculated allowance was agreed upon, and this brought the steam consumption to 13·8lb. per indicated horse-power hour and 21·8lb. per kilowatt. The test was supervised by a number of well-known experts.

As mentioned above, the whole of the valve gear of the Ferranti engine is collected together in the box, seen in Fig. 1, midway between the cylinders. The object of this box is to allow of the oil flooding of the parts, which ensures constant lubrication. The valve spindles are operated by means of cams, which revolve at half the speed of the engine. The arrangement for driving the exhaust valves is illustrated diagrammatically in Fig. 2. By this arrangement a very easy motion of the valve is obtained, and the connection between the cam bridle and the valve is an absolutely straight one, there being no moving joints or pins. The arrangement for driving the steam-valves is slightly different, owing to the necessity for obtaining automatic expansion. Each steam-valve has two cams, one being the opening cam and the other the closing cam. The opening cam has a fixed angle of advance, and thus gives constant load. The cut-off cam has its angle of advance variable by means of the governor, and thus cuts off earlier or later. The action is illustrated by Fig. 3. The handle of advance of the closing is adjusted by means of a spiral or scroll, this scroll being lifted or pushed down by the relay piston, which in turn is controlled by the governor. An advantage in the design of the cams pointed out by the author is that they are constant in diameter, so that the distance between the cam rollers is always the same. This gives a positive drive in two directions, without the use of the usual spring return. There is a spring, however, introduced in order to take up wear.

As regards the governing, the author considers that it is essential to accurate governing that the governor shall not be called upon to do much work. This condition is complied with in Corliss engines with triple gear. Mr. Day does not think it would apply, however, if the governor acted directly on the piston valve controlling the steam distribution in the high-pressure cylinder of a 2,000-h.p. engine. The effort required would then be too much unless everything were slack, which would result in bad economy and bad governing. The valve gear used by Messrs. Ferranti is illustrated in Fig. 4, in which *a* is the governor; *b*, the governor lever, one end of which is connected to the spindle of a small piston control valve, *c*. This control valve has oil under pressure between it, hence, if lifted slightly, the top port is opened and the oil under pressure is admitted to a port leading to the upper side of the relay piston, *d*. Thus this piston is forced down. If, on the other hand, the control valve is lowered the pressure is taken to the bottom of the relay piston, and this is forced up. As already described, this piston is connected to a spiral, *e*, which alters the angle of advance of the cut-off cams and thus changes the point of cut-off. If, then, the speed of the engine rises on load going off, the governor lowers the control valve, and the piston, D, is forced up until the cut-off is sufficiently early to balance the reduced load, and *vice versâ* in the case of increase of load. It will be seen that all the work the governor has to do is to operate the very small piston control valve, which on the largest engine can be worked by one finger. The device, however, in its simple form would try to give an absolute constancy of speed, which would make the working of dynamos in parallel somewhat difficult, as is shown on considering the following case of two engines, each of 1,000 h.p., driving alternators working in parallel. One engine has an isochronous governor, whilst the other has a governor with, say, a 6 per cent. range between full load and no load. Suppose each engine to be running at 200 revolutions per minute and loaded to half load, and that 500 h.p. suddenly comes on. The additional load would slow both engines down slightly, the consequence being that the isochronous governor would drop right down to its bottom position and give its engine its maximum quantity of steam, thus causing this engine to take up the whole of this additional load; whereas had this engine had a 6 per cent. governor like the other one, the governors would have opened out equally and the load been divided equally. If both governors were isochronous, a very unstable condition would occur, and the load would have a tendency to flow from one engine to the other. These difficulties have been overcome by the addition of the lever, *f*, the dash-pot, *g*, and the spring, *h*. The action of these parts is as follows: when the relay piston is at the top of its travel the spring, *h*, is compressed considerably, but when the relay piston is at the bottom the spring is much less compressed; thus, when the cut-off is late the load on the centre of the governor is much less than when the cut-off is early, consequently the governor speed is greater at light loads than heavy loads. By means of this small spring the range of the governor between no load and full load can be made anything which may be most suitable for running in parallel with other engines in the same station, and this result is obtained without any material movement of the governor itself. The action of the dash-pot also deserves attention. Suppose that the control valve opens at the top. The relay piston moves down, lifting the dash-pot piston up. The dash-pot cylinder is filled with oil, and thus there is a tendency to lift the governor up and cause it to return to its central position, and thus stop the movement of the relay piston. By this means the speed of action of the relay may be made fast or slow as is desired. The oil pressure which works the relay is obtained from a separate valveless pump, and an air vessel is provided to secure practically constant pressure. On these engines an emergency governor is also used, which comes into action at a slightly higher speed than the ordinary governor. This emergency governor acts on an equilibrium throttle valve. It does not hence shut the engine down at once, but prevents its speed from increasing in the event of the main governor failing. The handle on the throttle valve, however, enables the engine to be quickly shut down if desired. As regards the turning moment, Mr. Day points out the advantage which the high-speed engine has in driving alternators to be worked in parallel. This is so because with a constant frequency fewer poles are required, and hence a greater angular variation of speed is allowable for a given phase displacement.

In conclusion, the author states that he has confined his attention to novel points in design, and has shown in Fig. 1 the details of the parts in which old-established practice had been adhered to.

THE SIEMENS SOLID SYSTEM.

The well-known firm of electrical engineers, Messrs. Siemens Bros. and Co., have introduced a new solid system for laying electric light and power mains which is worthy of the attention of all electrical engineers. For containing the cables, troughs (Fig. 1) made of hard salt-glazed stoneware, in lengths of about 2ft., are used. The ends of these lengths fit together, in somewhat the same way as a spigot and socket joint, thus affording resistance to lateral displacement. The special feature of the joint is that the spigot piece is made to form a bridge for the cable. The separate bridge pieces of wood or other material used in most other systems are thus avoided. The covers of the troughs are made of strong, hard stoneware slabs, and are thickened to project into the troughs so as to avoid any liability to displacement during the filling in of the trenches. No cement or other jointing material is required. True alignment is obtained, and the surface finish of the troughs is such as to safeguard against damage to the cable by sharp edges.

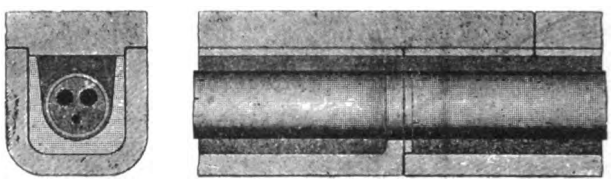

FIG. 1.—Sections of the Siemens Solid System for Cable Laying.

The standard sizes of trough carry one main only, but these troughs can be made to accommodate any reasonable number. Where a number of mains are laid side by side, and separate troughs employed for each, the Siemens troughs will occupy much less ground space than any type with external jointing sockets, as the absence of such expanded portions or projections allows of adjacent troughs being laid closely side by side, and a saving in trench work is thus secured. This applies to a run of troughs from which no branch connections would be made, but in the event of a distributor being run in the same trench as other mains, it would, of course, be so spaced that the service joint-box could be inserted at any point.

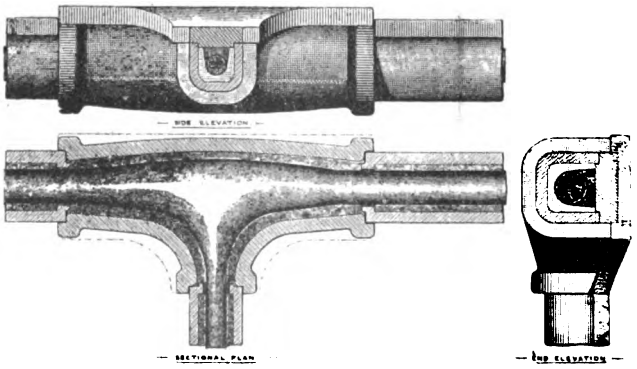

FIG. 2.—Details of Stoneware Ducts for Service Connections.

For through joints in the mains a type of junction which does not involve any alteration in the size or type of trough is recommended by the firm. The Siemens patent non-hygroscopic joint meets this requirement, and does away with the necessity of making joints in the lead, thus effecting a saving of time. In this joint the conductor ends are sweated with special soft solder into a brass tube, and insulated with layers of patent non-hygroscopic tape, which is extended over both ends of the lead casing. A lead

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tube previously slipped over the cable is drawn over the joint, and its ends then clamped and bound down with wires on the non-hygroscopic tape, which acts as an elastic packing, and ensures a perfectly watertight joint.

For consumers' connections a stoneware box (Fig. 2) is supplied, similar in all respects to the main run of troughing, with a T-branch for the service line and a stoneware lid to cover the whole. It can be readily substituted for a length of the trough, and is completely filled with the same compound that is used for the mains. The joint in the main is made with the patent non-hygroscopic material previously described. The details of the above solid system are well thought out, and should result in a thorough protection to the cables both against insulation troubles and mechanical injury.

THE RELATIVE ADVANTAGES OF THREE, TWO, AND SINGLE PHASE SYSTEMS FOR FEEDING LOW-TENSION NETWORKS.*

BY MICHAEL B. FIELD, M.I.E.E., A.M.I.C.E

In April last the Institution of Electrical Engineers did me the honour of asking me to read a short paper on the relative advantages of three-phase, two-phase, and single-phase power transmissions for feeding low-tension networks, to introduce the discussion on this subject in Section IX. of the Glasgow Congress. In putting this paper before you I wish to state that I have merely given expression to my own views on the subject, and have no idea whatever of dogmatically asserting that any one system is the best or the worst for a definite case. I have taken the Institution at their word, and have prepared a short paper in the hope that it may lead to a good discussion and call forth the views of other engineers more competent than myself to speak authoritatively on the subject.

To put my ideas in a few words, I must say that I completely fail to understand the objections of single-phase advocates to the three-phase system. For instance, in the case of a large tramway scheme I personally think that any one of the three systems should give excellent results; but while the three-phase is not one bit more complicated (except, perhaps, in theory) than the single-phase it possesses certain marked advantages from the point of view of prime cost, over-all efficiency, and stability of operation, which should justify its general adoption for any such extensive schemes as that now being developed in Glasgow. Let us consider, then, the transmission of power from a single central station to a number of feeding centres sufficiently remote to render the adoption of high-tension alternating currents for the transmission an essential; and, further, let us assume that we are not restricted as to the choice of frequency. I do not propose to discuss here the possibility of working the tramway system with alternating-current motors. I fully believe that before long this will be possible, but at present it is certainly impracticable. An efficient motor capable of economical speed regulation for city and suburban traffic, giving a large starting torque, and requiring but a single sliding or rolling contact for conveying current into the moving vehicle, has yet to be designed, and it, along with the accessory apparatus, will have to be standardised and subjected to severe tests over a lengthy period of time before railway engineers will be prepared to accept the same as a substitute for a continuous-current series motor.

Anyone acquainted with the Glasgow system will recognise the utter impracticability of working with two overhead conductors at different potentials per track at the very complicated crossings and junctions which occur in the city; or, further, the great difficulty and heavy expense of constructing a conduit system for two conductors owing to the enormous number of gas and water mains under the surface of the main thoroughfares; while the very heavy traffic in the same would render a surface-contact system unreliable. These facts alone, apart from all other considerations, strongly favour the adoption of the series motor (see Note I.). We have, therefore, no other choice than to assume sub-stations and suitable converters at the feeding centres for transforming the high-tension alternating into continuous current at 500 volts. In dealing with the possible types of converter, I wish to refer to the very detailed paper entitled "Polyphase Sub-Station Machinery," read before the Institution of Electrical Engineers on March 14 of this year by Mr. A. C. Eborall.

TABLE I.

Type of equipment.	Asynchronous motor-generator	Synchronous motor-generator	Rotary converters and step-down transformers.	Glasgow rotary.
Output of sub-station converter	500 kw.	500 kw.	500 kw.	500 kw.
Speed of converter	300	300	300	500
Number of field poles (generator)	10	10	16	6
Peripheral speed of commutator	1,880	1,880	3,100	3,250
Number of commutator bars	270	270	560	324
Temperature rise, any part after 24 hours at full load	35°C.	35°C.	35°C.	30° C.* after 12 hours.
Efficiency Full load	86%	87%	92%	92·5*
Efficiency Half ,,	80%	79%	87·5%	89·5*
Overload capacity for one hour with fixed brushes	25%	25%	75%	50%* rise of T=60°C.
Power factor Full load	91%	100-96% (leading)	100-96% (leading)	—
Power factor Half ,,	88%			
Starting current from A.C. side in terms of full load current	50% (rotor resistance)	100% (starting motor)	60% (starting motor)	—
Full load drop of speed	3%	None	None	None
Floor space required per kilowatt (square feet)	0·5	0·5	0·45	0·34

* Figures marked thus are guaranteed by contractors only.

TABLE II.

Type of sub-station converter.		Cost, including all necessary starting gear.	Total weight.	Efficiency of equipment. Full load.	¾ load.	½ load.
		£	Tons.			
Three-phase rotary with transformers	A	2,160	33	91	89·75	86·75
	B	2,560	31	92	90·5	88
	C	2,240	38	93·6	92·6	88·4
Two-phase ditto	A	2,240	34	91	89·75	86·75
	B	2,580	32	92	90·5	88
	C	—	—	—	—	—
Three-phase synchronous motor-generator	A	2,400	42	89·5	88·25	85·25
	B	2,280	44	86·5	85	81·5
	C	2,320	42	90	87	80
Two-phase ditto	A	2,400	42	89·5	88·25	85·25
	B	2,280	44	86·5	85	81·5
	C	2,320	42	90	87	80
Single-phase ditto	A	2,500	44	88·5	87·25	84·25
	B	2,440	48	85	83	79
	C	—	—	—	—	—
Three-phase induction motor-generator	A	2,680	50	89	87·75	84·75
	B	2,260	44	85·5	84·5	81·5
	C	2,360	43	89	86	80
Two-phase ditto	A	2,680	50	89	87·75	84·75
	B	2,300	45	85	84	81
	C	—	—	—	—	—
Single-phase ditto	A	3,200	64	85	83·75	81
	B	2,580	52	80	77	72
	C	—	—	—	—	—

N.B.—All the above refer to converter equipments of 500 kw. output at 500 to 550 volts on the direct-current side. Input at 6,500 volts on alternating-current side. To each equipment is direct coupled a negative booster, 600 amperes at 50 volts for rail return cables—*i.e.*, Glasgow practice—and where necessary a starting motor. A, B, C refer to different makers.

Generating and Transforming Machinery.—The choice of converter lies between (1) rotary converters combined

* Paper read in Section IX. of the Glasgow International Engineering Congress, 1901.

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with static transformers; (2) synchronous motor-generators without transformers; (3) non-synchronous motor-generators without transformers. The relative outputs for the same $C^2 R$ loss of a rotary converter if used as a continuous-current generator, or a single-phase, three-phase, four-phase, or six-phase converter respectively, are as follows:

D.C. generator.	Single-phase rotary.	Three-phase rotary.	Four-phase rotary.	Six-phase rotary.
1·00	·825	1·31	1·61	1·94

The four-phase connections will be employed with the ordinary two-phase transmission system, the three and six phase rotary connections with the three-phase system, or possibly with a suitable arrangement of transformers with the two-phase system. The table is based on calculations only, and I am not aware that the figures have been verified experimentally. I see, however, no reason to doubt their accuracy. Table I. has been taken from Mr. Eborall's paper, the last column, which refers to the Glasgow 500-kw. rotary, having been added. Table II. gives costs, together with a comparison of efficiency and weight, of three and two phase rotaries, three, two, and single phase synchronous and non-synchronous motor-generators, for 25 cycles 500 kw. output. (This is the size of Glasgow sub-station units.)

The single-phase rotary works at such a disadvantage compared with two and three phase rotaries, that I have not thought it worth while to include it in the above table. From these figures it is evident that the rotary converter, *per se*, has the advantage over all other converters. It is true it requires three or six extra single-pole low-tension switches on the switchboard, but in itself is a less complicated machine than the motor-generator. Taking it altogether, there is, as regards complication, nothing to choose between a rotary with its transformers and a motor-generator without. As regards ease of running and starting up, I would say that, with properly designed rotaries for low frequency, there is no difficulty in this respect. Much is talked about surging and hunting of rotaries; almost exactly the same may occur with synchronous motors; but in all well-designed machines of both types, driven from good generators coupled to well-designed engines, giving a uniform turning moment, with heavy flywheels, this trouble may be considered as practically non-existent.

Lastly, as regards overload capacity, ease of regulation and manipulation, the rotary converter affords all that can be desired. The Glasgow rotaries, for example, have from the moment they were first started run without trouble of any kind. It is, of course, *possible* to make them surge, but it is not easy. Perhaps the only trouble we have had at all has been the reversal of the polarity of the rotaries, due to a heavy surge of current throughout the system, which has occurred once or twice on switching out a generator. As a matter of fact, this has not caused us any inconvenience to speak of, as the cars do not know or care whether the trolley wire above them is positive or negative. It would not do if we were charging cells, but in any case I think it is a difficulty which we shall readily overcome as we become more experienced.

Cables.—It is interesting to note that theoretically the three-phase system should give the best results as regards power that can be transmitted with a given weight of copper and with a minimum strain upon the insulation of the system. Fig. 1 represents systems involving the single, two, or four, three, five, and six phase principles, the neutral point in each case being earthed. Let V be voltage and C current per leg in each system (in the single-phase case the line voltage equals 2 V), then the power transmitted in the different cases will be represented by n V C cos ϕ, where n = number of legs and ϕ = angle of lag. The power transmitted per unit weight of copper will be the same in each case, and similarly the maximum potential above earth; but the maximum potential difference existing between any two points in the system—*e.g.*, between the cores of a line cable—is a minimum in the three-phase case. Again, if the neutral point be not earthed, we must consider as the maximum strain on the insulation the voltage above earth of any line wire or pole if one other become accidentally earthed for an instant; this is again clearly a minimum in the three-phase case.

Consider a specific case. In Glasgow we have four three-core cables to each of the five sub-stations; the area of these cables is 0·1 or 0·15 square inch per core, as the case may be. Any one of these cables may be switched out independently of the others. An equivalent arrangement, if single-phase transmission had been adopted, would have been obtained by employing (1) one concentric cable per circuit, or four cables per sub-station; (2) two independent single-core cables per circuit, or eight cables per sub-station; (3) one two-core cable per circuit, or four cables per sub-station.

In the case of a two-phase transmission, we might have corresponding arrangements with (1) two concentric cables per circuit; (2) four single-core cables per circuit; (3) two two-core cables per circuit; (4) one four-core cable per circuit. In comparing the various systems, we can either

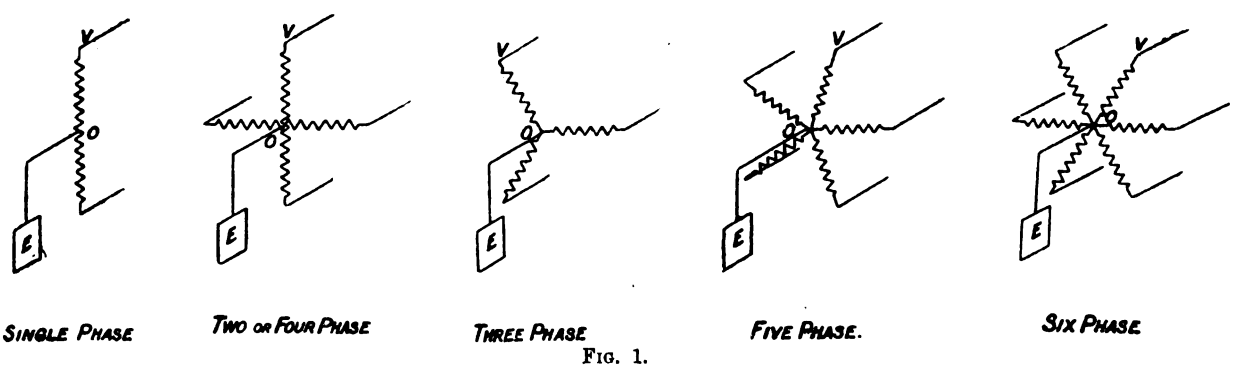

FIG. 1.

keep the maximum potential above earth the same in each case—in other words, keep the same strain upon the insulation of generators, etc.—or we can keep the difference of potential between the line conductors—that is, the strain on the insulation of the cables—the same in each case. It does not, however, follow that these two conditions will obtain at the same time.

Table IV. gives a comparison of these various cable systems, taking as a basis one mile of three-core cable with earthed neutral, transmitting 1,000 kw. at 6,500 volts (three-phase), the area of each core being 0·15 square inch. In every case the effective voltage is referred to, not the maximum of the voltage-wave curve. In the above case it will be seen that the strain on the insulation of generators, transformers, etc., is 3,750 volts, and on the insulation of the cables 6,500 volts. Cases 2 and 3 represent a single-phase transmission with concentric cables. In this instance it will be essential to work with an earthed outer conductor to ensure stability of working. With 3,750 volts between inner and outer we shall have the same strain on the insulation of the generators, but a smaller strain on that of the cables. With 6,500 volts working pressure the strain on the generators will be greater and on the cables the same as in Case 1. The amount of copper in the line will be 4 times and 1·33 times respectively that in Case 1 for the same transmission loss. Cases 4 and 5 represent a single-phase transmission with two-core cables, the neutral point being earthed. In Case 4, with 1·33 times the amount of copper, we have the same strain on cables, but smaller strain on generators; with the same copper in the line (Case 5), we have the same strain

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TABLE IV.

1,000 kw. transmitted one mile through	Volts between line wires or covers.	Volts per leg of system.	Current per line wire.	Area cross-section per line wire.	Total area cross-section.	Volts above earth of any line wire—*i.e.*, electrical strain on generators, switch gear, etc.	Volts between cores—*i.e.*, strain on insulation of cable.	Cost per mile laid and jointed, including ducts and drawing in. A.	Cost per mile laid and jointed, including ducts and drawing in. B.
								£	£
(1) Three-phase, three-core ; earthed neutral point of system	6,500	3,750	89	·15	·45	3,750	6,500	956	1,072
(2) Single-phase concentric ; earthed conductor	3,750	—	267	·9	1·8	3,750	3,750	2,244	2,154
(3) Ditto, ditto	6,500	—	154	·3	·6	6,500	6,500	1,150	1,499
(4) Single-phase, two-core ; earthed neutral	6,500	3,250	154	·3	·6	3,250	6,500	1,090	1,175
(5) Ditto, ditto	7,500	3,750	133	·225	·45	3,750	7,500	968	1,067
(6) Single-phase, two separate cables ; outer earthed neutral	7,500	3,750	133	·225	·45	3,750	strain on insulation 3,750	1,128	1,280
(7) Two-phase, four-core ; earthed neutral	6,500	3,250	77	·15	·6	3,250	6,500	1,132	1,256
(8) Ditto, ditto	7,500	3,750	66·5	·1125	·45	3,750	7,500	948	1,182
(9) Two-phase, two two-core cables ; earthed neutral	6,500	3,250	77	·15	·6	3,250	6,500	1,540	1,482
(10) Ditto, ditto	7,500	3,750	66·5	·1125	·45	3,750	7,500	1,352	1,374
(11) Three-phase, three-core ; not earthed	6,500	3,750	89	·15	·45	6,500	6,500	1,144	1,168
(12) Single-phase, two-core ; not earthed	6,500	3,250	154	·3	·6	6,500	6,500	1,204	1,284
(13) Single-phase, two separate cables ; not earthed	6,500	3,250	154	·3	·6	6,500	6,500	1,420	1,456
(14) Two-phase, four-core	6,500	3,250	77	·15	·6	6,500	6,500	1,240	1,388
(15) Two-phase, two two-core	6,500	3,250	77	·15	·6	6,500	6,500	1,692	1,590

The above prices refer only to paper-insulated, lead-covered cables drawn into cement-lined iron ducts—*i.e.*, Glasgow practice. In each case the same power is transmitted, and the loss per mile in kilowatts is 6·3.

on the generators, but a greater in the cables. Case 6 represents a single-phase transmission with two separate cables and an earthed neutral. In this instance the working voltage should be 7,500, when the strain on both generators and cables will be 3,750, the weight of copper being the same as in Case 1. The disadvantage is, of course, that twice the number of actual cables is required, and the self-induction of the line materially increased. Cases 7 and 8 represent two-phase transmissions with four-core cables and earthed neutral points. They exactly correspond to the single-phase Cases 4 and 5, and to Cases 9 and 10, where two two-core cables per circuit are employed. Case 11 represents the three-phase three-core case where the neutral is not earthed. Here we have, of course, as maximum possible strain on generators and cables, 6,500 volts. With this we may compare the systems with two-core, four-core, and separate cables. In this instance the strain on both generator and cables, as in Case 10, will be 6,500 volts, but the weight of copper will be increased by 33 per cent.

This is a somewhat lengthy discussion on the cable question, but I think it includes all possible cases, and the basis of comparison is a fair one. The last column of the table, giving costs, applies to lead-covered paper-insulated cables, and includes the cost of duct-laying on the system adopted in Glasgow. The table clearly shows that the advantage certainly lies with the three-phase system. It has been assumed throughout that in the single, two, and three phase cases the shape of the E.M.F. wave will be the same, and I see no reason why it should not be so. Before dismissing this cable question, I would like to say that I personally much prefer to have an unearthed system, and to rely on keeping a proper check on the insulation. If concentric cables be employed, it is imperative to earth the outer conductor. I think a three-core cable is the handiest and best. Of course, if other side issues enter in here, such as Board of Trade requirements in the way of earthed metallic sheaths outside the cables and distinct from the lead covering, or limit of power to be transmitted through any single cable, the above considerations may be entirely modified. For example, the two-phase and single-phase systems require the same weight of copper as long as each phase is supplied through a two-core cable and the systems be unearthed ; the two-phase system with a three-conductor cable is much more extravagant from the copper point of view than the single-phase, but if we have to provide an earthed sheath, and we utilise this as one conductor, the two-phase with two concentric cables requires less copper than the single-phase with one concentric cable, since in the former case the two outers being connected by earth form a common main, and hence their cross-section can be reduced.

Table V. illustrates this, showing how the question of Board of Trade regulations may entirely modify one's views. Note that the three-phase system with earthed neutral is considerably better than the two-phase with two concentrics. In the former case the copper area is ·45, and strain on generators 3,750 ; in the latter, copper area is ·437, the strain on generators being 6,500 volts, or twice as many cables are required as in the three-phase case.

TABLE V.

Type.	Volts per phase.	Current	Area.	Loss total	Max. possible strain on insulation of system.
				Per mile.	
Single-phase, two-core, or two separate cables—unearthed system	6,500	154	·3 + ·3 = ·6	6·3 kw.	6,500
Two-phase, three-conductor, with or without common conductor earthed	4,600	109 / 109 / 154	·256 + ·256 + ·362 − ·874	6·3 kw.	6,500
Single-phase, concentric, earthed outer	6,500	154	·3 + ·3 = ·6	6·3 kw.	6,500
Two-phase, two concentric earthed outers	6,500	77 / 77 / 109	·128 + ·128 + ·181 = ·437	6·3 kw.	6,500

Switchboards.—Here alone will a simplification be effected by employing a single-phase circuit. The mere fact, however, of requiring three legs per switch instead of two, or possibly, though not necessarily, three ammeters per circuit instead of one, should not have very much weight in determining the choice of a system. I may say that in the Glasgow scheme all switchboards put together constituted only about one-fifth of the value of the cable system, so that the saving effected here by the employment of a single-phase system could not have amounted to much.

In this connection there is one thing to be said in relation to the space question : it is often extremely difficult to fit in a switchboard ; for a large scheme particularly the boards may assume such proportions as to cause considerable difficulty in making an entirely practicable arrangement, and any system which will diminish the over-all dimensions of the board *safely* will in that respect have the advantage.

(To be continued.)

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Now Ready, Vol. XXVII., bound in blue cloth, gold lettered, price 8s. 6d.

STOKE NEWINGTON LIGHTING.

The history of the various first steps which have been taken to give a supply of electric light in Stoke Newington would be of great interest if one could have the same for perusal. In the first instance, a large portion of what is now the metropolitan borough of Stoke Newington was included in the Hackney parish. It follows accordingly that when the Hackney Board of Works in 1893 obtained a provisional order, it included in the area scheduled to that order a good portion of Stoke Newington. We do not think that it has ever been decided quite how the powers then granted to the Board of Works were altered when the new Vestry of Stoke Newington came into existence. It would seem, however, that the Hackney authorities now are not advised that they have any right to supply individual consumers within the ceded area. The next futile steps towards an electric light supply were taken by numerous electric lighting companies. These applications were all refused by the Board of Trade; even when the North Metropolitan Electric Supply Company had obtained powers for the supply of electrical energy in bulk to a large tract of country in the North of London, they were unable either to get a provisional order or the consent of the Council to allow them to supply in Stoke Newington. It would seem now that what this company failed to do, the Hackney Council will be allowed to carry out. Elsewhere in this issue will be found the full text of a most able report by Lieut.-Colonel Crompton, R.E., on the prospects of electric lighting in Stoke Newington, and also on the offer which the Council has received from the Hackney Council. We have to congratulate all concerned with the proposal in question. The essence of any scheme for the distribution of electrical energy in bulk is that the consumer shall receive the supply at a lower rate than that at which he can generate it himself. In considering the rates, of course interest on the capital outlay and also depreciation of the plant must be taken into account. If the cost of the supply in bulk does not show favourably in comparison with the above, it is obvious that either the supply company is making an undue profit, or that the local conditions are such that it is impossible for an outsider to compete with a local station. We regret to say that in a number of instances brought to our notice in which power distribution companies have offered to supply in bulk to municipal authorities, there has been no advantage to the authorities in question in consequence of the rates demanded. It is often found that at the same time an alternative offer is made to take over the provisional order from the town. In a number of these instances it has obviously been the policy of the company to obtain both the distributing and the generating profits in their own hands. The reverse of this is the case at Stoke Newington. According to Lieutenant-Colonel Crompton's report, the Hackney Council offered to supply electricity in bulk to the neighbouring authority at a lower rate for a given output than it has yet been produced at by any London authority. The figures given in the report show that the offer is sufficiently advantageous in the earlier years of the proposed undertaking, and we note with interest that the Hackney Council only propose a seven-year agreement; hence, after having worked up a connection and having obtained a large number of consumers, the Stoke Newington Council may find it expedient to put down their own works. We say "may find it expedient," because at the end of seven years the Hackney Council may be able to offer still more favourable terms, which will still show an advantage as regards cost over what would obtain

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in smaller works in Stoke Newington. We cannot but congratulate the Hackney Council and its electrical adviser, Mr. Robert Hammond, on the suggested arrangement, which has been accepted by the Stoke Newington Electric Lighting Committee, and is now being considered in full Council. The offer shows a broad-minded consideration of the subject which is to be highly commended. It will be advantageous to the Hackney electric lighting undertaking to get the Stoke Newington load, and the Hackney Committee have shown that they are quite prepared to share this advantage. We trust that the matter will go through quickly, and that the results will be such as to encourage similar combinations.

REVIEWS.

The "Mechanical World" Pocket Diary and Year-Book for 1902. Emmott and Co., New Bridge-street, Manchester.

The issue before us is the fifteenth in order, and has been considerably enlarged over the present year's volume. Amongst the additional matter we notice some notes as to the care and management of dynamos and motors, and the author of these extra pages gives some most useful information on the subject in question. He rightly advocates that electric motors should be selected with an ample margin of power, so that they would not be overloaded under normal conditions. We hardly, however, agree with his statement that the limit to the capacity for work for both dynamos and motors is fixed more by mechnnical than electrical considerations. It may be, however, that he looks upon the breakdown of the insulation of an armature due to the overheating of insulation as a mechanical fault, whereas we would attribute it to the electrical side. Mechanical engineers will find these notes on dynamo and motor management worth issuing to the workmen in charge of such plants. Another addition to "'Mechanical World' Year-Book" are the tables of logarithms and anti-logarithms. These are of the four-figure class, and will be found exceedingly useful. The section devoted to hydraulic engineering has been revised, as has also a number of other divisions of the pocket-book. The large amount of information given somewhat restricts the space available for diary, but there is still ample room opposite each day to jot down appointments, etc. This little year-book of some 300 pages is still sold at the low price of 6d.

ELECTRIC GLASS FURNACE.

The melting of glass is always a wasteful process as regards fuel economy, owing to the fact that the arrangement of the melting crucible and the fire having to meet certain conditions in order that the glass shall not be rendered impure. It would seem, therefore, that in the manufacture of glass an electric furnace, if properly constructed, might have a chance of success. Such a furnace has been described by the *Scientific American*, who got their information from Dr. Voelker, of the Société Anonyme L'Industrie Verrière et ses Derivés, Brussels and Cologne. In the use of this furnace for the making of glass the ingredients are mixed in a hopper above the furnace, and are gradually dropped through on to three inclined melting hearths. Just over each hearth are the carbon electrodes between which the arc plays, so that the heating is commenced as the ingredients fall on to the first hearth. The molten glass trickles down the first hearth, drops upon the second hearth, is there subjected to the heat of the second arc, falls upon the third hearth, and finally reaches the collecting cup as an exceedingly liquid glass, free from all gases and impurities. Since it is of the utmost importance that no air be allowed to enter the melting chamber during the operation of fusing the silica, a compartment is provided at the side of each wall, which compartment is filled with refractory material packed so closely around the electrodes that no air can possibly enter.

FORTHCOMING EVENTS.

FRIDAY, OCT. 18.

Institution of Mechanical Engineers.—At 8 p.m., monthly general meeting. Paper: "Second Report to the Gas-Engine Research Committee," by Prof. F. W. Burstall.

THURSDAY, OCT. 24.

Lecture.—At 8 p.m., at the Technical College, Leonard-street, City-road, E.C., third lecture by Mr. M. O'Gorman on "Insulation."

FRIDAY, OCT. 25.

Institution of Junior Engineers.—At 8 p.m., at Westminster Palace Hotel, annual general meeting for presentation of report of council and election of officers for twenty-first session.

Physical Society.—At 5 p.m., ordinary meeting. Papers: "On the Variation with Temperature of the Thermo-Electromotive Force and of the Electric Resistance of Nickel, Iron, and Copper between the Temperatures of − 200deg. and + 1,050deg.," by Mr. E. P. Harrison; and "On Asymmetry of the Zeeman Effect," by Mr. G. W. Walker.

SATURDAY, OCT. 26.

Manchester Association of Engineers.—Ordinary meeting. Paper: "American *v.* English Methods of Conducting Engineering Establishments," by Mr. Edward Wood.

TUESDAY, OCT. 29.

Arbitration.—At 11 a.m., at the Offices of the Board of Trade, Whitehall, S.W., opening of enquiry as to the system of electric traction to be adopted on the "Underground" Railway.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

421. What class of repairs to tramcar electrical equipments does it pay to undertake with a specially-organised corporation staff, and what should be sent back to the makers to do?—P. T.

422. In a Tudor battery of the H.A. type, maximum discharge 140 amperes for one hour, a soft, white powdery deposit repeatedly collects on the horizontal surface edges of the positive plates. It can be removed with camel-hair brush. Some of the + plates are also somewhat blistered on the *edges*. The battery is a new one, and is kept well charged, but is rarely used up to maximum capacity. Can any reader give the cause of above phenomena, and the remedy?—E. M.

ANSWERS.

Question No. 415. It is stated in pocket-books that lightning conductors should have no abrupt bends. What is the reason (if any) of this rule, and would a right angle be considered an abrupt bend? I have noticed hundreds of lightning conductors with abrupt bends.

Best Answer to No. 415 (*awarded* 10*s.*).—In order to learn how to arrange lightning conductors, we must study the conditions existing during a thunderstorm. During a storm the atmosphere and all conducting bodies in the immediate neighbourhood become charged with electricity at a constantly increasing potential as we recede from earth. Even objects directly on the earth's surface, railway tracks, high fences, and the like, become charged and will spark. The characteristics of a lightning discharge are: (1) surgings due to the oscillatory character of the spark, and consisting of a series of disruptive discharges, sudden and violent; (2) self-induction; (3) side flash—the result of self-induction.

A disruptive discharge will often leave what would ordinarily be called an excellent conductor and side flash through the air to another much worse conductor. For instance, the discharge, instead of continuing to earth by

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the lightning rod, may select its own path through a wall of brick or stone to a neighbouring gas-pipe or bell-wire. An instance of this happened at All Saints' Church, Nottingham, a few years ago; a lightning discharge passing from the conductor through a solid wall of masonry 4½ft. thick into a gas-pipe on the other side. In a paper read by Colonel Parnell in 1884 the author states that out of 828 cases of lightning strokes, the effects of *heat* were visible in only 228. The mechanical effects of an electric discharge are often very violent, and are always greatest where the current springs from one body to another. The splintering effect on trees is often noticed.

What we want to ensure in a system of lightning conductors is that the discharge shall be conveyed to earth *by the conductors only*, as if it passes through any portion of the building it is liable to do damage. For this purpose it is necessary to so arrange the conductors that they offer the least possible resistance to the passage of the discharge. We have to consider not only the ohmic resistance, but the impedance of the whole arrangement, as given by the formula $I = \sqrt{R^2 + L^2 p^2}$, where L = self-induction of the system and $p = 2\pi$ times the frequency of the oscillations. No method has yet been devised for measuring the frequency of an oscillatory lightning discharge, but it is believed to be enormous. Tesla has shown that with very high-frequency currents an iron pipe conveying gas becomes an insulator for the current, while the gas is a good conductor. It is quite possible that the frequency of some lightning discharges may be high enough to produce this effect. In any case the conductors should be as short and as *straight* as possible, since the inductance of a straight wire is a minimum. As to whether a right angle would be an abrupt bend, it depends on circumstances. If you are protecting a large building by one conductor leading to earth, this conductor should be straight, and other conductors connected to the metal parts of building should be joined to the main conductor at right angles. To effect this, the main conductor should preferably be supported *away* from the building, so as to avoid following its contours. Probably the ideal way to protect a tall square tower would be to have four vertical conductors supported about 1ft. from each corner (so as to form a square of larger side), and connected together at the top of tower by a circular conductor provided with about a dozen pointed collectors, the ring being just above the highest point of tower. The aim must always be to enclose the building in a metallic envelope. Probably few of the public buildings in England are really efficiently protected from lightning, conductors following the contour of the buildings at all angles and bends being the rule.—E. M.

Answer to No. 415 (*awarded* 5*s.*).—There is a very good reason why sharp bends should be avoided in lightning conductors, and the fact that many conductors with abrupt bends are seen shows that insufficient attention is paid to the protection of buildings from lightning, most people thinking that as long as they have a lightning rod they are quite safe, and not troubling how it is erected. A right angle would certainly be considered an abrupt bend. The characteristics of a flash of lightning which concerns us most are: (1) surging that is due to the oscillatory character of the spark, which, unlike the currents generated from a dynamo, is a sudden and violent disruptive discharge; (2) self-induction, a property which gives rise to counter force as choking effect, noticeable in straight wire, but which is more pronounced in coils of wire or bends; and (3) side flash, the result of self-induction. A disruptive discharge will often leave what would ordinarily be called an excellent conductor and side flash through the air to other much worse conductors. For instance, the lightning rod may be struck, but instead of following the course provided, a side flash may select its own path through a wall of brick or stone to a neighbouring gas-pipe or bell-wire. The often quoted example of this danger is the accident at All Saints' Church, Nottingham, about 1870, when the discharge passed from the lightning conductor through a solid wall of masonry 4½ft. thick to a gas-pipe.

Now, these evils may be avoided to a great extent by making the lightning conductor as straight as possible. If, on the contrary, there are any sharp bends or curves, it will be easily seen that the self-induction will be more pronounced than in the former case, which may result in a side flash to some other conductor in another part of the building, thereby doing great damage; also, a disruptive discharge not being like a continuous electric current, but more sudden and violent, and the fact of it having to travel through, say, half a mile of air space before striking the conductor, there is no reason why this discharge should not leave the lightning rod before reaching earth, and side flashing to some other earthed conductor, especially if there are any sharp bends or curves, as they give rise to a throttling or choking effect, which, as before mentioned, facilitates the side flash.

In conclusion, the writer will refer to an article on the "Protection of Buildings from Lightning," published in the *Electrical Engineer* of Sept. 27.—R. F. W.

Answer to No. 415 (*awarded* 5*s.*).—In his recent paper read to the British Association, and published in the *Electrical Engineer* for Sept. 27, Mr. Killingworth Hedges points out that lightning conductors as at present constructed afford only "incomplete protection, and are far from being efficient." One of the reasons mentioned by Mr. Hedges for their inefficiency is that they neglect the rule about abrupt bends. In the report of the Lightning-Rod Conference it is stated that no bend on a conductor ought to be sharper than 135deg. This rule was deduced from the practical experience gained by the inspection of numerous cases where the lightning rod had broken down. Prof. Lodge was the first to point out the theoretical reason why there should be no abrupt bends, and he illustrated his theory by what he called "the experiment of the alternative path." He bent a thick copper conductor so that at the middle it formed part of a circle. On sending a discharge from a battery of Leyden jars through this conductor it was often observed that the discharge preferred to spark across between the ends rather than go round by the copper conductor. The discharge had two paths open to it: one through the air, having a resistance of millions of megohms, and having practically no self-inductance; the other through the copper, which had a resistance of only a few microhms, but an appreciable self-inductance. The experiment showed that "the path of least resistance" for the electric discharge was the path of least inductance. Faraday had previously shown this experiment, but he offered no adequate theoretical explanation of it. Dr. Lodge insists that it is the inductance, and not the ohmic resistance, that has to be considered in lightning conductors. The danger of an abrupt bend therefore arises from the risk of the lightning discharge sparking from one part of the conductor to the other. Where it leaves the lightning conductor a powerful mechanical force is brought into play, so that the rod is broken or torn or melted, and hence its use as a lightning conductor for protecting from subsequent flashes would be at an end. As sharp bends can always be avoided by having a few more feet of copper rope, it seems to me that in this case it would be wise to follow the advice in the text-books. I imagine that Dr. Lodge would consider a right angle an "abrupt bend."—J. C. R.

Answer to No. 415 (*awarded* 5*s.*).—It is an important point in the erecting of lightning rods to avoid abrupt bends, and yet in hundreds of cases, as the question says, no attention seems to have been paid to this matter. Take, as an example, a case that I saw the other day. The top of a chimney was shaped something like the sketch (Fig. 1), and the lightning rod faithfully followed every curve and corner. Now, the lightning conductor would have been far more efficient if it had been curved over the projections (as shown in Fig. 2), or if this is objected to as having an unsightly appearance, the conductor could have followed the curves of the chimney a little closer (as shown at Fig. 3). Of course, if a current of electricity from a dynamo had to be sent along the conductor, there would be no objection to the sharp angles, but a flash of lightning is a very different thing. A discharge of lightning is almost certainly oscillatory, being composed of a series of discharges in opposite directions, and the rapidity of alternation will be very great—above

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1,000,000 per second. The intensely high pressure needed for the passage of electricity through hundreds of feet of air (most certainly several millions of volts) must also be taken into account. Taking these facts into consideration, it will be seen that if any encouragement is given in the way of sharp bends, defective joints, etc., the flash will not be hindered by thick masonry or a few feet of air space

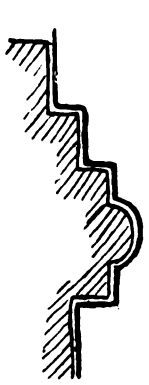

FIG. 1.

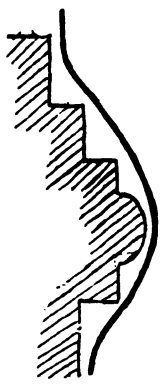

FIG. 2.

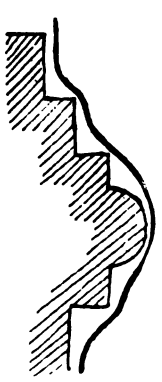

FIG. 3.

from taking another course than that provided, say to a neighbouring gas-pipe. In the question it is asked whether a right angle would be considered an abrupt bend. It depends upon what is meant by a right angle. For example, a conductor is shown bent at right angles in Fig. 4A, while the conductor shown at Fig. 4B might also be described as bent at right angles. The first is an abrupt bend, but the second is not; still, even a bend of this description is best avoided.

FIG. 4A.

FIG. 4B.

Prof. Lodge, who is an authority on lightning conductors, in a communication to the Institution of Electrical Engineers in 1889, finished his article by giving several rules to be observed in erecting lightning conductors. Rule No. 3 is as follows: "Bends at angles should be avoided. At abrupt curves lightning is apt to spring from one point to another with the risk of rupture." Major Pescetto, of the Italian Royal Engineers, in a paper on this subject says: "The zone of protection does not exist, since lateral discharges may set out from the very shaft of the lightning rod." He, of course, is referring to the rule found in many articles on the subject, that the area protected by any rod is one with a radius equal to twice the height of the rod above the object to be protected. The truth is that buildings are struck sometimes within this very area, and it is now held that there is no such thing as a definite protected area.—W. A. T.

Question No. 416.—What is the most practical way of determining the "curve" of single and polyphase alternators, both before and after manufacture?

Best Answer to No. 416 (*awarded* 10*s.*).—The predetermination of the no-load voltage curve of a disc armature alternator or an iron armature alternator with a fairly large number of slots per pole can be carried out with sufficient accuracy as follows, but for iron-type alternators with only one or two slots per pole the method does not lead to good results: An assumption must first be made as to the fringing of the magnetic lines round the edges of the poles, and for this purpose it will be sufficiently close if we assume that the flux all over the actual pole-face is of uniform density, and that, in addition, a flux of half this density passes into the armature from two spaces, one at the leading and one at the trailing edge of the pole-face, each of a width equal to the length of air-gap separating magnet iron from armature iron (or in the case of a disc alternator, one pole-face from the opposite one). This is, of course, not accurate, as the fringe really varies in density gradually from the full value at the edge of the pole to zero at a point midway between two poles, but as far as the curve is concerned the difference is very slight. A diagram (as in Fig. 1) should be drawn showing the relative dimensions of pole, fringe, and armature coils. The total induction leaving a pole is given approximately by the ordinary formula:

$$N = \text{flux per pole} = \frac{\text{volts per phase} \times 10^8}{\text{conductors per phase} \times \sim \times 2{\cdot}22}.$$

The constant 2·2 is only correct for a sine curve of E.M.F., but does not vary much for other shapes. If the area of a pole-face be A square inches, and the area of the assumed fringe be a square inches, we get the density under the pole-face itself to be $B = \frac{N}{A + \frac{a}{2}}$ in C.G.S. lines per square inch, and the density in the fringe has half this value. If the length of a pole-face parallel to the armature conductors be L inches, and the effective diameter at which the conductors rotate be D inches, the voltage induced in a single conductor when actually under the pole-face will be $\frac{B \times L}{60 \times 10^8} = E$, where R is the number of revolutions per minute, and the voltage when in the fringe will be $\frac{E}{2}$. The line $x\ y$ (Fig. 1) represents the centre point of one sheaf of windings in a single-phase alternator armature with six occupied slots per pole. With the line

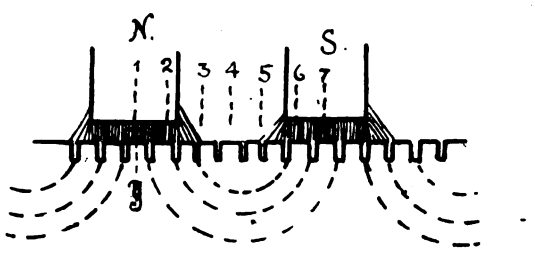

FIG. 1.

$x\ y$ opposite the centre of a pole, as shown, the voltage four slots are under the pole-face and two under the fringes, and if there be n conductors per slot, the total voltage induced in the sheaf at this instant will be

$$E \times n \times 4 + \frac{E}{2} \times n \times 2.$$

In the same way, by assuming the line $x\ y$ successively placed in positions 2, 3, 4, 5, and 6, we can readily determine the voltage induced in a sheaf at each of these points At position 4, for instance, there will be an occupied slot under a north pole and one under a south pole, as well as one slot under each fringe, and as the conductors under opposite poles have induced voltages in opposite directions, the net effect of the sheaf at this point will be zero. At point 7 the voltage will be a maximum again, but in the opposite direction to that at 1. In the case of polyphase alternators the process is exactly the same, the curve being determined for each phase separately. The effect of load on the shape of the curve is very slight, so long as the load is non-inductive, but becomes more pronounced as the load becomes inductive. The process of allowing for inductive loads is, however, too lengthy to admit of its practical use.

To turn next to the method of determining the curve experimentally when the alternator has been constructed. The most accurate results are undoubtedly given by the oscillograph, but failing this somewhat delicate and expensive apparatus, one of the numerous modifications of Joubert's contact method must be resorted to, and of these perhaps the simplest is the following. It is applicable at no load or full load, inductive or non-inductive, and give results quite accurate enough for practical purposes with little trouble or expense. A disc of insulating material, such as fibre or ebonite, which need not be more than 6in. or 8in. diameter, is attached to the rotating alternator armature. In the periphery of this disc a number of narrow (say $\frac{1}{16}$in. wide) metal contact pieces must be inserted flush with the periphery of the disc. The number of these contacts must divide into the number of poles, and can be either equal to the poles, to half the poles, to a quarter the poles, etc., but the larger the number the better,

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They must be accurately spaced at equal distances round the periphery, and must all be electrically connected together. One terminal of the alternator is connected to these metal contacts, whilst the other terminal is connected to the frame of the machine. The instantaneous voltage of the machine can then be measured by an ordinary electrostatic voltmeter connected between the frame and a small brush rubbing on the periphery of the disc of insulation. In this way the disc, as it rotates, closes the circuit between the armature and the voltmeter as many times in the revolution as there are contact pieces, and always when the armature coils are in the same definite position relatively to a pole. By moving the brush, *b*, along the scale (Fig. 2) the instantaneous voltages at all positions can be rapidly

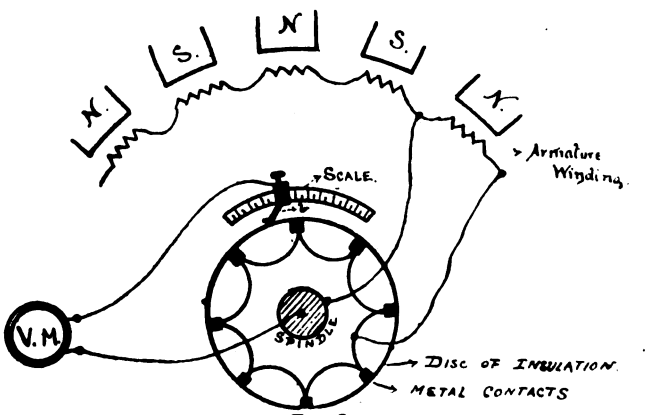

Fig. 2.

obtained, and by plotting these values as ordinates, with degrees of phase angle as abscissæ (the distance between the centre of a north pole and the centre of the adjacent south pole being taken as 180deg.), the curve of E.M.F. is obtained. If no convenient voltmeter is at hand capable of measuring the whole voltage of the machine, the connection may be made to one (as shown in Fig. 2), two, or more armature coils, instead of to the whole armature windings. If a condenser is available for connecting across the voltmeter terminals, it is possible to dispense with all but one contact piece on the rotating disc, as the only purpose of the numerous contacts is to prevent the meter needle having time to swing between one contact and the next, and a condenser has the effect of maintaining the voltage practically constant at the meter terminals between the contacts. The arrangement of Fig. 2 is intended for a rotating armature alternator; but very little modification is necessary for a stationary armature. In that case the disc would be attached to the rotating magnets, and the contact pieces would be electrically connected to a continuous metal ring fixed to the side of the disc, and on which a brush, connected to one of the armature terminals, rubs. The other armature terminal would again be connected to the frame, and the voltmeter from the frame to the brush, *b*.—Q.

Answer to No. 416 (*awarded* 5*s*.).—To trace the curve of an alternator, an instantaneous contact must be employed—that is, contact is made during an indefinitely short time on a point in the phase. This contact is made many times a second (proportional to the speed), so that a permanent deflection is given. This deflection does not give the volts; but this is not necessary, as the voltage is known (virtual). Referring to the sketch (Fig. 1), C is the alternator, A the electrometer (a voltmeter or galvanometer will do), B is a brush which can be moved round the centre of the armature with a scale so that the degrees moved may be noted, D is a pointer fastened on and connected to the collecting ring, F, G is a brush which connects one of the alternator terminals to the ring, F. The pointer, D, and collector, F, are pierced on the shaft so that they rotate with it. To take a test: The brush, B, is fixed over a point, say, what is thought to be the zero line. The alternator is then run up, and must remain at constant speed during the test. Now if B is at zero no reading is given on the meter, A, so B is moved forward or backward (the movement of B must always be in the same direction), say, 10deg. of the phase. A deflection will then be noted on the meter; this must be taken down. B is then moved again, another reading taken, and so on until zero is reached. We have then got the pressure every 10deg., and can plot a curve, from that curve we can calculate the virtual volts. We compare the virtual volts of the curve to the virtual volts on a voltmeter we have had across the terminals, and from the comparisons we get the scale of the curve. The above method is simple, and might be employed in a workshop without fear. A very pretty arrangement has been made by M. Blondel. He uses a luminous ray on sensitive paper in place of the instrument A, B being moved round at a proportional speed to the sensitive paper. To get the curve at the end of a feeder a synchronous motor may be used, but it must use very little power.

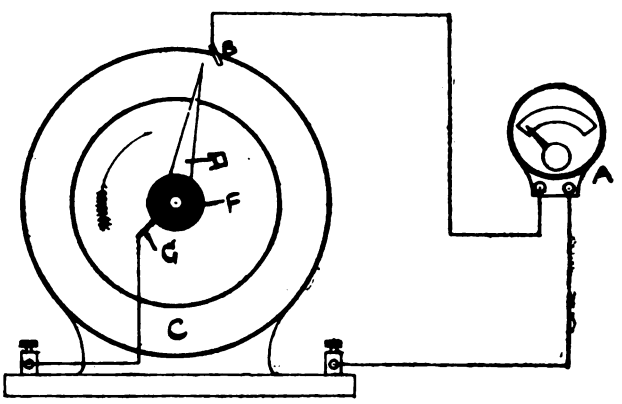

Fig. 1.

When designing an alternator the designer always aims to give his machine a sinusoidal curve. He knows that the armature tends to pull the magnetism over to the trailing horn of the magnet. He tries to prevent it by increasing the resistance to the magnet path by employing a very high density at that side, putting saw-cut at right angles to the rotation and radial from the shaft, by making the air-gap larger at the trailing side or by combining two or more of the above methods I have never, I am sorry to say, designed one myself or seen one with a true sine curve. With polyphase alternators it only means separating the phases, thus making a single-phase one of it and treating it as such.—T. W. S. H.

STOKE NEWINGTON LIGHTING.

The following is a report (addressed to the town clerk) by Lieut.-Colonel R. E. Crompton on the lighting of Stoke Newington by electricity, which is now under consideration:

In accordance with your request that I should furnish you with a report of advice to your Council on the three following questions: (1) the adaptability of your district for electric lighting at a profit; (2) whether the Council should manufacture the supply themselves, or take it from other sources in bulk, and if the latter, at what price? (3) whether in or not in conjunction with the dust destructor? I have carefully read over the particulars furnished by you to me, giving the length of the streets, the ratable value, the number and description of the various business premises and private dwellings. I have also studied the map of your district and went round the principal streets in company with yourself and your surveyor, Mr. Loveday. I have since met by appointment Mr. Hammond, the engineer to the Hackney Borough Council, and discussed with him the Hackney system of supply. I have also read the resolution of the Hackney Borough Council as to the terms on which they are prepared to supply the borough of Stoke Newington with electrical energy in bulk. I have also gone through the accounts of the works carried out by local authorities under conditions closely resembling your own, in case you should decide on putting down your own works to supply your district, and am now able to report to you as follows:

The points on which your councillors require information to enable them to come to a decision on the first question submitted to me—*i.e.*, the adaptability of your district for electric lighting at a profit—are these: Has your district any special features which make it different from other metropolitan districts that have successfully and profitably introduced electric light? What are these peculiarities, and how do they affect this question? If we compare your district with the neighbouring ones of Islington and St. Pancras, we find that it differs from them chiefly in the fact of the large open spaces that exist towards the centre of your borough. I refer to Abney Park Cemetery, Clissold Park, and the large open spaces occupied by the New River Company's reservoirs in the northern part of the district.

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TABLE I.—SHOWING ANNUAL EXPENDITURE AND COST IN PENCE PER UNIT OF TAKING ELECTRICAL ENERGY IN BULK FROM HACKNEY AT A POINT IN STOKE NEWINGTON, AND THENCE DISTRIBUTING IT THROUGH YOUR OWN MAINS.

Units sold per annum (Lighting / Power)	250,000 / 100,000				500,000 / 200,000				1,000,000 / 300,000			
	£	s.	d.	Cost per unit in d.	£	s.	d.	Cost per unit in d.	£	s.	d.	Cost per unit in d.
Wages on distribution, meter readings, etc.	200	0	0	·138	300	0	0	·10	500	0	0	·09
Repairs to mains, 2 per cent. on outlay	400	0	0	·275	600	0	0	·20	1,000	0	0	·18
Management	200	0	0	·138	300	0	0	·10	500	0	0	·09
Interest and depreciation charges—												
At 4¾ per cent. on £25,000	1,200	0	0	·825	—			—	—			—
,, ,, ,, £40,000	—			—	1,900	0	0	·65	—			—
,, ,, ,, £60,000	—			—	—			—	2,850	0	0	·53
Total cost of distribution	2,000	0	0	1·376	3,100	0	0	1·05	4,850	0	0	·90
Charge made by Hackney works on proposed scale—												
Light... 100,000 at 3d.	1,250	0	0		1,250	0	0		1,250	0	0	
Light... 150,000 ,, 2½d.	1,720	0	0		1,720	0	0		1,720	0	0	
Light... 250,000 ,, 2½d.	—				2,600	0	0		2,600	0	0	
Light... 500,000 ,, 2½d.	—			2·6	—			2·47	5,200	0	0	2·45
Power.. 100,000 ,, 2d.	833	0	0		—				—			
Power.. 200,000 ,, 2d.	—				1,666	0	0		—			
Power.. 300,000 ,, 2d.	—				—				2,500	0	0	
Total of Hackney charges	3,803	0	0	—	7,236	0	0	—	13,270	0	0	—
Total, including distribution	5,803	0	0	4·0	10,336	0	0	3·52	18,120	0	0	3·35
,, less 10 per cent. of power	5,720	0	0	3·92	10,170	0	0	3·48	17,870	0	0	3·301
By sale of energy—												
75,000 units for public lighting—say, 50 arcs at 2¾d.	860	0	0	—	860	0	0	—	—			—
150,000 ,, ,, ,, ,, ,, 2¾d.	—			—	—			—	1,720	0	0	—
175,000 ,, private ,, at 5¼d.	3,828	0	0	—	—			—	—			—
425,000 ,, ,, ,, 5d.	—			—	8,854	0	0	—	—			—
850,000 ,, ,, ,, 4¾d.	—			—	—			—	16,800	0	0	—
100,000 ,, power at 2½d.	1,040	0	0	—	—			—	—			—
200,000 ,, ,, 2d.	—			—	1,666	0	0	—	—			—
300,000 ,, ,, 2d.	—			—	—			—	2,500	0	0	—
Total £	5,728	0	0	—	11,380	0	0	—	21,020	0	0	—

TABLE II.—SHOWING TOTAL COSTS OF FOUR METROPOLITAN ELECTRIC WORKS OWNED BY LOCAL AUTHORITIES WHO MANUFACTURE THEIR OWN SUPPLY, THE OUTPUT BEING ABOVE ONE MILLION UNITS.

Output in units	Hammersmith. 1,202,783				Hampstead 1,418,442				Islington. 1,346,437				Shoreditch 1,630,426			
	£	s.	d.	Cost per unit in d.	£	s.	d.	Cost per unit in d.	£	s.	d.	Cost per unit in d.	£	s.	d.	Cost per unit in d.
Total works cost, including coal, stores, wages, maintenance, rent, rates and taxes, management, etc.	10,324	0	0	2·06	13,948	0	0	2·36	14,474	0	0	2·58	15,060	0	0	2·22
Interest on loans, less credits	3,895	0	0	·77	4,072	0	0	·69	6,568	0	0	1·17	4,496	0	0	·65
Depreciation and sinking fund	2,469	0	0	·49	2,896	0	0	·49	2,619	0	0	·45	1,147	0	0	·16
Total cost	16,688	0	0	3·32	20,916	0	0	3·54	23,661	0	0	4·2	20,703	0	0	3·03

The existence of these open spaces will have the effect, that for a given number of houses or premises supplied, the total length of electric supply mains and the losses of pressure in them, and consequently the cost of distribution, will be somewhat greater than would be the case in more compact districts, and this will cause some, though not a very notable increase in the capital expenditure on mains necessary to serve your district economically and efficiently.

Another point which is of great importance, but on which I do not feel myself competent to fully advise you until I have much greater acquaintance with the district than I could possibly have in the short time that I have had the matter before me, is the extent to which certain of your business premises and private houses will take the supply. In the better class of houses towards the north of your district there can be no question that the residents will avail themselves of the supply to as great an extent as has been found to be the case in other London districts, and I think that in many business streets there is little doubt that a very few years will see the light used in the majority of the shops. But there are parts of Wards No. 3, 4, 5, and 6 which appear to consist chiefly of workmen's houses, some of them certainly of an improved class, but I believe that up to the present this class of consumer has not taken greatly to the electric light, and the cause is not difficult to understand, as the houses are chiefly held on very short tenancies, so that you can rarely find a tenant who is prepared to himself find the money necessary for wiring and fitting his premises. I believe this question has already been considered in Hackney and other metropolitan districts, and to meet it various schemes for free wiring have been proposed. I am informed that in Hackney the Council have entered into an agreement with the National Electric Wiring Company, under which the benefits of free wiring are afforded to consumers of electrical energy. On the application of a consumer who wishes for electric light, the wiring company will, on behalf of the Hackney Council, provide and fix on the premises the wires and fittings for electric light, and the consumer will be required to pay to the Council a guarantee of 5½d. per lamp per quarter, these rental charges for the wiring being additional to the charge made by the Council for the supply of the electrical energy itself. I have been at some pains to ascertain how far your Council could enforce payment of these wiring rentals, if, as I believe is intended to be the case at Hackney, the wires remain the property of the National Electric Wiring Company, and this becoming known to a litigious consumer he might tender the amount necessary to pay for the energy only, and it would be extremely difficult either for your Council or for the National Electric Wiring Company to enforce the rental payment. The National Electric Wiring Company is reputed to be a substantial well-managed concern with ample capital, and it is believed that they have been so far fortunate in avoiding the above-mentioned troubles. If they are prepared to enter into an agreement with your Council for the free wiring of the premises mentioned in the southern wards of your borough on terms similar to those entered into with the Hackney authorities, it will greatly increase the probabilities of making your electric supply a profitable one. If, on the other hand, the wiring of premises and charging for it by rentals cannot be carried out either by yourselves or by a third party, the question of the supply of light and power limits itself to that of private houses and business premises above the ratable value of £40, of which you inform me that there are about 800 in your borough. If out of these the usual proportion eventually take the electric supply, a sufficient income would be obtained to make the supply profitable, but your Council must face a very strong probability that in your district, and without the aid of rental wiring, the load will come on very gradually, so that it is almost certain that for several years after first starting your works the fixed charges for management, interest, and sinking fund will bear such a heavy proportion to the output that there would be a deficit to be charged on the rates during these early years.

Probably the best method of bringing before you the answer to your first question will be for me to show you, by the following Table I., what will be the probable annual expenditure and cost in pence per unit of taking electrical energy in bulk from Hackney at a point in Stoke Newington, and from thence distributing it through your own mains.

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Table I. shows what I estimate will be the cost of doing this. It shows what will be your probable commitments at various scales of demand, commencing at 250,000 units per annum for light and 100,000 units for power up to 1,000,000 for light and 300,000 for power. I have not thought it worth while to show you it at any lower scale, as the above-mentioned lower figure is the lowest one at which the necessary wages of the staff and interest and depreciation charges on your works can be paid. And I have not attempted to give exact results, but have worked out the distribution costs on round figures which give results per unit corresponding sufficiently closely with similar figures obtained elsewhere in London to be a correct guide for you in this case. You will notice that a very large share of distribution cost lies in the interest and depreciation charges on your expenditure and works. I have supposed that you will commence by laying mains in about one-third of your streets, and that from the sale of energy from these mains during the first year you will reach the small output of 350.000 units, that in succeeding years an additional expenditnre of £15,000 on distributing works will bring your total output up to 700,000 units, and that a further expenditure of £20,000, bringing the total sum spent on works up to £60,000, will enable you to distribute 1,300,000 units taken in bulk from Hackney. To the distribution costs which must be paid by you I have added the charges for energy and bulk which will be made by Hackney, and which vary from 2·6d. per unit for the small output down to 2·45d. for the large output of 1,300,000. From these figures you will see that the total cost to you will be approximately 3·92d. per unit at the small output, which would be reduced to 3·301d. at the larger one.

This brings me to your second question as to whether you should take the supply in bulk from Hackney and at the cost as above indicated, or whether you should yourselves set up works and manufacture in your own district. I think the best guide to you on this question would be for you to examine the results already obtained in four metropolitan electricity works owned by local authorities who have been manufacturing their supply for several years past. For this purpose I have prepared Table II. You will see that Hammersmith, with an output of 1,200,000, has brought its total cost down to 3·32d.; Hampstead, with an output of 1,400,000, have brought theirs down to 3·54d.; Islington, with an output of 1,350,000, to 4·2d.; and Shoreditch, with an output of 1,600,000, to 3d. In no case have they brought down their costs so low as I have shown would be your costs at the same output in my Table I. This result may be accounted for in two ways, either that my figures for distribution in your district are under-estimated (and this I do not think is the case), or that the charges made to you by Hackney are too low (this, again, I do not think is the case). I believe the Hackney works are well considered, and are put down on lines closely resembling the Shoreditch works, but with improvements which warrant their engineer in believing that the costs of Hackney will be lower than those of Shoreditch, which you will notice are the lowest of the four metropolitan works, the accounts of which are analysed in my Table II. Further than this, the supplying in bulk to your district from one set of works situated in Hackney undoubtedly gives increased economy in management and other fixed charges due to concentration at one works. This concentration undoubtedly leads to such economy up to a certain limit of output, but that limit is probably not less than 2.000,000 or possibly 3,000,000 units per annum. I cannot, therefore, advise you better than by stating that evidently your best course, if you intend to give an electric supply to your districts, is, at all events for the first few years, to take your electricity in bulk from Hackney, and confine your capital expenditure to the laying down of distribution works. When your output gets to be a large one, it may pay you to discontinue taking your supply from Hackney and to lay down your own works. I understand such a course was contemplated by the Hackney Borough Council when they made their offer to you.

As for the present I do not recommend you to manufacture the supply yourselves. it is evident that I cannot advise you on the dust destructor question, which must now be considered quite apart from electric supply works ; but I think the opinion of electrical engineers generally is on the whole against the combination of the dust destructor with electrical works, so that even if you now decide to put up your own generating works it is most probable that you would put up your destructor quite apart from it and not attempt to use the waste gases from the destructor as a source of power for manufacturing electrical energy.

(Signed) R. E. Crompton, Lt.-Col. R.E., M.I.E.E., etc.

LEGAL INTELLIGENCE.

FINCHLEY ELECTRIC LIGHT CABLES.

The Lord Chief Justice sitting in the Vacation Court on Wednesday heard the case of the Finchley Electric Light Company, Limited, v. Finchley Urban District Council. The application was one in which the plaintiffs sought an interim injunction to restrain the defendant Council from interfering with their electric light cables.

Mr. Buckmaster appeared in support of the application, and Mr. Chubb was counsel for the defendants.

At the outset **His Lordship** said he had read the affidavits, and did not see why the defendants should not give an undertaking in terms of the notice of motion.

Mr. Chubb replied that the plaintiffs had clearly encroached upon their rights, and the defendants could, therefore, not give the undertaking. The plaintiffs had put up an overhead wire without the Council's consent, and in contravention of the rules of the Board of Trade. Accordingly the defendants cut it down.

Mr. Buckmaster said he represented a company which was not incorporated by any Act of Parliament other than the Companies' Act of 1862. They derived no powers and obtained no protection from the Electric Lighting Act, and, therefore, they were not privileged to open up the roads. Being barred in this way, they proceeded to carry their cable across the road, and in doing so had complied with the regulations of the Board of Trade, and erected their wire 34ft. above the level of the road. This the defendants had cut down, and the plaintiffs were prevented from carrying out their contract with neighbouring property owners.

The **Lord Chief Justice** asked if the managing director of the plaintiff company would give his personal undertaking in damages if he made the order, and, Mr. Buckmaster assenting, his Lordship held that the plaintiffs were entitled to an injunction till the trial of the action in terms of the notice of motion, and made an order accordingly, costs to be costs in the cause.

TRAMWAY NOT A RAILROAD.

Judge Bagshawe, at the Brentford County Court, has just given a decision of importance to tramway undertakers and engineers generally. Under the Workmen's Compensation Act, a workman named Fletcher claimed £40 damages for injuries received whilst employed by the London United Tramways Company, as the result of a splinter flying off a steel pin while it was being hammered and he was holding it. There was no question as to the amount of compensation if under the Act he were entitled to any. The only question was whether the car road was a "railroad" within the meaning of the Act as differing from "railway" and as including a "tramway." The work which he was engaged in at the time was the laying of a line of rails on the Uxbridge-road. The applicant's case was based on the contention that the word "railroad" in the Act included a "tramway," and that as he was at work on a tramway at the time of his injury, he came within the purview of the Act. The learned judge, however, refused to accept this interpretation, holding that "railroad" did not materially or at all differ from "railway," and that the former word could not be applied to a tramway within the meaning of the Act. Nor was the work the applicant was engaged upon of laying down rails "engineering work" within the meaning of the statute, especially as no "machinery driven by steam, water, or other mechanical power" was used. His Honour accordingly dismissed the claim. No order was made as to costs.

OBSTRUCTING A TRAMCAR.

A curious point arose at Brentford last week, when James Hilton appeared in answer to an adjourned summons for obstructing one of the London United tramcars on that portion of the line between Hanwell and Southall which was sanctioned by an order under the Light Railways Act. Mr. Hanson, who prosecuted, said that he was proceeding under the company's private Act of 1900, which he contended gave the company a general right of prosecution in respect of their whole system—light railway or tramway. The Bench declined to accept that view, and having regard to the absence from the Light Railway Act of any clause providing for the infliction of any penalty in respect of obstruction, dismissed the summons. A special case is to be stated for the opinion of a higher Court.

CLAIM FOR AN ELECTRIC MOTOR.

At the Lord Mayor's Court this week, before the Recorder (Sir Forest Fulton, K.C.), Mr. A. Rothschild, electrical contractor, sued Mr. Tracey, carrying on business in Clerkenwell, to recover £25, the price of an electric motor supplied. During the examination of the plaintiff, the Recorder said the question seemed to turn upon the point whether the motor supplied was a 500-volt motor or not. In the result, by his Lordship's direction, the jury returned a verdict for the plaintiff for the amount claimed, subject to a reference to the assistant judge, who would have the assistance of an electrical engineer.

TELEPHONES.

At Cardiff County Court on Wednesday, 2nd inst., before his Honour Judge Owen, the National Telephone Company, Limited, sued Mr. A. J. Howell, contractor, Cardiff, for the sum of £9 for one year's rental of telephone, due in advance Sept. 13, 1900. The defendant put in a counter-claim for £9 for damages suffered by reason of an inefficient service.

Mr. Ingledew appeared for the plaintiffs, and Mr. Sankey (instructed by Mr. William Thomas) defended.

The counter-claim for damages was the only point contested in court.

Mr. Marsh, one of the local representatives of the company, gave evidence to the effect that when the complaints, 10 of which appeared on the books, were received from Mr. Howell, investigations were made, and it was found that the line had been lately split, and that the job had not been completed. Other defects caused by wet weather or high wind were not preventable, but the company put them right. Most of the complaints were of ordinary accidents, which could not be prevented.

Mr. Ingledew submitted that the counter-claim failed under the contract, which stated that the company would not be liable for any damage caused by delay, and nothing had happened to the defendant other than the ordinary accidents incidental to a telephone installation.

His Honour, however, held that the terms of the contract referred only to cases in which there was an incidental stoppage, and not where there was gross carelessness. Mistakes might arise from the company being short-handed at the exchange. He would give judgment for £9 and costs on the claim, and award the defendant £5 and costs on the counter-claim

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ST. HELENS ELECTRICITY ACCOUNTS.

From the accounts of the St. Helens electricity works just issued, it appears that the total expenditure on capital account to March 31, 1901, amounts to £100,175. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given herewith:

REVENUE ACCOUNT.

Dr.		£ s. d.	£ s. d.
Generation of Electricity.			
Coal or other fuel		£1,342 19 11	
Oil, waste, water, and stores		194 17 7	
Wages at generating stations		712 3 2	
Repairs of buildings and plant		560 10 8	
			2,810 11 4
Distribution of Electricity.			
Repairs, etc., of mains		299 11 2	
Free wiring		1 17 7	
Repairs, etc., of transformers		0 19 2	
Repairs, etc., of overhead equipment		281 4 1	
Changing over from alternating to direct current		34 2 9	
			617 14 9
Rents, Rates, and Taxes.			
Rents payable		215 5 8	
Rates and taxes		199 11 7	
			414 17 3
Management Expenses.			
Salaries—Engineer's department		218 0 0	
Accountant and clerical staff		323 18 11	
General establishment charges		330 3 5	
			872 2 4
Interest on loans		1,628 18 10	
Dividend 3 per cent. stock		274 18 4	
Interest per bank		240 6 7	
Interest on deposits		9 1 10	
			2,153 5 7
Repayment of loans		2,398 5 4	
Redemption fund		264 11 3	
			2,662 16 7
Superannuation fund			4 17 6
Subway charges account			51 3 11
Insurances, etc			43 3 3
Total expenditure			9,630 12 6
Balance profit for year			1,219 12 4
			£10,850 4 10

Cr.	£ s. d.
Sale of current per meter, less discount and bad debts	6,389 2 4
Public lighting	214 3 5
	6,603 5 9
Rental of meters and other apparatus	89 18 9
Fittings account	27 6 9
Repairs, etc., public lamps	2 8 2
Rents receivable—New St. Helens Tram Company	4,051 3 7
Interest technical education, *re* purchase of plant	7 3 7
Gas account, *re* purchase of plant	68 18 3
	£10,850 4 10

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Capital account—amount received	78,479 0 10
Sundry creditors	5,129 7 5
Sinking fund account	948 10 4
Deposits (consumers)	295 11 0
Parr's Bank, Limited (overdraft)	20,078 12 0
Due to treasurer	335 11 0
Stock redemption fund	297 14 9
Premium on stock	354 4 6
Loans repaid from revenue	2,146 14 8
Stock redeemed	520 0 0
Revenue account (surplus)	553 13 9
	£109,139 0 3

Cr. Assets.	£ s. d.
Capital account—amount expended on works	100,175 12 2
Stores on hand	2,209 15 3
Sundry debtors for current supplied	2,194 18 11
Other debtors	3,180 13 0
Suspense account	131 15 10
Parr's Bank—stock redemption	297 14 9
Parr's Bank—sinking fund	948 10 4
	£109,139 0 3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			1,012,878
Quantity sold	Public lamps	51,290	910,736
	By contract	599,042	
	Private consumers by meters	260,404	
Quantity used on works			40,267
Total quantity accounted for			984,323
Quantitity not accounted for			28,555
Number of public lamps			35
Total maximum supply demanded (kilowatts)			675

With respect to the foregoing accounts Mr. J. S. Highfield points out that the item of £281. 4s. 1d. for repairs to overhead equipment is usually not included in the costs of electric lighting stations, but in St. Helens the Electric Lighting Committee is also the Tramways Committee. The cars are run by a company, but the track and the overhead equipment are maintained by the Corporation. Owing to the use of batteries on a rather large scale, the plant load factor is greatly in advance of the actual load factor, as the following interesting figures show:

		April to June. Kw.	July to Sept. Kw.	Oct. to Dec. Kw.	Jan. to March. Kw.	Years. Total. Kw.
Maximum load on feeders.	Lighting	180	216	278	250	278
	Traction	307	344	402	466	466
	Combined	482	560	638	675	675
Maximum load on plant.	Lighting	194	195	292	220	292
	Traction	206	302	212	255	302
	Combined	390	470	504	466	504
Plant hours.	Lighting	670	618	1,304	1,391	3,988
	Traction	1,455	1,418	1,410	1,451	5,734
	Combined	1,455	1,418	1,410	1,451	5,734
Load factors.	Lighting	12·1	11·8	17	19·4	12·7
	Traction	17·5	17·8	19·0	18·0	14·7
	Combined	15·9	15·1	19·4	19·5	15·4
Plant load factors.	Lighting	45	53	32	41	32
	Traction	41	33	60	52	37
	Combined	31	31	43	46	35

The units consumed for various purposes are as follows: Traction, 599,042; private lighting, 160,298; public lighting, 51,290; motors, 100,106—total, 910,736. The number of consumers connected to March 31, 1901, was 260 with 21,229 8-c.p. lamps. The number of motors connected was 46 with a total of 200 hp. The price charged for motors was 2d. per unit; this has now been reduced, the present price being 2d. per unit for two hours' use of the average maximum demand per day, and 1d. for all units above such amount.

NEW COMPANIES REGISTERED.

The following new companies have been registered since our last issue:

Tramways Construction Company, Limited.—Capital, £1,000. Object: to carry on the business of contractors for the construction and equipment of tramways, light railways, and any roads or ways to be used for traction by electricity, steam, horse, or other power, and for the construction and equipment of subways, bridges, electric lighting, etc., and to work and carry on any tramways or light railways, either as owners or lessees, or under contract.

Bell's Time Indicators, Limited.—Capital, £3,000. Object: to carry on the business of electrical and mechanical engineers, manufacturers of and dealers in apparatus and other things required or capable of being used in connection with such business.

Pioneer Power Company of London, Limited.—Capital, £10,000. Object: to carry on the business of manufacturers of and dealers in plant and machinery used in the creation or application of any motive power, and, in particular, compressed and heated air, electricity, and heated water, and in the application of the same to the haulage and propulsion of goods trucks and passenger vehicles, to equip, maintain, and work by such motive power any train or railway or other system of vehicular communication, and to carry on the business of tramway, omnibus, and light and other railway proprietors, locomotive and trolley builders, manufacturers of accumulator dynamos, carriers of passengers and goods, etc.

APPOINTMENTS VACANT.

Assistant, to take charge of mains laying, fault localising, etc., electricity department, Bristol; £2. 15s. per week, Oct. 23. Full particulars in our advertisement columns.

Assistant Engineer, Epsom District Council, £100 per annum, Oct. 24. Full particulars in our advertisement columns.

Shift Engineers, Bradford Corporation, 50s. per week of 50 hours, Oct. 28. Electric Lighting and Tramway Company, Cork, 40s. to 50s. per week. Full particulars in our advertisement columns.

Dynamo and Switchboard Attendant, Dewsbury Corporation Electricity Works, Oct. 23. Full particulars in our advertisement columns.

Switchboard Attendant for combined lighting and traction station, 20s. per week. Full particulars in our advertisement columns.

Cable Jointer, Doncaster Corporation, Oct. 21. Full particulars in our advertisement columns.

Traffic Superintendent, Bradford Corporation Tramways, £200 per annum, Nov. 9. Full particulars in our advertisement columns.

Works Manager, with thorough knowledge of copper deposition and competent to take full engineering control of a special plant; £500 per annum. Full particulars in our advertisement columns.

Superintending Engineer, Borough of Hammersmith electricity department, £175 per annum, Oct. 25. Full particulars in our advertisement columns.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

East London.—Tenders are invited for the supply of a 50-kw. alternator and engine. Tenders by Nov. 26. Details in our advertisement columns.

Dudley.—The Electric Light and Tramways Committee invite tenders for supply and erection of pipework. Tenders by Oct. 25. Details in our advertisement columns.

London County Council.—Tenders are invited for wiring and fittings for the electric lighting of fire brigade stations at Homerton, West Hampstead, East Greenwich, and Perry Vale. Tenders by Oct. 31.

Leyton.—The Electric Lighting Committee invite tenders for the supply of a multipolar dynamo of about 450 kw. capacity, and a balancer. Tenders by 26th inst. Details in our advertisement columns.

Blackpool.—The Corporation invite tenders for poles, plinths, etc., cables, etc., overhead materials, trolley wire, and bonds, 20 electrical car equipments. Tenders by Oct. 21. Details in our advertisement columns.

London, W.—The Directors of the Great Western Railway invite tenders for the supply of the various stores from Dec. 1 next to Nov. 30, 1902. Tenders by Oct. 21. Details in our advertisement columns.

Chesham.—The Urban District Council invite tenders for the transfer of their provisional order enabling them to supply electricity within the Chesham urban district, by Nov. 16. Full particulars in our advertisement columns.

Oldham.—The Corporation invite tenders for the supply and delivery of concentric feeder cable, pilot cable, joint-boxes, etc., and motor booster, motor generator, switch gear, etc. Tenders by Nov. 5. Details in our advertisement columns.

Hurst.—The Council invite tenders for the supply, delivery, and erection of steel poles, bases, section boxes, and overhead line for the equipment of electric tramways approximately 1½ miles long. Tenders by Oct. 29. Details in our advertisement columns.

Liverpool.—The Directors of the South Lancashire Electric Traction and Power Company, Limited, invite tenders for the supply and laying of high and low tension insulated electric cables, stoneware pipes, etc. Tenders by Nov. 4. Details in our advertisement columns.

Bootle.—The Corporation invite tenders for the wiring of the extension of the town hall buildings in Trinity-road for purposes of electric lighting. Specification, etc., may be obtained from the Borough Electricity Works, Pine-grove. Tenders by Oct. 23.

Ilford.—The Urban District Council invite tenders for the supply and erection of a water-tube boiler, with fittings, pipework, etc.; one 550-kw. steam dynamo (vertical enclosed high-speed engine); main switchboard and connections. Tenders by Oct. 29. Details in our advertisement columns.

Limerick.—The Corporation invite tenders for the supply, delivery, and erection of cables, arc lamps, Westinghouse engines, dynamos, boosters, and Dowson gas plant. Preference will be given to a contractor who tenders for the whole of the work. Tenders by Oct. 28. Details in our advertisement columns.

Newport (Mon.).—The Corporation invite tenders for the supply and erection of winches, cables, overhead construction, complete electric motorcar, and repair shop equipment. Specifications, etc., can be had on application to Mr. H. F. Parshall, consulting engineer, 8 Princes-street, Bank, London, E.C. Tenders by Oct. 21.

Boulder City (Western Australia).—The Boulder City Council invite tenders for construction of about 3½ miles of electric tramway, with all necessary plant complete according to specifications, and the right to construct and run tramways within the municipality. Tenders by Nov. 23. Details in our advertisement columns.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station and sub-stations of two 6,000-h.p. triple-expansion engines, two 3,750-kw. three-phase alternators, 48 motor-generators for sub-stations. Tenders by Nov. 6. Details in our advertisement columns.

Swindon.—The Corporation invite tenders for the supply, delivery, and erection at their electricity works, Swindon (Wilts), of three Lancashire boilers and economiser, two jet condensers, feed pumps, pipework, and accessories, water-cooling tower, and 10-ton overhead travelling crane. Tenders by Nov. 12. Details in our advertisement columns.

Barking Town.—The Council invite tenders for the supply of an electrically-driven locomotive crane, together with the permanent way in connection therewith, at the Council's Wharf, Gascoigne-road, Barking. Specification, etc., can be obtained upon application to the Council's Surveyor, Mr. C. F. Dawson, Public Offices, Barking. Tenders by Nov. 12.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection of three Lancashire boilers, economiser, and mechanical stokers, and for two ejector condensers and circulating pumps, one feed pump, one grease extractor, and the extensions to the present steam, exhaust, condenser, and feed pipes. Tenders by Nov. 8. Details in our advertisement columns.

Bury.—The Tramways Committee invite tenders for the supply and delivery at Bury, Lancashire, of 14 69-passenger electric tramcars and 14 48-passenger electric tramcars. Specification, etc., may be seen at the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar, 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster, and may be obtained from the latter office. Tenders by Nov. 18.

Ashton-under-Lyne.—The Corporation invite tenders for the supply, delivery, and erection in the borough of Ashton-under-Lyne of steel poles, bases, section boxes, and overhead line for the equipment of the first section of electric tramways, approximately 1½ miles long. Specification, etc., may be obtained from Mr. N. Appelbee, borough electrical engineer, Electricity Works, Ashton-under-Lyne. Tenders by Oct. 29.

Amsterdam.—The Secretary of State for Foreign Affairs has received a dispatch from his Majesty's Consul at Amsterdam, stating that tenders are invited by the Town Council of Amsterdam, not later than Nov. 18, for the supply of above-ground conductors of electricity and the connections of rails for electric tramways. Particulars may be obtained at the Stadsdrukkerij of Amsterdam on payment of 3·50fl. (5s. 10d.). Information is given at the office of the Manager of the Town Tram, 164, Achtergracht, Amsterdam.

Rockhampton (Australia).—The Council of the Municipality of Rockhampton, in the State of Queensland, Commonwealth of Australia, has to announce that it is prepared to consider applications from companies desirous of undertaking the construction and working a system of electric tramways under the Queensland Tramways Act of 1882 and the Amendment Act of 1890, within the Municipality of Rockhampton aforesaid. Rockhampton, with a population of 15,461, is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882 and the Amendment Act of 1890, copies of which may be seen at the office of this paper. Applications to be forwarded to Mr. H. W. Johnson, mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31.

RESULTS OF TENDERS.

Yarmouth.—The Tramways Committee have accepted the tender of Crompton and Co. for battery and booster at £1,606.

Leeds.—The Works Sub-Committee have decided to recommend the General Committee to accept the tender of the British Thomson-Houston Company for the supply of 50 electric cars. The amount of the tender is nearly £26,000.

Middlesbrough.—The Council have accepted the following tenders: Askham Bros. and Wilson, mechanical coaling apparatus, £791; A. J. Cooke, engine foundation, boiler setting, and flues, £243; Nalder Bros. and Thompson, extension of switchboard.

Broompark (Durham).—The Broom Parish Council have accepted the tender of Reid, Ferrens, and Co., Sunderland, at £185, in connection with the erection of poles, laying of cables, and all necessary fittings for lighting with electricity the village of Broompark and the western portion of the parish.

Poplar.—The Borough Council have received the following tenders for supply of high-tension continuous current transforming plant and switch gear, &c.:

Johnson and Phillips	£5,720
Brush Electric Company	5,596
Mather and Platt	4,624
Electric Construction Company (accepted)	4,073
Johnson and Phillips	3,750

Poplar.—The Borough Council have received the following tenders for the supply of multiple-core, lead covered feeder and network cable and accessories for mains extensions:

British Insulated Wire Company (accepted)	£10,522	10	4
Western Electric Company	11,017	3	4
Henley and Co.	11,872	19	2
Glover and Co.	12,068	4	5
St. Helen's Cable Company	12,910	2	1
Anchor Cable Company	14,265	19	2

Poplar.—The Borough Council have received the following tenders for the supply of arc lamp columns for one year from date of acceptance of tender:

Crompton and Co.	£143	14	6
Sloan and Co.	143	19	6
Veritys, Limited (accepted)	143	19	6
O. Scholzig	144	2	6
Blackwell and Co.	144	0	8
Brush Electric Company	152	12	4
International Electric Company	156	7	0
British Thomson-Houston Company	160	12	9
De Grelle Houdret	161	4	0
International Engineering and Electric Company	162	19	0
G. Braulik	164	19	0
Brockie-Pell Arc Lamp, Limited	165	4	6
General Electric Company	171	5	6
Brush Electric Company	173	5	11
Atkinson, Schmahl, and Co.	174	15	0

BUSINESS NOTES.

TRACTION.

Ayr.—Incandescent lamps will shortly be affixed to some of the tramway poles.

Blackpool.—It is decided to proceed with the work of construction at once of the Clifton-street section of tramways.

Adelaide (S.A.).—The Westinghouse Company are endeavouring to obtain control of the tramway system in the city.

Whitworth.—A public meeting is to be held on Nov. 20, the object of which is the consideration of the tramways question.

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Swansea.—The local Bench has inflicted a fine of 40s., including costs, on a driver of an electric tramcar for furious driving.

Perth.—A conference has been held between the Town Council and the tramway directors for the purpose of considering the municipalisation of the tramways.

Dundee.—It is probable that in December the electric cars will be running on the Seagate, Blackscroft, and Broughty Ferry road routes, now in course of completion.

Batley.—It is proposed to let the contract for the laying of the permanent way of the proposed electric tramways to Messrs. Graham Bros., of Huddersfield, for £30,000.

Sydney.—It is reported that an American company has secured an order from the Sydney City and Suburban Tramways, running into about £12,000 or £15,000, for electric equipment.

Epsom.—A special meeting of the Highways and General Purposes Committee of the Rural District Council will shortly be held to consider the London United Tramway Company's scheme in their district.

Walsall.—The Town Council have resolved to obtain tenders for the whole of the proposed tramway extensions authorised, and the working of the tramways is to be under the control of the Council.

Sunderland.—The Tramways Committee have promised to consider the question of making a connection whereby double-decked cars would be able to run from the Christ Church route to St. Barnabas's Church.

Helston.—The Light Railway Commssiioners opened an enquiry on Wednesday at Helston to consider the expediency of granting the application made by the Lizard Light Railway Company to substitute steam for electricity as the motive power.

Cape Electric Tramways Co.—The directors have declared an interim dividend of 4 per cent. (free of income tax), payable to all shareholders registered on Oct. 10, and to the holders of coupon No. 10 attached to share warrants to bearer.

Salford.—The Salford electric cars ran for the first time on Monday over the route between the Grove Inn (Manchester boundary) and Kersal. Eight cars have also been placed on the Higher Broughton route. All the cars are working satisfactorily.

Sheffield.—An electric car service has now been put on the new section from Ranmoor to Nether Green, the fare from the city being 2d. The alternative route to Nether Green, *viâ* Ecclesall-road and Rustlings-road, will be opened in another week or so.

Proposed Brighton Electric Express.—In connection with this scheme we note that Mr. W. Emden, L.C.C., is engaged in making the designs for the terminus at Brighton. The estimated cost of the proposed railway is between six and seven millions sterling.

Bolton.—The last report of the Bolton Corporation Electric Tramway Committee shows that the receipts continue steadily on the increase. In the last two weeks they have gone up over £380, whilst from April 1 last to 6th inst. the increase has been £4,647.

Brighton.—The Town Council have resolved to include in the provisional order already authorised by the Council application for power to construct a single line of tramway from Seven Dials northwards to the Drove, such line to be connected with the existing tramway in New England-road.

Dewsbury.—The contract between the Dewsbury, Batley, and Birstall Tramways Company and the British Electric Traction Company, who have purchased the first-named undertaking for £27,769, having now been signed, the traction company will undertake the management of the concern themselves on Dec. 1.

Tramway Officials in Leeds.—The autumn meeting of the members of the Northern and Midland Counties Association of Tramway Officials was held at Leeds this week. Mr. W. Wharam, manager of the Leeds Corporation tramways, occupied the chair, and delivered an address on the different methods of traction in vogue.

Birmingham.—The Tramways Committee will report to the next meeting of the City Council on the proposed line to Harborne and Edgbaston by way of Broad-street. A scheme has been propounded, and is now awaiting the favourable verdict of the Watch Committee, under which it is proposed to float a company for providing motor 'bus services in the city.

Southport.—On Saturday evening last about 400 men who have been employed in the construction of the electric tramways in the town were entertained to tea by the Tramways Committee of the Corporation in the Cambridge Hall. In the course of a long speech the Mayor congratulated the men upon the way in which they had carried out the work.

Cardiff.—In connection with the tramways, the latest report of the borough engineer states that as regards the power station fair progress continues to be made. The chimney stack has been completed, with the exception of the fixing of the last two stones of the granite coping, and the whole of the concrete foundations for the extension of the cable subway has been finished.

Aspull.—At the last meeting of the Bolton Tramways Committeee the Aspull Urban District Council wrote enquiring as to what probability there was of the Bolton Corporation tramways being extended to Aspull, and a reply was directed to be forwarded to the effect that there was at the present time no probability of the tramways being extended to that district.

Aston.—Negotiations are now pending between the District Council and the tramways company for the acquisition by the former of the lines of the company in their district. Electric traction will be adopted, and the work of equipment will be carried out side by side with the electric lighting of the district, tenders for the carrying out of which are now being considered by a committee.

Yarmouth.—With regard to the leasing of the tramways to a company, the Corporation have decided that tenders to lease be invited with option to determine at the end of seven or 14 years, or with no option for 21 years. On Wednesday the ceremony of turning the first sod in connection with the construction of the new tramways took place in the presence of the mayor and town councillors.

Tramways in Surrey.—It has now been finally decided by the London United Tramways Company to proceed with the promotion of the electric lines by which they are seeking to connect Richmond with Kew, Mortlake, and Barnes by means of another private Bill, to be introduced next session. Whether the Ham and Petersham line from Kingston will be included therein is not yet quite certain.

London County Council.—The Council propose to acquire a site at New Cross-gate about 7½ acres in extent for the establishment of car-sheds, depôt, and car works in connection with their tramways scheme, and to apply in the next session for powers to acquire the same compulsorily. It is also proposed to acquire the freehold of that portion of the Camberwell depôt now held on lease by the Council.

Plymouth.—It has been decided to increase the charge for current to the Tramways Committee from 2·3d. to 3d. Messrs. Shellabear, Shears, and Shellabear having accepted the Corporation conditions with reference to the laying of tramlines through the Pound Estate, the line is to be laid along the authorised route as soon as the Board of Trade sanction to the necessary borrowing powers has been obtained.

Long Eaton.—The Urban Council have had under consideration a scheme for light railways between Derby and Nottingham and from Long Eaton to Ripley, and have decided to further the project in every way. The scheme is to construct a light railway from Derby to Nottingham, through Draycott, Breaston, Long Eaton, and Beeston; also one from Long Eaton to Alfreton, through Ilkeston, Heanor, and Ripley.

Mannofield.—Referring to the scheme mentioned under this heading in a previous issue for the construction of a line of tramways from the present terminus of the Aberdeen city tramways at Woodside to Dyce and from the present terminus at Mannofield to Culter, we learn that the cost of the undertaking is estimated at between £50,000 and £60,000, and the intention is to approach Parliament in the ensuing session.

Middlesex.—At a recent meeting of the Light Railways Sub-Committee of the Middlesex County Council, at the Guildhall, Westminster, the question of the noise caused by the electric trams of the London United Tramways Company, where they are in operation, was raised, and the chairman explained that the County Council vehicles would be smaller and lighter than the ones referred to, and would not make anything like so much noise.

Isle of Man.—The holders of debenture bonds of the Isle of Man Tramways Company have agreed to a proposal put forward by the liquidator, that he should apply the £50,000 to be received from the Corporation of Douglas as the purchase price of the horse and cable sections of the tramways within the borough to paying off the A class of debentures, leaving the B and C debentures the only charges on the electric sections and other property of the company.

Derby.—The Mayor of Derby with the chairman and members of the Tramways Committee visited Glasgow on Tuesday, and inspected the tramway system of that city. The Corporation recently purchased their tramway system from a company, and are at present carrying on the old horse system over about six miles of track. They have, however, obtained powers for extending the system, and are making arrangements for the introduction of electrical traction.

Glasgow.—Another motorman has been fined for having driven an electric car in a culpable and reckless manner in Victoria-road, and running into a flock of sheep, injuring a number of them. He pleaded not guilty, but the charge was found proven. He was fined a guinea, with the alternative of a fortnight's imprisonment. There is a diversity of opinion as to the best fender to adopt for the tramcars. A special committee has the matter under consideration.

Heywood.—A special meeting of the Corporation will be held next month, at which the business will be to determine upon the expediency of applying to the Board of Trade for a provisional order under the Tramways Act, 1870, to authorise the construction of electric tramways in the borough, and to empower the Corporation to enter into agreements with the Corporations of Bury and Rochdale in regard to the leasing and working of the tramways in the borough.

Preston.—It is recommended by the Tramways Committee that in seeking parliamentary authority for the alteration of the gauge of the tramways to 4ft. 8½in., and of the alteration of the site for the generating station and car-shed to Holmrook-road, off St. Paul's-road, powers be sought for the extension of three existing lines and the construction of three new tramways. A deputation has waited upon a sub-committee to urge the extension of the tramways to Fulwood.

Rochdale.—A joint meeting of the Paving and Sewering and Tramways Committees of the Corporation, called to consider the question of using wooden blocks for paving on certain parts of the tram routes, recommend the Council to approve a proposal for paving the whole breadth of the road with wood in cases where that is desired, providing that the church authorities are willing to defray the additional cost entailed and to bear a share of the cost of repairs subsequently.

Sedgley.—Lieutenant-Colonel von Donop, on behalf of the Board of Trade, has inspected the reconstructed tramway between Sedgley depot and the Fighting Cocks, which has recently been completed for a continuation of electric traction from Dudley. The extension is about three miles in length, and the work of reconstruction, including overhead equipment, has been carried out in about three months. The cars will commence running on the new section as soon as the formal sanction of the Board of Trade is received.

The Berlin High-Speed Trials.—The Berlin correspondent of the *Morning Post* states that on the military railway between Berlin and Zossin, a distance of about 33 miles, which has been the scene for

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more than a month past of experiments in fast travelling, conducted by Messrs. Siemens and Halske, the first trial took place a few days ago with the electric motor carriages. A speed of 66 miles an hour was attained with perfect safety. In the trials that are now taking place this speed is being gradually increased.

Ashton.—The Telephone Company and owners of private wires in the town are to be requested to divert the wires belonging to them where the same cross streets through which tramways are proposed to be laid. The route of tramway in Cowhill-lane is to be abandoned in favour of the Henrietta-street and Canterbury-street route. Tenders for cars and tenders for overhead equipment will shortly be invited. The Board of Trade have renewed the license to use electric traction on the company's tramways, which expired on Oct. 10.

Camberwell.—Notice of motion has been placed on the agenda paper to the effect that the Borough Council ask the London County Council to include the Camberwell Green to Forest Hill tramway scheme in the London County Council Bill, 1902, suggesting as an alternative route to that in the scheme rejected by the House of Lords last session the following: in lieu of Champion-park, Grove-lane, and Dog Kennel-hill, substitute Denmark-hill to Triangle, Champion-hill private road (by means of a cutting), and new road across cricket fields to Grove-vale.

Hull.—An accident occurred to one of the electric cars on Tuesday in endeavouring to turn a corner in a new street. According to the newspaper reports, "something went wrong with the trolley pole overhead, causing two of the overhead wires to fire. Immediately the whole street was illuminated by brilliant light from the wires. The trolley of the car was smashed and fell to the ground, missing a passing cyclist by no more than 1in." This is the first accident of any consequence that has occurred on the Hull electric tramways since their introduction 10 years ago, which is a sufficiently good record.

Stockport.—Mr. Trotter, of the Board of Trade, has made an inspection of the overhead equipment of the electric tramway recently opened from the town to Woodley eastward and northward to Reddish. The Stockport Committee is in communication with the Manchester Tramways Committee with reference to the taking over and reconstruction of the Manchester lines within Stockport borough, and as to which Corporation should undertake the work of reconstruction; in the event of Manchester doing the work the charge for superintendence and establishment charges to be at the rate of 10 per cent. on the cost.

Leeds.—On Monday horse tramcars made their final disappearance from the streets of Leeds. The only route upon which they have lately been running is along Whitehall-road, and they have now been superseded by electric cars. The tenders for the supply of 50 new electric cars were opened on Tuesday by the Tramways Works Sub-Committee, and revealed the fact that a number of German firms are competing. Altogether there are between 50 and 60 firms tendering. As reported in another column, the sub-committee on Wednesday decided to recommend the acceptance of the tender of the British Thomson-Houston Company for the 50 new cars at a cost of about £26,000.

Greenock.—The electrical equipment of the Port Glasgow section of the tramways will be completed shortly. The running of the cars on Sunday last by the tramway company was discussed by the Corporation on Tuesday. The company maintain that their agreement empowers them to run Sunday cars, and that matters in dispute must be referred to the Board of Trade. The view held by the Corporation is that Sunday cars are contrary to the agreement. A proposal was made that the Corporation, who own the electricity works, should cut off the current next Sunday and prevent the service, but several members were opposed to such a course, and nothing was decided.

Speed of Tramcars.—A prosecution against the Glasgow Corporation relative to the speed of electric cars was commenced before Sheriff Fyfe in chambers on Tuesday. The pursuer, Mr. Thomas Simpson, coalmaster, residing in Albert-drive, Pollokshields, sued the Corporation, with the concurrence of the Procurator-Fiscal, and in the public interest, for contravening the regulations made by the Board of Trade regarding the speed of the cars. His case was that at a point between Shields-road and St. John's-road, on Sept. 6 and Sept. 9, between six and eight o'clock, six cars were driven eastward and six cars westward on each evening at rates varying from eight to twenty-two miles an hour. The hearing of evidence was postponed till the 21st inst.

Stirling.—Addressing a meeting of his constituents at Cowan-street Ward on Tuesday, Provost Thomson referred to the negotiations for the purchase of the tramways to the Bridge of Allan. From the beginning, he said, the traction company had made the Town Council suspicious. They had asked leave to promote a provisional order on condition that the Council gave them a blank cheque to appear for them. On the best advice, however, the Council had refused the proffer till terms were arranged. They had offered the company terms which they seemed to be waiting to accept. Negotiations had now been broken off. The Council were as anxious as possible to sell their current, but they would not agree to terms without the permission of the ratepayers unless they made a reasonable bargain.

Constantinople.—We understand from the *Levant Herald* that a Swiss company has applied to the Ministry of Public Works at Constantinople for the concession to work and develop the tramway system in that city. The charter of the present company has 15 years to run yet, but it is pointed out that it has not fulfilled its engagements, and is liable to forfeit the concession at any time. The applicants propose to double all existing single lines and to build new lines. They ask that the concession may be for a term of 65 years. The Council of the Prefecture of the city has decided to grant the application, and has reported in that sense to the Grand Vizierate, where the matter at present remains. The applicants undertake to buy the material of the existing company. It is not stated whether it is the intention of the new company to apply electric traction to the system or not.

Liverpool Self-Propelled Traffic Association.—At a meeting of the council of the above association on the 14th inst., at African House, Water-street, a letter was read from the judges of the recent trials, intimating that their report would be ready about the 24th inst. The chairman announced that Mr. Walter Long, president of the Local Government Board, had consented to receive a deputation from the association and the commercial associations of Liverpool with reference to the present limit of tare upon motor wagons—viz., three tons—which it is sought by the association to have increased. It was arranged that the presentation of the report should take place at the same time as the deputation to Mr. Walter Long, which will be at 11.30 a.m. on Thursday, the 24th inst., at the rooms of the Liverpool Incorporated Chamber of Commerce.

Blackpool-Fleetwood Tramways.—From reports which have appeared in the local Press, we gather that a dispute amongst the tramway employés on the Fleetwood-Blackpool line is pending. On the Corporation system a number of men have received their notices, but this is in accordance with agreement. A large proportion of the drivers and conductors are engaged for the season only, and they know that as soon as the busy season is over they must go. The men engaged on the Fleetwood line have made a lengthy statement, alleging that only union men have been turned adrift and non-union men retained. The manager of the tramway company declares that the statements in the appeal are not correct. The exigencies of the season require that a large number of men should be dispensed with, and he states that he has made a selection without any knowledge as to who are union men and who are not.

Berlin.—According to the Berlin correspondent of the *Daily Chronicle*, a new overhead line of electric tramways or light railways, which will run from the east to the west of the city, will be opened for passenger traffic in about a month. The iron structure of this railway is most graceful, and cannot be called an eyesore. The stations are elegant constructions in carved stone and iron, and by an ingenious contrivance the noise of the trains will be reduced to a minimum. Trains will run 25 miles in the hour. The fare from one end of the city to the other (about four miles) will be only 1½d. The remarkable development of electrical tramways from Berlin to the suburbs threatens to inflict a heavy blow on the hitherto existing local railways. The statistics of the last half-year's traffic point conclusively to a falling off in the number of passengers conveyed by rail. The tramcars are driven at great speed, averaging 20 miles an hour. They are run every five or ten minutes, and no matter how great the distance the fare is only 1d. The victory of electricity over steam in Berlin is assured.

Isle of Thanet.—The accident which occurred to a car on the light railway in descending Fort Hill at Margate on Aug. 10 last has been the subject of an enquiry by the Board of Trade. The car was full of passengers at the time, and 27 persons complained of injury. Major Pringle, in his report, gives it as his opinion that the motorman was responsible for the accident, in that, in the first place, he misapplied the electric current, and, in the second place, failed to use the reversing lever to reduce the speed of the car before reaching the sharp curve where it went off the line. It was only the second day on which the man had been called upon to act as motorman in charge of a passenger car, and he failed in an emergency, for which his training of 16 days did not seem to have been calculated to fit him. The inspector considers, from the second accident that occurred on the hill on the same evening, that a sudden acceleration of speed may occur which cannot be quickly enough reduced to avoid danger of leaving the line or collision, and therefore some further appliance appears to be required to render such a sudden acceleration improbable. He thinks that is to be found in the slipper brake, and recommends that the cars should be fitted with it.

Light Railways.—Among the latest light railway orders to be confirmed by the Board of Trade are the following: (1) authorising the construction of light railways in the city of Wakefield and the townships of Horbury, Alverthorpe, Sandal Magna, and Outwood, in the West Riding of the county of York; (2) authorising the construction of a light railway in the counties of Norfolk and Suffolk, from Bury St. Edmunds to Stanton, Walsham-le-Willows, South Lopham, and Diss; (3) amending the Welshpool and Llanfair Light Railway Order, 1899; (4) authorising the construction of light railways in the boroughs of Kidderminster and Bewdley and in the parish of Kidderminster Foreign, in the rural district of Kidderminster, in the county of Worcester; (5) authorising the construction of light railways in the urban districts of Rishton, Clayton-le-Moors, Great Harwood, and Padiham, the rural districts of Clitheroe and Burnley, and the parishes or townships of Read, Simonstone, and Whalley, and (under certain conditions) in the county borough of Blackburn, all in the county palatine of Lancaster; (6) amending the Hadlow Light Railway Order, 1897; and (7) authorising the construction of light railways in the city of Durham, the parish of Brancepeth, the urban district of Brandon and Byshottles, and the parishes of Bearpark, Neville's Cross, and St. Oswalds, in the county of Durham.

Purchase of Cardiff Tramways.—The long-awaited reply of the Provincial Tramways Company with regard to the offer of the Corporation to purchase their undertaking for £40,000 was received this week. The company have accepted the offer subject to certain conditions, which are to the following effect: (1) the company to retain possession of the tramways until April 30 next without accounting to the Corporation for the profits and without claiming 5 per cent. interest from Jan. 1 on the total amount of the purchase-money; (2) the company to undertake to reconstruct the whole of the lines according to the plans prepared by the borough engineer, with all new materials of their several kinds—viz., a total length of single line of 11½ miles: (3) the sum to be paid to the company by the Corporation for such

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reconstruction, including the amount already expended by the company during the current year, will be £90,841. In the event of the company receiving notice to begin operations before the end of the present month, and that the clause of the Tramway Act which stipulates that only 100 yards shall be broken at one time in a street, with quarter-mile intervals, be altogether waived, the company are prepared to undertake to complete the whole of the 11½ miles of single track before April 30, 1902. A special meeting of the Tramways Committee of the Corporation was held yesterday, at which the above reply of the company was considered.

Tramways in Tottenham Court-road.—The tradesmen of Tottenham Court-road are carrying on a vigorous campaign against the proposal of the London County Council to construct an electric tramway in that thoroughfare. On Wednesday a large deputation waited upon the St. Pancras Borough Council to ask that authority to oppose the County Council's proposal as regards Tottenham Court-road. The deputation, though not averse to such tramways as part of a general scheme of tramways affecting London at large, strongly protested against a project which had for its terminus Oxford-street, which was not, it was said, needed in the interest of the travelling public, and which, if carried into effect, could not fail to injure the business of the deputation and those whom they represented. It was further urged by the deputation that businesses were injuriously affected by electric tramways. Alderman N. Robinson, L.C.C., stated that the widening of the southern end of Hampstead-road by the London County Council was absolutely conditional upon the St. Pancras Borough Council permitting tramways along Tottenham Court-road. Eventually a motion was carried thanking the County Council for their promptitude in dealing thus far with the question of widening the southern end of Hampstead-road, but deferring consideration of tramways along Tottenham Court-road until the Council had a complete scheme for connecting north and south and east and west.

Bradford.—A sub-committee of the Tramway Committee have received a deputation from the Shipley District Council with regard to the conditions under which the Corporation would continue the electric trams from Frizinghall to Saltaire. Nothing definite was decided. The question of extending the tramway from the present boundary at North Park-road to the King's Arms, Heaton, is under consideration, with a view to applying for powers to carry out the extension. It is decided to seek power in the ensuing session of Parliament for the following objects: extension of time for the construction of certain tramways authorised by the Bradford Tramways and Improvement Act, 1897; the reconstruction as double line of the following tramways: Allerton-road, Wakefield-road and Tong, Otley-road, North Park-road, from St. Mary's-road to the terminus, and Shelf (the portion within the city); the construction of new tramways as follows: (double line) Church-bank and Barkerend-road (Well-street to Otley-road), and Killinghall-road, from Laisterdyke to Otley-road; (single line) Commercial-street, Hall Ings (Leeds-road to Well-street), and Garnett-street. It has also been resolved to proceed at once to reconstruct as double line the terminus of the North Park-road tramway, and that the construction of the extension line in Little Horton-lane, from Laisteridge-lane to Southfield-lane, be proceeded with when the relaying of the Leeds-road tramway is completed. The city surveyor has been authorised to open negotiations with the Shelf Tramway Company with a view to the acquisition by the Corporation of the portion of the Shelf tramway which lies outside the city and is owned by the company. Instructions have also been given that the Demerbe points should be used in the reconstruction and linking up of the various tramways in the city, and that a double junction be constructed in Leeds-road at the bottom of East-parade. A proposal that powers be sought for the construction of a tramway up Church-bank has also been approved.

Huddersfield.—At the Town Council meeting on Wednesday the Investigation Committee presented a report on the tramways, showing that the cost of the electric power station and plant was £30,969. 1s. 3d.; that the electrical equipment of Lindley and Outlane sections, Linthwaite section, Paddock and Longwood, and Crosland Moor sections was £33,848. 0s. 3d.; that 25 cars cost £15,834. 14s. 7d.; and that the new permanent way for Outlane and Lindley, Linthwaite, and Longwood sections had cost £35,874. 11s. 6d. These gave a total of £116,526. 7s. 7d. The electrical equipment cost £2,103. 4s. per mile, and the new track for Outlane, Lindley, Linthwaite, and Longwood sections had cost £4,445. 3s. 3d. per mile. The receipts of the steam-worked sections from March 16 to June 8 last were £4,909. 19s. 6d., or 13·26d. per car mile; and the expenses £7,421. 11s. 11d., or 19·983d. per mile. This left a loss of £2,511. 12s. 5d., or 6·723d. per mile. The electric traction receipts were £5,857. 11s. 10d., or 10·11d. per mile, and the expenditure was £7,521. 13s. 3d., or 12·94d. per car mile, showing a loss of £1,664. 1s. 5d., or 2·83d. per mile. The three months chosen for investigation were, in the opinion of the sub-committee, as high in cost as any which could have been selected, and were previous to the commencement of the Sunday running of the cars. It would be seen from the foregoing figures that in the interests of economy, as well as from the standpoint of public convenience, the sooner the conversion of the whole system to electricity was proceeded with the better. The sub-committee expressed approval of the proposal to extend the line from Manchester-road, along Outcote Bank, Manchester-street, and Market-street, down Westgate to Kirkgate, but thought it would be inadvisable to take up the line along Northgate. The tramway receipts for September were £4,351. 17s. 2d., an increase of £1,200 over the receipts for September, 1900. It was recommended that provision be made for the electrical equipment of the Newsome-road line, at an estimated cost of £1,608. This report was adopted by the Town Council. The Tramways Committee reported that they regard with favour the proposal of the British Electric Traction Company, in the event of their adopting the gauge of the Huddersfield tramways, to arrange for the granting of mutual running powers.

Glasgow Tramways.—With such extensive tramway systems as we are now getting in some of our larger provincial towns, the public is sometimes at a considerable loss to know exactly the destination of the cars on the various routes, and much inconvenience is experienced in gathering other information as to fares, time of journey, and so forth. The Corporation electric tramway system at Glasgow is perhaps as good—or bad—an example of this as any other large system in the United Kingdom, and the visitor to the city is often much puzzled to know where the gaily-painted car in which he has taken a seat is going to land him. In future, however, such will not be the case at Glasgow. The Corporation, we are informed, are now providing large-sized plans of the complete tramway system of the city, which will be placed in conspicuous positions inside the cars for the enlightenment of the passengers on the several points mentioned. The plan, a copy of which has just reached us, is, in our opinion, exceedingly well conceived, and reflects much credit on the originator of the idea. Each route is marked on the plan by the colour corresponding to that of the cars running on that particular route. Thus the route from Anniesland to Bennistown, on which green cars are run, is coloured green; that from Langside to New City-road, yellow; that from Govan to Possilpark, blue; and so on. As regards the white cars which are run on certain of the routes in Glasgow — that from the University to Pollokshields, and that from Govanhill to Springburn—the exigencies of the case necessitated these being indicated on the map in black, but this is the only exception to the general rule. The principle underlying the arrangement of the plan is decidedly good, and will doubtless prove a great boon to passengers who are not well acquainted with the many routes which go to make up the very extensive tramway system at Glasgow. The arrangement of routes and the times of departure of the first and last cars from both ends of the several routes are shown in small tables at the side of the plan. Here, again, distinctive colours are employed to quickly reveal the position on the plan of the route in regard to which information is wanted. Only the times of the first car in the morning and of the last at night are given, because the tram service in Glasgow is so very frequent that on some of the routes the cars are run at intervals of only two minutes; on others, four minutes. The time occupied on the journey and the general arrangement of fares, are also given on the side tables of the plan.

Paisley.—Messrs. Mordey and Dawbarn have submitted a report to the Town Council in connection with the supplying of motive power generally and the electricity works and their requirements for providing energy for the projected electric tramways. In this report they state they have no doubt that the system as prevailing in Paisley could, with the necessary additions, be used for the tramway system. The matter was of great importance, not only because of the large amount of energy wanted, but because of the effect it would have, if undertaken by the Corporation, on the economy of the general supply for all purposes. The tramway load would not only be profitable in itself, it would react favourably on the present system, enabling the station to be worked to much better advantage for the ordinary lighting load and for any power demand that might arise. Economy of production was improved by everything that increased and diversified the load, especially if the increase was from tramways or other things taking power for many hours daily. In an interview which they had had with Mr. H. F. Parshall, consulting engineer to the tramway undertakers, they learnt that, subject to the necessary financial arrangements being made, he anticipated that a service of 40 to 50 cars would commence in from 15 to 18 months, and that 70 to 80 cars would ultimately be required. Assuming that 40 cars were used, the energy used annually would be about 1,000,000 units, which would produce an income of about £6,146, or 1·475d. per unit. The tramway load would be a very favourable one, because of its amount and steadiness, and because it would involve no distribution losses or expenses. As regards extensions, etc., required for the increased consumpt, Messrs. Mordey and Dawbarn estimate the cost of these at £38,000 The works had not been working long enough to enable an opinion to be formed as to the sufficiency of the present charges to make the undertaking profitable. That they were not at present covering expenses was partly due to the system being larger and more complete than was necessary for the present output. This would, of course, remedy itself as the demand increased. Another part of the deficit was due to the very low price charged for the street-lighting. This would be remedied by a fair adjustment between the two departments concerned. The deficit on this account should not in any case be regarded as a loss to the Corporation. The effect of the tramway load would be to bring in a profit of about £2,566 a year. There was thus a practical certainty that within a very short time the electricity department would be working profitably. The above report has been adopted by the Town Council, and Mr. Parkinson, burgh electrical engineer, will prepare a statement as to the cost of supplying and erecting plant to provide energy for 40 tramcars.

The Manchester-Salford Dispute.—The Tramways Committee have obtained the opinion of Mr. Balfour Browne, K.C., with reference to the dispute with Manchester. Mr. Balfour Browne concludes his statement to the committee with the following expression of opinion: "I do not think the Board of Trade would make an agreement for the parties, which is practically Manchester's proposal, but the parties must make an agreement for themselves, which, in my opinion, ought to be on the lines I have indicated. There ought, therefore, to be an end of the deadlock. There ought to be mutual running powers to Manchester over the Bury New-road tramways and to Salford over the city tramways from the bridges to Deansgate These running powers should not exclude the owning Corporation from running and carrying local traffic. The owning Corporation's traffic should be protected. Running powers are understood to be the right to run over another company's lines, but not an obligation. The exercise of these powers and the extent of their exercise are at the option of the running Corporation. I see no reason, if the principles were agreed upon, why the

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terms of the exercise of these powers should not be referred to arbitration." On the advice of the Tramways Committee, the General Purposes Committee have decided to recommend the Corporation to send a reply to the Manchester Corporation to the effect that it is infinitely better, in view of past experiences, for both Corporations to disregard all former attempts at negotiation, and to refer the question to arbitration on the lines indicated by Mr. Balfour Browne—namely: The Manchester Corporation to have the right for the period of 21 years to run cars over the Salford tramways in Bury New-road, from the Grove Inn to the boundary between Salford and Prestwich, and over the existing and new tramways in Bury Old-road, between Cheetham Hill and the boundary between Salford and Prestwich. The Salford Corporation to have the right for the same period to run cars over Manchester tramways from Regent, Albert, Blackfriars, and Victoria Bridges to St. Mary's-gate, and from Trafford Bridge to Old Trafford Bar. The rental to be paid in each case to be fixed by the arbitrator, regard being had to all the circumstances of the case and to the value of any facilities which may result from the grant of the respective running powers. The rental may be revised on the application of either party at the end of every third year during the period of 21 years. The arbitrator to ascertain and to apply in respect to the service of cars to be run by each Corporation over the tramways of the other the practice of railway companies in exercising running powers. The fares to be charged by each Corporation in the district of the other to be subject to the approval of the owning Corporation. The Town Council on Wednesday resolved to adopt the above recommendation of the committee.

LIGHTING AND GENERAL.

Heywood.—The formal opening of the electricity works has been arranged for Saturday, 26th inst.

Battersea.—The London County Council have agreed to lend Battersea Borough Council £6,000 for electric lighting purposes.

Rotherham.—The borough electrical engineer, Mr. Cross, is to report as to the cost of erecting arc lamps in certain parts of the borough.

Morecambe.—It has been decided by the Urban District Council to apply for sanction to borrow £5,000 to complete the extension to the electric light works.

Louth.—A committee consisting of five members of the Town Council has been appointed to consider the practicability of electric lighting for the borough of Louth.

East Barnet Valley.—The Urban District Council have the question of engaging an engineer to advise them on the matter of electric lighting still under their consideration.

Middlesbrough.—The Local Government Board has notified the Corporation of its readiness to sanction the additional loan of £34,100 required for electricity supply purposes.

Stratford-upon-Avon.—Councillors Everard and Barnard have been appointed members of the Electric Light Committee in the place of the late Councillors Holtom and North.

New Zealand.—The Timaru Borough Council have under consideration the lighting of the town by electricity, and have asked Mr. A. D. Dobson, C.E., of Christchurch, to report on a scheme.

Blackburn.—The following appointments have been made at the Corporation electricity works: Mr. Crawford, of Dundee, as shift engineer; Mr. Watkins, of Newport, as switchboard attendant.

Pudsey.—The Electricity Committee of the Town Council has been empowered to take preliminary steps for ascertaining how far a Corporation electricity supply would be utilised by the ratepayers.

Westhoughton.—The clerk to the District Council has been instructed to write for an interview with the National Telephone Company with regard to the establishment of a telephone service for the township.

Alloa.—The question of introducing the electric light into the offices of the Parish Council has been remitted to the Finance Committee with powers to obtain an estimate of the cost of a complete installation.

Hampstead.—The Borough Council have decided to lay mains for the supply of electric current to private consumers in East Heath, Priory, Cotleigh, and Belsize roads, Princess-mews, and Upper Belsize-terrace.

Ambleside.—At the monthly meeting of the Urban District Council the seal of the Council was put to the agreement whereby the provisional electric order obtained by the authority is transferred to the Windermere Electric Supply Company.

Swansea.—We understand that Mr. Bell, having resigned his position as assistant electrical engineer to the Corporation, it has been left in the hands of Mr. Prusmann, the chief engineer, to appoint a competent successor, preferably a local man.

Boston (Lincolnshire).—The following resolution was passed by an enthusiastic meeting of Boston ratepayers held last week: "That this meeting strongly urges the Town Council to take immediate steps to secure an installation of the electric light for the town."

Henley's Telegraph Works Co.—We have received from this Company a neat glass letter-weight which will serve two useful purposes. It will tend to keep one's papers in order and will also remind one of the firm and of the excellent cables which they manufacture.

Kirkcaldy.—On the recommendation of the engineers, the Electric Lighting Committee have decided to accept the offer from Messrs. Henley's Telegraph Works, London, for mains and feeders, amounting to £11,239; and also Messrs. Crompton and Co.'s offer for arc lamps, £546. 6s.

Wolverhampton.—The Town Council have received the consent of the Local Government Board to the borrowing of money for the purpose of providing private houses with electricity on condition that the proceeds from the supply be devoted to the repayment of the principal.

Brandon.—At their monthly meeting the Urban District Council gave their consent to an application being made by the Cleveland and Durham County Electric Power Company for a provisional order for the district. The company propose to supply electricity to the neighbouring collieries, etc., in bulk.

Greenock.—During the four weeks ended Sept. 27, 21,684 units of electricity were generated at the works owned by the Police Board and 18,504 sold. This is an increase of 8,540 since last year for the same period. Applications for supply numbered seven, making the total 238, equivalent to 26,559 8-c.p. lamps.

Brechin.—The work connected with the introduction of the electric light into the town being now well advanced, it has been decided by the Town Council to ask Mr. Lackie, Glasgow, their consulting engineer, to make tests. The question of installing the light in the city hall and municipal buildings is receiving attention.

Police Station Telephones.—The Bucks Standing Joint Committee at a meeting in Aylesbury recently decided to place the police stations in the county in telephonic communication. It was urged by some members that this would enable the police to better deal with drivers of motorcars who rushed about the country at a terriffic speed.

Hamilton.—At a special meeting of the Town Council held on Monday last to consider a letter from the Board of Trade in regard to the burgh Electric Lighting Order, 1898, it was decided to report to the Board of Trade what had already been done, and to give an undertaking that the provisions of the order would be proceeded with.

Error.—In our report of the results of tenders for Maidenhead last week we inadvertently credited the Lancashire Dynamo and Motor Company, Limited, with having tendered for engines of their own make. The firm, we are requested to state, do not manufacture engines, and consequently did not offer an alternative tender with their own engines.

Leeds.—The electric lighting mains on the west side of the town are to be extended. The Lighting Committee have decided to proceed with the laying down of the mains for the two-phase current along Kirkstall-road as far as Cardigan-lane, with connections into Burley-road. The work will be commenced when the Tong-road extension is well in hand.

Western Telegraph Co.—The directors, after transferring £35,000 to the general reserve fund and £2,000 to the maintenance ships' reserve fund, recommend a final dividend of 3s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ended June 30, and also the payment of a bonus of 2s. per share, both free of income tax.

Hebburn.—At the meeting of the District Council reference was made to the prospective supply of electricity to the town, and it was pointed out that through the contract entered into between the Council and the Northern Counties Electricity Supply Company the ratepayers would not be called upon to pay a single penny. The power-house is to be situated at Hebburn.

Hull.—The proposed establishment of municipal telephones is receiving the further attention of the Corporation Telephone (Special) Committee. The receipt from the Postmaster-General of the necessary license to carry out the scheme was announced at their last meeting. Application has been made to the several local authorities concerned for the necessary wayleaves.

Aberdare.—The District Council resolved at their last meeting to apply to Parliament for a provisional order to construct an electric tramway from the Aberdare cemetery to Cap Coch, also for a provisional order for the electric lighting of the town. Committees were appointed to formulate the schemes, with instructions to appoint an electrical engineer to prepare plans, etc.

Marriage.—The following extract from the marriage column of the *Times* of Thursday, Sept. 26, will doubtless interest many of our readers: "Lehmann-Reekie.—On Sept. 25, at Camden-road Chapel, Oscar Lehmann (of Lehmann Bros., Walthamstow, and South-villas, Camden-square), youngest son of the late Theodor Lehmann, to Bella, youngest daughter of James Reekie, of Brecknock-road."

Lowestoft.—The Electric Lighting Committee of the Town Council reports that the sanction of the Local Government Board has been received for the borrowing of £10,000 for the purposes of street-lighting. It is proposed to provide 586 incandescent electric lamps throughout the borough, spaced at intervals of 66 yards. About 200 of these lamps will be of 32 c.p. each and the others of 16 c.p. each.

Ayr.—At the monthly meeting of the Town Council, the Electrical Engineer (Mr. A. J. Fuller) reported that the extensions to the generating plant were well in hand. The consumers connected to the mains numbered 482, and during last month 45,374 units were generated. The question of reducing the price of current for motors was considered and remitted to the sub-committee for consideration and report.

Withington.—At the meeting of the District Council a statement was made that the Manchester Corporation were not connecting any further installations to their mains until they were in a position to say definitely when current could be supplied from the Bloom-street generating station. Some dissatisfaction was expressed at this, it being opined that the district had been very much neglected in the matter of electricity supply.

London Gazette.—The partnership existing between G. E. Norvall and S. Parkinson, electrical and general engineers, 45, Essex-road, Islington, N. (trading as the City Engineering Works) has been dissolved by mutual consent.—The partnership existing between F. Hodgson, A. H. Hodgson, and F. G. Andrews (trading as F. Hodgson and Co.), electrical engineers, 4A, Downshire-hill, Hampstead, N.W., has been dissolved by mutual consent.

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Grimsby.—On the recommendation of the Electric Lighting Committee the Town Council have decided to add a new generating set to the existing electric lighting plant, at an estimated cost of about £12,900, to meet the anticipated demand for electricity during the next year or two. Application is to be made to the Local Government Board for permission to borrow the amount.

North Berwick.—At a special meeting of the Town Council on Monday last, it was announced in connection with the *plebiscite* that of 587 cards returned 301 voted for proceeding with the agreement with Messrs. Crompton and Co. for the introduction of electric lighting, whilst the votes in the negative numbered 286, being a majority of 15 in favour of proceeding. The Council resolved to proceed with the agreement with Messrs. Crompton and Co.

Tunbridge Wells.—Report says that the Tunbridge Wells municipal telephone system is achieving remarkable success, in spite of the National Telephone Company's competition. Official figures show that the total number of subscribers to the municipal system since its inauguration two months ago is 606, although the Corporation only estimated 300 in the first year. The National Telephone Company, who have reduced their tariff from £8 to £4, have 392 subscribers.

Brecon.—At the monthly meeting of the Brecon Town Council the Mayor, who presided, mentioned that Colonel Morgan had gone to the expense of procuring a provisional order for the lighting of Brecon by electricity. This was worth £500, and had been presented to the Corporation by Colonel Morgan. If the Corporation did not think proper to take up the matter they could sell it. It was decided to postpone the consideration of the whole question to an adjourned meeting.

Bury St. Edmunds.—At the last meeting of the Electric Lighting Committee a report was submitted by the borough electrical engineer, from which it appeared that the revenue for the last quarter was nearly double that of the corresponding quarter last year. Applications had been received since the previous meeting equivalent to 77 8-c.p. lamps, and an order had been received for the installation of a 5-b.h.p. motor. Springfield-road and Chalk-lane public lighting had been completed, and Victoria-street was being proceeded with.

Horsham.—It was reported at the meeting of the Urban Council that several tradesmen had asked that arc lamps should be erected in Queen-street, but it was decided to carry out the original scheme for lighting the thoroughfare by means of incandescent lamps. The question of lighting the Star-row district came up for discussion, and it was pointed out that the Council could not light the district with electricity until application had been made to the Local Government Board for power to borrow the necessary money.

Cheadle and Gatley.—At a meeting of the Tramways and Electric Lighting Committee, held on the 7th inst., the question of the Council undertaking the supply of electric light and power was discussed at some length by the committee and Mr. Page, electrical engineer, of Manchester. Eventually it was resolved that the chairman of the committee should see the secretary of the Royal Asylum and enquire as to what likelihood there was of terms being agreed upon for the asylum to take electric light from the Council.

Cardiff.—The report of the electrical engineer (Mr. A. Ellis) submitted to the Electrical and Lighting Committee at their last meeting showed that during the six months ending Sept. 30, 1900, the income from the electricity supply undertaking had been £3,582. 2s., whereas for the current six months it had been £4,787. 3s. 4d., an increase of £1,204. 1s. 4d. The estimated increase for the 12 months ending March, 1902, was £1,670, hence the estimated increase on the year's working has been almost reached within half that period.

Municipal Telephone Project.—The proposal of the Bradford Corporation for a conference of the principal cities and boroughs of the West Riding on the subject of the municipalisation of the telephone system in the Riding has been favourably considered by Leeds, Sheffield, Halifax, and Huddersfield. On the suggestion of Leeds, it is proposed that the first conference shall be held in that city at an early date. Delegates have been appointed by the Bradford Corporation, and preliminary steps have been taken to convene the conference.

Hampstead Electric Supply Co.—A meeting to consider a proposed scheme for the winding-up and reconstruction of the above Company is to be held on Monday next, 21st inst. The scheme, as far as we have seen, does not really face the difficulties caused by the over-capitalisation of the Company in 1898. We would warn shareholders against throwing good money after bad, and would suggest that the engineers who approved of the company's prospects in 1898 should be asked to attend the meeting and explain why their predictions in the report published in the prospectus had not been realised.

Swindon.—The report of the Lighting and Tramways Committee, recommending that it be left to their chairman, the clerk, and the borough surveyor to open the tenders received for the erection of the proposed electricity buildings, and to forward the same to the engineers for them to examine and report upon, and that a special meeting of the committee be called to consider the report, also that the town clerk advertise for tenders for the supply and delivering at the proposed electricity works of certain machinery and plant, including three Lancashire boilers, was adopted by the Town Council at their last meeting.

London County Council and the Telephones.—At a recent meeting of the London County Council a member asked for some particulars about the relations between the Post Office and the National Telephone Company. Mr. Benn replied that the committee had no official information that the company is bringing any pressure upon the Post Office to raise its prices to those now charged by the company, but the Highways Committee had written to the Post Office asking that before any agreement with the Telephone Company was come to, or before the Post Office fixed its own charges, it should confer with the Council.

The Merwarth Metallic Casket.—The Fairbanks Company, of 16, Great Eastern-street, E.C., have sent us samples of the above casket, which they are introducing into this country. It consists of a soft ring of a lead alloy, which is surrounded by a copper ring. On to this copper ring are soldered two small tags of copper wire, the loose ends of which can be wound round the bolts of the pipe coupling, so as to secure the soft ring of metal in a position concentric to the axis of the pipe. The device is a patented one, but we presume that on account of its simplicity it will be supplied at a reasonable rate.

Pemberton.—The question of extending the electric cable to Worsley Mesnes is under consideration. A circular has been issued by the District Council calling the attention of the ratepayers to the scheme which the Council have had prepared, and are now carrying out, with a view of supplying a considerable portion of the district with electric light and power during the coming winter. The maximum charge for the light, it appears, will be 5d. per unit, which is equal to the present price of gas in the town, and if the price of gas is reduced that of the electric light will be reduced also. It is evident that the Council mean business.

St. Annes-on-Sea.—The Electric Lighting Committee have resolved that, provided Mr. Sutcliffe will give a written undertaking to wire the whole of the houses he is erecting in York-road and not put any gas fittings therein, a cable be laid along the street as requested by him. In answer to complaints as to the meter rents charged, it is pointed out that consumers will probably get their electricity cheaper in the near future and the meter rents wiped out. An enquiry was held on Tuesday last into the application of the Urban Council for sanction to borrow £7,230 for purposes of electric lighting. It is proposed to substitute electricity for gas in street lighting.

King's Lynn.—The cost of fixing eight arc lamps on Gaywood is estimated by the engineer at about £224. An alternative scheme for lighting the road with incandescent lamps is to be considered. With regard to the progress of the electricity supply works, the working expenses, etc., during the months of July and August were: July, 1900, £104. 18s. 5d.; July, 1901, £84. 3s. 5d.; units generated, 10,674, 13,064; units sold to private consumers, 2,552, 2,968. August, 1900, £149. 4s. 8d.; August, 1901, £101. 17s. 3d.; units generated, 17,325, 17,079; units sold to private consumers, 2,735, 3,481. The salary of Mr. A. Howell, assistant engineer, has been raised to 45s. per week.

Burton.—It was reported at the monthly meeting of the Town Council that during the past month the quantity of electric light sold in Board of Trade units was 13,098, an increase of 3,076 units as compared with the corresponding month of last year. The Gas and Electric Light Committee had considered the subject of borrowing £1,020, part of the sum disallowed by the Local Government Board from the electric light loan of £5,000, brought before the Council at their last meeting, and it was resolved that such sum of £1,020 be borrowed from the gasworks reserve fund and paid back by 18 equal annual instalments, or earlier if it is found convenient to do so, at interest at the rate of 3½ per cent. per annum.

Municipal Telephones.—At the monthly meeting of the Brierfield District Council, the clerk reported with respect to the conference on municipal telephony held on the 3rd inst., at Burnley, that the practical result of it was that the four boroughs represented—Burnley, Nelson, Colne, and Todmorden—agreed that they would bear the cost of an expert going into the matter and seeing whether, in a financial sense, it would be possible to provide the district with the telephonic system. The District Councils—Barrowford, Brierfield, and Padiham—and the Rural District Councils were not put to any expense in the matter. The next step would be to get the authority to report on the matter, and his impression was that it would not be long before that was done, as Burnley and Colne were very enthusiastic in the matter.

Bangor.—At the monthly meeting of the City Council the following recommendations by the Lighting Committee were adopted after considerable discussion: that a new feeder be laid to the electric light main near the clock tower at a cost of £369, and that the town clerk be instructed to write to the Local Government Board to expedite the enquiry on the application for a loan; that the tender of Mr. Watkin Jones for concrete foundation for the sum of £38. 10s., also that of Messrs. Babcock and Wilcox for steam-pipes, for the sum of £82. 13s. 8d., be accepted; that application be made to the Local Government Board for sanction to borrow the sum of £2,032. 15s. 2d. to cover extras and extensions at the electricity works; that the tender of Messrs. Dorman and Smith, Salford, for extensions to the switchboard in connection with the new steam dynamo, be accepted for the sum of £98. 10s.

Electricity at St. George's Hall.—The Salambo and Olivette's New Wonders Company at St. George's Hall have been eminently successful in solving the problem of getting a great deal of enjoyment and amusement out of the latest scientific discoveries. Their exposition of wireless telegraphy through the body, whether it be through the body of man or the body of the hall, by means of a 300,000-volt Tesla apparatus, a 1,000-ohm receiver, and some 6ft. long vacuum tubes, are not only highly interesting to the scientist, but there is not a dull moment in the whole performance. The rapidity with which Olivette gives blindfolded the cubes of a number of figures suggested by the audience, the clever child Historian Elia Cecilia Salambo, the biolaughograph, the play with oxygen flames, and a number of other items new this side of the herring pond, make the show a most attractive and highly amusing one.

Rochester.—At the last meeting of the Town Council a communication from Messrs. Norman and Stigant was reported, which stated that the offer of £5,000 made by the Corporation for the purchase of so much of the Chatham, etc., electric light undertaking as is situate within the district of the city was inadequate, and that the company therefore declined the Council's offer. It was resolved that, inasmuch as the amount offered by the Corporation exceeded by a large sum the

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valuation put upon the property by an expert valuer, and having regard to the most unsatisfactory way in which the service is carried out by the company, the town clerk should give notice to the Board of Trade that the Corporation object to the proposed revocation of so much of the provisional order as relates to the area of the Gillingham urban sanitary district, with a view to obtaining a guarantee that in future the terms of the provisional order shall be properly complied with.

Progress Sheet.—We have received from the General Electric Company, Limited, a copy of their October "General Electrical Progress Sheet." Amongst the articles described may be mentioned an automatic time-recorder for telephone trunk line calls, a pocket micrometer gauge, a two-way wall plug for circuits up to 250 volts, and the "Robertson Sunshine" lamp. The latter is, we understand, especially designed for street-lighting. The lighting of side streets by means of electricity is becoming more and more frequent, and in the majority of cases where the authorities prefer to adapt the present gas lamp, something is wanted to throw the light clearly in both directions. It is claimed that the "Robertson Sunshine" lamp fulfils this purpose very effectively if two are used. It is provided with a detachable opal reflector, which can be used over and over again, whereas the lamp itself may want renewal. Moreover, the lamp is specially made to stand vibration.

Proposed Exhibition.—We are informed that arrangements are being made for an exhibition of labour-saving machinery and novelties in engineering and electrical trades in St. James's Hall, Manchester, from Thursday, March 6, 1902, to Saturday, March 15, 1902, both dates inclusive. For some years past there has been an increasing number of applications from firms in the engineering and electrical trades for space in the annual cycle and motor shows held each spring in the St. James's Hall, but owing to the keen competition for space by cycle and motor firms all such applications have had to be refused. For this reason, and at the special request of a number of engineering firms, it has been decided to organise an exhibition devoted wholly to machinery. The exhibition will be under the same management as the annual cycle and motor shows. Entries are now being booked, and applications for space should be addressed to the secretary, Mr. William A. Carson, 2, Parsonage, Manchester.

Gravesend.—A Local Government Board enquiry was conducted by Mr. H. Percy Boulnois, M.I.C.E., last week into the application of the Town Council for sanction to borrow £31,000 for electricity supply purposes, and £3,500 for the provision of a refuse destructor. There was some opposition. At the meeting of the Town Council last week the formal approval of the Board of Trade to the proposed system for the supply of electrical energy was announced. The Town Clerk submitted the draft agreement for the supply of electrical energy prepared by the solicitor of the Gravesend and Northfleet Electrical Tramways, Limited, according to which the Corporation are to supply the company with all the energy they require for working their tramways at the rate of 2d. per unit on the minimum annual quantity of 180,000 units. For energy consumed over and above this minimum up to 300,000 units 1½d per unit will be charged. It was decided to seal the contract with Messrs. Veritys, Limited, for the supply, fixing, and maintenance of accumulators for five years after completion of their contract.

Coventry.—At the last meeting of the City Council the General Purposes Committee charged with the consideration of what amendments should be made in the standing orders to carry into effect the resolution of the Council to enable the Gas and Electric Light Committees to present the minutes of their proceedings to the Council for confirmation, presented a long report. The effect of the sub-committee's recommendations, which were adopted, will be that the Gas and Electric Light Committees will print their minutes as other committees do, but will retain control over the ordinary working of their respective departments, and will have the power to make contracts for all ordinary purposes. This will include the power of extending mains from time to time as the interests of the respective departments may require. The minutes of the committees will not show the details of the contracts entered into and tenders accepted, but it is proposed to enter complete details on duplicate lists to be signed by the chairmen, one of which will be retained by the manager for his guidance, and the other filed at the town clerk's office for reference.

Wimbledon.—An interesting little ceremony took place at the offices of the Wimbledon Urban District Council on Saturday evening last, when Mr. S. C. Gibson, the chief assistant engineer at the electricity works, was presented with a spirit and smoking cabinet by his brother officials on his leaving to take up the appointment of resident engineer to the Nuneaton electricity works. Mr. R. H. S. Butterworth, the clerk to the Council, alluded from the chair in felicitous terms to the good feeling existing amongst the various departments of the Council, and Mr. F. Barnes Spencer, the Council's chief electrical engineer, in making the presentation drew attention to the loyal support he had always received from Mr. Gibson during his connection with the department and under many trying circumstances, and on behalf of his colleagues asked his acceptance of this small token of their esteem and regard. Mr. H. Tomlinson Lee, A.M.I.E.E., at present chief assistant engineer to the Wakefield Corporation electricity works, has been selected by the Electric Lighting Committee of the Wimbledon Council to fill the vacancy out of over 100 applicants.

Exeter.—In another column will be found a report of a special meeting of the City Council, held on Monday last, to consider proposals for the proposed new electricity generating station at the Basins. It may be explained here that the scheme was prepared by the city electrical engineer, Mr. H. D. Munro, who, under the directions of the Electric Lighting Committee, issued specifications for a complete equipment on either the single or two-phase systems, inviting at the same time alternative offers, or tenders for complete equipment. The only variations in the tenders received were as to the size and type of steam alternators and the condensing arrangements. The whole of the tenders received were submitted to Mr. R. Hammond, who selected and recommended a series of sectional tenders for the equipment, including Parsons steam-turbines, making, however, other suggestions, including the consideration of conversion to direct current. It will be gathered from the report in question that the committee has decided to recommend the inclusive tender of the Westinghouse Company, and to adopt Mr. Munro's advice as to converting the existing system to two-phase.

Arc Lamps and Accessories.—We have received from the Union Electric Company, of 101, Queen Victoria-street, E.C., their list of arc lamps and accessories, which runs into almost 100 pages. This firm are now supplying all of Messrs. Korting and Mathiesen's specialities in arc lamps and accessories. The catalogue in question gives one a good idea of the enormous output which the firm in question have. Thus we find arc lamps of all types—open lamps and closed lamps, shunt-wound lamps, differential lamps, converted lamps, alternating-current lamps, and, lastly, lamps for searchlights for projector work. In view of the large number of types, it is quite as well that the Union Electric Company have given advice in the opening pages of the list on the selection of lamps for any special circuit. We believe that they are prepared to extend the advice so given to meet any case submitted to them. As regards the accessories, attention should be given to the great variety of reflectors, lanterns, and globes which are manufactured and stocked by the firm. The other details and accessories appear to be equally well thought out, and the list is one which will be of service to electrical engineers who have to design indoor and outdoor lighting.

Presentation.—On Friday evening last the Gladstone Arms Hotel, Brighton, was the scene of a very pleasant gathering. The occasion wil be remembered by the people of Brighton in years to come, for it marked the completion of the electric tramway scheme throughout that charming seaside resort. The event was celebrated by the presentation of a very handsomely illuminated address and testimonial to Mr. John F. Kerwin, superintendent, who, we believe, has carried out the work, not only to the entire satisfaction of Messrs. Macartney, McElroy, and Co., Limited, the contractors, but also the municipal authorities, many of whom were present and took part in the presentation. Among those present were Councillor F. Allen, Councillor Buckwell, Councillor Grinstead, and Councillor Swift, of the Tramways Committee. The contractors were well represented by the following: Messrs. B. Hartley, walking foreman; D. Wallace, working foreman; P. Gorman, concrete foreman; W. F. Hopgood, wood paviors' foreman, London branch; M. Doherty, platelayers' foreman; W. Bodle, cartage foreman; M. Hayes, wood paviors' local branch, etc.; and J. Stephenson, engineer (as well as chairman Presentation Committee). Among the townspeople who took part may be mentioned Messrs. T. Bonner, C. Duke, J. Cornford, S. Crooke, J. Green, C. Hill, C. Lemark, W. H. Holman, B. Harmer, G. Farrell, S. Holman, J. O'Connor, W. Tidey, W. E. Clancy, G. Cole, and L. Sarre (in the vice-chair). Speeches, songs, and recitations were the order of the night. We offer Mr. Kerwin our congratulations upon making himself so popular among all classes, and at the same time carrying out so important an undertaking to the entire satisfaction of all concerned. Mr. J. J. Pakenham acted as hon. secretary, and deserves a word of praise for the manner in which he performed his duties.

West Bromwich.—At last week's meeting of the Town Council Alderman Pitt, in moving the adoption of the report of the Electric Lighting Committee, which recommended a reduction in the electricity charges for both lighting and power purposes, remarked that they did not expect to make a profit in connection with the undertaking for the first year or two. Although their charges were about the lowest in the kingdom, yet the committee believed when they had the trams running they would make things pay. The tramway company, it was anticipated, would take from them altogether 600,000 units of electricity annually, and in order to supply this quantity the present plant would have to be extended. The total cost of making those extensions was estimated at £1,494, but the revenue from the tramway company would be about £4,000, which would leave a balance on the right side of £2,506. Things would be completely altered when the trams were running, and they expected a considerable profit from the undertaking. A discussion ensued, and the Mayor considered that in connection with the undertaking there had been certain mistakes made, and the electric lighting station had been erected 18 months too soon. They would have to face an expenditure of £2,000 or £3,000 before they could expect to make a profit. The Electric Lighting Committee now proposed to reduce the price by 25 per cent., and he urged that in doing so they were making a grave mistake. He moved an amendment to the effect that the charges be for 500 units and upwards 2½d. per quarter instead of 2d., 50 units and upwards 3d., and below 50 units 4d. There was no seconder, and it was urged by several members that the tradesmen, who, it was stated, were still dissatisfied with the committee's charges, should give them a fair trial. Councillor Bushell asked if the loss on the undertaking would be within £2,000 for the 18 months, but Alderman Pitt said he could not supply any information on this point until he knew the extent of the demand. The report was ultimately adopted.

An Engineer's Watch.—We have recently had brought to our notice the "Engineer's" watch, which is being manufactured by Messrs. J. W. Bensons, Limited, of Ludgate-hill. This watch has numerous advantages from an engineer's point of view, and is especially suitable for electrical engineers in central stations and manufacturing works. It is a keyless centre-second stop-watch, such as is most useful in taking the speeds of machinery. A third dial, besides the ordinary second-dial, is added, on which the minutes are recorded when using the stop-watch action. In the type made with a half-hunter silver case, the stop action is so interlocked with the case that when an extended record has to be kept, the stop cannot be moved all the time

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the case is closed. The centre second-hand records accurately to one-fifth of a second. When inspecting the watch we were afforded an opportunity of examining the chronograph action, and found it an example of the wonderful excellence to which the watchmaking art has reached in the hands of the firm's experts. These watches are all non-magnetisable, so as to be unaffected by the stray fields of dynamos.

Southampton.—It was reported by the Electricity Committee at the last meeting of the Town Council that the units sold in August amounted to 51,154 for private lighting, as compared with 31,136 in the corresponding month of last year, an increase of 64·3 per cent.; for cranes, 3,652; public lighting, 4,050; used in works, 5,196; tramways, 65,040; equivalent number of 8-c.p. lamps connected during the month, 215; coal, oil, wages, etc., £795. 1s. 4d., the cost per unit generated being 1·54d. The sub-committee had considered the 72 applications for the position of electrical engineer at a salary of £500 per annum, and recommended the appointment of one of the nine candidates selected. Subsequently the Deputy-Chairman reported that he and Councillor Blakeway had carefully read the applications and testimonials of the nine candidates selected by the sub-committee, and were of opinion that Messrs. S. W. Newington, Oldham; H. F. Street, Halifax; and H. Boot, Tunbridge Wells, should be interviewed. The Town Clerk then read the applications and testimonials submitted by the three gentlemen referred to, and also the application of Mr. F. Aspinall, superintendent engineer, City of London Electric Lighting Company, and it was resolved that a deputation, consisting of the deputy-chairman and Councillor Blakeway, be appointed to visit Oldham, Halifax, London, and Tunbridge Wells to interview Messrs. Newington, Street, Aspinall, and Boot, and report the result to the committee.

Conduit Explosions.—We have just had the opportunity of perusing the report of Mr. Albert Gay, the electrical engineer to the borough of Islington, on the accident which occurred on the 8th inst. in the electric lighting conduits in Highbury-park. It is evident that there was a serious escape of gas in the neighbourhood, as the men of the Gaslight and Coke Company had been on the look out for the leak the day before the explosion occurred. The explosion lifted the iron covers of eight street boxes, four of them being broken, but there was no one injured. The conduits in which the explosion occurred consisted of two 6in. cast-iron pipes. Only one pipe contained a cable, which was of the armoured concentric and high-tension type, and this cable was not damaged in any way by the explosion, so that the electric lighting of the district was not interfered with at all. Also there were no connections made on to this cable in any of the boxes which were affected. Mr. Gay assumes accordingly that the gas was fired by a lighted match or cigar end, or possibly by the gasmen's torch in a pit alongside the line of explosion where they were excavating for the purpose of looking for the leak. The leak was actually found shortly after the explosion had taken place. The cubical contents of each box were about 2ft., and we understand that the boxes were ventilated. In view of the above, it is obvious that electricity played no part whatever in the explosion in question. We would recommend the case to Mr. George Livesey as one which his experts, Messrs. Ayrton and Perry, would do well to investigate in order to ascertain the liability of gas companies for the damage which the leakage of their commodity causes.

Exeter.—A special meeting of the City Council was held on Monday evening last to consider the report of the Electric Lighting Committee respecting the equipment of the new works which are to be erected at the Basin. The committee had selected Mr. Robert Hammond, consulting engineer, as the expert, and had placed in his hands the electrical engineer's scheme, the tenders received, and the alternative plans. After very full and careful consideration of the whole matter, the committee recommended the placing of the contract for the entire equipment of the station in the hands of one firm of contractors, and the adoption of the two-phase system; that subject to the consent of the Local Government Board being given to the raising of the money by loan, the complete tender of the British Westinghouse Company of £28,989, with an addition of £718 for larger boilers, making a total of £29,707, be accepted. The committee decided to postpone the consideration of the tenders for the building until the foregoing recommendations had been decided on by the Council. Mr. Hammond in his report said: "In comparing the tenders with others it must be borne in mind that the old plant, which I have valued at £2,000, is left in your hands. The equated value of the tender therefore is: amount of tender, £28,989; credit for steam economy, £600; credit for old plant, £2,000—total, £26,389." Mr. Hammond suggested certain alterations in the specifications and in the suggested arrangement of the plant. The site of the building itself was an excellent one, but he considered that the plans involved more expense than need be incurred. In a supplemental report, Mr. Hammond concludes: "Before issuing the specification I should seriously consider whether or not it is advisable to substitute low-pressure generation and feeding for your present high-pressure transformer system. It seems to be a mistake, in view of probable tramway development, not to thoroughly consider the *pros* and *cons* of changes of system." Mr. Munro, the city electrical engineer, counselled the pushing forward of the work so as to avoid the necessity for increasing the plant at the present works. Mr. Domville, in moving the adoption of the report, spoke of the advantages of the two-phase system recommended by the committee. Amongst other things, the system would enable the Council to make use of the greater part of their present plant in the shape of mains, transformers, and so on. Having spoken of the relative advantages of condensers, the speaker observed that 140 tenders were sent in, and a mass of figures was consequently involved. Although the committee only had before them tenders from three firms for the complete scheme, it was very unfortunate that the result of the committee's investigation into the tenders should have been early made known out of doors, and that newspapers should have commented upon the reports of the committee at such an early stage. He thought the proceedings of the committee on so important a subject should be held sacred until brought before the Council. Owing to the publication of their deliberations the committee had considerable difficulty placed in their way in arriving at a final conclusion. The plant at present in the hands of the Council cost them £5,000, and would have to run for another year, and having regard to the possibility of improvements taking place in electrical machinery, he questioned whether the old plant would fetch so high a sum as £2,000. Mr. Rowe seconded, and agreed with Mr. Domville that the deliberations of the committee had been dealt with in a very regrettable manner in the Press. In regard to the attitude of the minority on the committee, he expressed his opinion that they had arrived at an erroneous decision. He did not think the Council could do better than accept the Westinghouse tender. The Town Clerk read letters from C. A. Parsons and Co., Ferranti, Limited, and the British Westinghouse Company offering to amend various particulars in their tenders, and also offering certain bonuses in confirmation of undertakings given to the committee by the representatives of the firms. Mr. Councillor Munro moved an amendment in favour of the acceptance of C. A. Parsons and Co.'s tender to execute the works for £27,981 on certain conditions. He dwelt on the advantages of steam-turbines which would be used in the scheme proposed by the firm, and which were specially adapted for generating electricity. In reply to various public criticisms which had been made, the speaker stated that whatever tender was accepted the same amount of work could be done locally. Mr. Wilson seconded the amendment, and after a long debate, in the course of which several members suggested that further information should be obtained, Mr. Stokes moved the adjournment for that purpose. Mr. Turner seconded, but the motion for adjournment was defeated by 21 votes to 18. After another long debate, however, the adjournment was carried.

COMPANIES' MEETINGS AND REPORTS.

BROCKIE-PELL ARC LAMP.

Lord Suffield presided over the second ordinary meeting of the shareholders in this Company on Tuesday, at the offices, 60, Worship-street, E.C.

The **Chairman**, in moving the adoption or the report and accounts (which appeared in our last issue), said that although the directors were not in a position to pay a dividend, the business stood in a very satisfactory condition. The accounts showed that the scheme of reconstruction, which was loyally supported by the shareholders, had borne fruit, and as the result of the past year's trading, after writing off £430 for depreciation, there was a net profit of £2,465. This sum was sufficient to pay a dividend of at least 2½ per cent. and to carry forward a respectable balance, but the directors felt that, in the interest of the Company, it would be wise to keep the money in hand in order to enable them to cope with the increasing demand for the Company's lamps. During the year under review the orders had steadily increased, and the turnover was nearly 25 per cent. in excess of what it was in the previous 12 months. Among the larger contracts entered into they had supplied 800 lamps for the public lighting of Westminster, 200 lamps for Poplar, 200 lamps for the tramways of Newcastle, and 115 lamps for the Brighton tramways. Many other orders were now being carried out, and a consulting engineer who was a leading man in the electrical world had stated that the Brockie-Pell lamps, though rather more expensive, were, in his opinion, the best lamps on the market, as the cost of maintenance was so small as compared with others. In addition to the above contracts, the Company had supplied 1,100 lamps for the lighting of the Glasgow Exhibition, which had given great satisfaction. A certificate to that effect was expected to be received daily. As regarded the current year, the chairman stated that the orders which had come in during the quarter ended Sept. 30 showed an increase of more than 50 per cent. over those in the corresponding period of 1900. In conclusion, he referred to the death of the late managing director, and remarked that in Mr. W. J. G. Fitzgibbon the Board had found an able and energetic successor to Mr. Shrimpton.

Sir F. Dixon-Hartland, M.P., seconded the motion, and in doing so referred to the principal items in the accounts, and quoted statistics to show the progress made in the business since the formation of the original company. The report for the first year's trading showed that £10,000 worth of lamps were sold, and that the gross profit was £2,000, the establishment charges £7,700, and that there was a loss of £4,590. As the result of the second year's working the loss was £1,496, but for the following year there was a profit of £439. In the period under review, however, they had sold £24,546 worth of lamps, and the net profit amounted to £2,456. He believed that the Company had now turned the corner, and would henceforth be a dividend-paying concern. Sir Dixon-Hartland also stated that if the business of the Company increased at its present rate they would have to look out for new premises in another two years. In reply to shareholders, Sir Dixon-Hartland admitted that it was hard on shareholders, after waiting so long, not to receive any dividend this year, but, as the chairman had explained, the money was required in the business for the time being. If the profits admitted of it at the close of the half-year, there was no reason why the question of paying an interim dividend should not be taken into consideration. With regard to the lamps supplied for the Glasgow Exhibition, these would be taken back into stock at cost price, and no profit had been credited in the present accounts in respect of those lamps. As to their contract with the London and North-Western Railway Company, the latter made their own lamps, and paid this company a royalty on each one used. Incidentally, Sir Dixon-Hartland mentioned that he should like to see the shareholders take

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up 20,000 debentures, because that would bring the capital of the Company to £200,000. The directors were quite willing to take their share.

The motion was then put, and carried unanimously.

CONSOLIDATED TELEPHONE CONSTRUCTION.

On Tuesday the annual general meeting of the shareholders of this Company was held at Winchester House, Mr. H. F. Jackson in the chair.

The directors' report for the year ended March 31 last stated that the results had been adversely affected by a flood which took place at the Coventry works during January last. A considerable quantity of goods ready for delivery were damaged. The business of Williamson and Joseph, Limited, had been acquired. The directors were satisfied with this purchase, and believed it would add materially to the profit-earning capacity of the Company. The trading profit amounted to £2,832, to which should be added the portion of the profit of Williamson and Joseph, Limited, in form of dividend, amounting to £366. These two figures gave a total trading profit of £3,199, against £1,192 for the previous year. The total income on revenue account amounted to £5,430, against £3,780 for the previous year. Deducting expenses amounting to £2,956, and adding the amount brought forward, there remained an available balance of £5,642. The directors proposed a dividend at the rate of 3 per cent. per annum, making a total distribution for the year of 3 per cent., and leaving £2,452 to be carried forward. The directors had devoted a great amount of time and attention to the improvement of one of the principal assets of the Company, which consisted of shares and debentures in the Anglo-Portuguese Telephone Company. Long and important negotiation with the Portuguese Government had recently resulted in the granting of a new concession, which extended the period of the monopoly to 1937 (the old concession would have terminated in 1917). There were many changes in the terms of this concession, which secured important advantages to the Company. The directors looked to increased profits accruing to the Consolidated Company from this source in the near future. The lawsuit initiated by the Edison-Gower-Bell Telephone Company against infringers in Belgium had made progress, but the directors were unable to report that it had been finally disposed of.

The **Chairman**, in moving the adoption of the above report, referred to the trading profit, which showed a considerable improvement, and indicated that the Company had turned the corner, and that the hopes which the new Board had when they were elected had, to some extent, been justified. Dealing with the several items in the balance-sheet, he said the stock of instruments, materials, etc., stood at £11,075, or roughly, about £4,000 more than in the previous balance-sheet. The reason for the increase was that the Board had determined to extend the field of the Company's operations—a measure necessitating the holding of more stock. They were considering the advisability of removing a very large portion of the works from Coventry to the neighbourhood of London. This would necessarily involve some outlay, but he thought that the change would produce good results.

Mr. F. W. Kerr seconded the motion.

Answering a shareholder, the **Chairman** promised to consult with the other members of the Board prior to the next stock-taking as to the suggestion that the stock should be valued by an expert.

The motion for the adoption of the report was unanimously adopted.

HIRAM MAXIM LAMP.

At the offices of this Company, 17, Shaftesbury-avenue, W., on Wednesday, Sir Henry Wardlaw, Bart., presided over the first general (statutory) meeting of the shareholders.

The **Chairman** explained that the meeting was called in accordance with the Companies Act, 1900, which required that every company registered since Jan. 1 last should hold its statutory meeting within three months from the date at which it was entitled to commence business. It would be seen from the report of the directors and auditors that the whole of the working capital of the Company had been fully subscribed and allotted, and there was not a single defaulter among their list of shareholders, and the whole amount entitled to be paid had been duly paid into the Company's bankers. The Company had incurred no extraordinary expenses, but had merely paid the stamp duties on its capital and deed stamps on registration and other such fees, amounting together to the sum of £198. 2s. 6d., which left the Company with its working capital practically intact. The concession referred to in the prospectus was duly vested in the Company, and they were in the position foreshadowed in that prospectus, the organisation and business of the Company being now on a sound basis. They had the sole right and monopoly all over the world for the sale of the Maxim lamps. It would be unnecessary for him to emphasise the intrinsic merits of this lamp; it was an invention of that well-known and successful inventor, Sir Hiram Maxim, whose name alone imparted to it the hall mark. The factory belonging to the Sir Hiram Maxim Electrical Corporation, who manufactured these lamps, was, even before this Company agreed to take the concession, in a most thoroughly and perfectly equipped condition; but that corporation, wishing that there should be no possible obstacle in the way of delivering a thoroughly perfect article, had since spent some thousands of pounds in further equipments, to anticipate an early increase of this Company's sales over the number contemplated by the prospectus. They had, moreover, on the suggestion of the manager of this Company, made an improvement in the style of the lamp itself, and they believed that with these new improvements the articles they should supply would be second to none. There were several lamps upon the market at the present time, some of which enjoyed a high reputation; but this Company had the advantage of being the last in the field, and, consequently, had had the opportunity of considering all the merits and defects of other lamps in conjunction with the new processes of Sir Hiram Maxim, and had been enabled thereby to produce what they believed to be a perfected article. He might say that arrangements had been made, and were in course of negotiation, for the Company to be represented in the most influential centres, and that important agencies were being established in the Colonies, from which the Company expected to receive large business. They had made arrangements for taking over the lease of the showrooms, situated as they were in a central position, and branch establishments would be opened also in the important towns of the provinces; but the policy of the directors at the present time was to keep down the outgoings of the Company to the lowest possible point, so economising and making the working capital available for more extensive operations in connection with the sales. The Sir Hiram Maxim Electrical Corporation had the power of nominating two directors to their Board; at present they had appointed one—namely, Mr. Jules de Meray, the chairman of that corporation, who was working heartily with this Company. He anticipated before meeting the shareholders again that another gentleman from that Board would be amongst their number. They had in their managing director, Mr. Stokes, and their manager, Mr. Trussell, two energetic men who understood the meaning of "progress," and with electric lighting this was what was wanted to make the Company a success. Naturally improvements of one kind or another were being daily made, and under the guidance of Sir Hiram Maxim he did not doubt but that they should take advantage of all these improvements. He hoped the next time he had the pleasure of meeting the shareholders it would be to discuss a prosperous balance-sheet, and from the outlook of things he did not think he was too sanguine in foreshadowing the payment of an interim dividend. He then formally moved the adoption of the report.

Mr. Carl Vigant de Falbe seconded the motion, which was carried without discussion.

CAPE ELECTRIC TRAMWAYS.

Colonel Sir Chas. Euan-Smith, K.C.B., presided over the fifth ordinary general meeting of the shareholders in this Company, held at Winchester House, E.C., on Wednesday last.

The **Chairman**, speaking on the motion for the adoption of the report (which appeared in our issue of the 4th inst.), congratulated the shareholders upon the very satisfactory results of the last year's working. The war—which indirectly had affected them somewhat prejudicially in the direction of delaying the erection of the new works and of landing rolling-stock, etc.—had so far had no adverse influence upon the receipts of the Company. The progress made was not only of a very substantial but also of a markedly progressive character. They had carried over two million more passengers this year than they did in the preceding year, and the net profits (after providing for the payment of the debenture interest) aggregated a total sum of £75,922. 2s. 9d., against profits for the year 1899-1900 of £65,204. 4s. 5d. With regard to the proposed extensions of the Company's systems, both in Cape Town and in Port Elizabeth, he referred more particularly to that to the dock gates. It appeared that, although the formal sanction for the docks line extension had been passed, the final instructions to the Company's officials for immediately proceeding with this work were being withheld by the municipal authorities until certain matters (now in process of negotiation) had arrived at a satisfactory solution. They did not anticipate, however, that the final orders would be delayed for any serious length of time, especially as Mr. Syfret was now on his way to the Cape, and was in full possession of the views of the Board, and it was hoped that the result of his return would be to remove all difficulties. The delay that had been occasioned in the landing and erection of the very large amount of new machinery and rolling-stock had certainly had a somewhat serious effect in the overcrowding of the cars at Cape Town, which had produced a very natural expression of public discontent. The Board had, however, done all that was necessary to meet the full requirements of the public which experience had disclosed, and they had no doubt whatever that within a very short time, when the works now in progress were finished and the rolling-stock now in transit was placed upon the rails, all these causes of discontent would finally disappear. Referring to the interim dividend of 4 per cent. which the directors recommended, the chairman said they should be wrong to encourage the belief that the Company would in the immediate future find itself in a position to maintain this high rate of interest regularly.

Mr. J. Taylor seconded the motion.

Replying to a question with regard to a further extension of the lines beyond the dock gates, the **Chairman** said the policy of the Board had always been a very progressive one, and they had endeavoured to study the public taste. Therefore he thought the shareholders might safely leave the question of running beyond the dock gates in their hands.

The motion for the adoption of the report was unanimously carried, and the following directors were re-elected: Colonel Sir Charles Euan-Smith, K.C.B., C.S.I., Vice-Admiral Albert Hastings Markham, Dr. Frederick Rutherfoord Harris, Mr. Ludgiw Breitmeyer, Mr Alfred Parrish, Mr. James Benjamin Taylor, and Mr. Frank Robinow

The meeting closed with a vote of thanks to the chairman and directors for their services during the past year.

ELECTROLYTIC ALKALI: SANGUINE ANTICIPATIONS.

Presiding at the annual meeting of this Company in Manchester, **Mr. W. Thomson** stated that 4½ months' working of the absolutely unique process at the Company's works at Middlewich resulted in a profit of £1,241, which it was proposed to carry forward. The directors estimated that constant working of the present limited plant would

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realise, even under present disadvantages, an annual profit of £3,800. Another unit would be working within six months, and on the present basis an annual profit of £15,000 should be yielded. The directors suggested issuing £100,000 additional shares, and immediately constructing five additional units of cells, which it was believed would realise the most sanguine expectations. He then formally moved the adoption of the report and accounts.

Mr. C. Connor seconded the resolution.

A discussion followed, the directors' action in appointing the chairman as managing director at a salary of £500 a year without the shareholders' consent being criticised. General satisfaction was, however, expressed at the success of the process.

The motion was ultimately carried, and it was resolved that no remuneration be at present paid to the directorate.

ANGLO-PORTUGUESE TELEPHONE.

In their report for the year ended Dec. 31 last the directors state that the amount to the credit of profit and loss account, with the balance brought forward from last year, and, after making all deductions, is £6,799, from which they propose to pay a dividend of 2½ per cent. for the year, amounting to £1,250, and to carry forward £5,549. The revenue from all sources in Portugal for the year was £19,209, and for the previous year £18,575, showing an increase of £633. The working expenses were £10,952, as compared with £9,009 in the previous year—an increase of £1,943. This increase is made up by expenditure on accounts which were formerly charged to capital, but are now debited to revenue account. The management and general expenses in London show a decrease for the year amounting to £162. The directors have pleasure to inform the shareholders that a contract has been entered into with the Electric Tramway Company of Lisbon, by which the Company receives the sum of £6,000 as compensation for the damages which it may suffer from the installation of electric traction in Lisbon. An extension of the Company's concession by 20 years (making a total period yet to run of 37 years) has been granted by the Portuguese Government under very favourable conditions. These arrangements make it necessary for the Company to reconstruct the telephone systems in Lisbon and Oporto. Though the expense involved will amount to a considerable sum, it is confidently expected that the company will be largely benefited through the increase of subscribers which will undoubtedly accrue from an improved service.

PROVISIONAL PATENTS, 1901.

Oct. 7.

19932. New or improved means of interconnection or disconnection between a number of circuits for the distribution of electric energy. William Joseph Howard, 95, Wilkinson-street, Sheffield.

19939. An alternative system of tubes with soldered connections for gas or electric cables. D. Purves and Co., Churchill Works, Edinburgh.

19973. Improvements in brushes for dynamos and the like. Joseph Matthews and William Davies, 77, Colmore-row, Birmingham.

19990. Improvements in electric arc lamps. Charles Mahlon Shafer and Joseph Voye, senior, 11 Southampton-buildings, Chancery-lane, London. (Complete specification.)

20004. Improvements in spark arresters. Elmer E. Jarvis, 18, Southampton-buildings, Chancery-lane London. (Complete specification.)

Oct. 8.

20072. Improvement in accumulators. Thomas Alva Edison, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20089. Improvements relating to printing telegraphs. Ernest Malcotti, 45, Southampton-buildings, Chancery-lane, London.

20093. Automatic synchroniser for coupling alternating-current electric machines. John Pearson and James Franklin Williamson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20106. Improvements in and relating to combination plough switches and wheel switches for electric tramways on the slot conduit system. William Albert Heindel, 322, High Holborn, London.

Oct. 9.

20175. Improvements in apparatus for transforming electric currents. Robert Cecil Turle Evans, 118, Maroon-street, London.

20187. Improvements in telegraph apparatus. Henry Casevitz, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

20193. Improvements in the process of covering electric conductors or wires with insulating material and in apparatus therefor. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

Oct. 10.

20215. Improvements in electrical cut-outs or fuses. Harry William Cox, Brougham-chambers, Nottingham.

20243. Improvements in electric measuring instruments. Alfred R. Hakoumoff, 43, Ormiston-road, Uxbridge-road, London.

20258. Improvements in electrical measuring instruments. Ernst Reiniger and Hermann Lyon, 165, Queen Victoria-street, London. (Complete specification.)

20283. Improvements in repeaters for wireless telegraphy. Emil Guarini Foresio, 72, Cannon-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 13, 1901, being date of application in Belgium.)

20294. Improvements in track construction of conduit electric railways. William Chapman, Westinghouse-building, Norfolk-street, Strand, London.

Oct. 11.

20312. Improved electric terminal for concentric cables. Thomas John Ballard and William Joseph Howard, 95, Wilkinson-street, Sheffield.

20364. Improvements in plural fuse cut-outs for electric circuits. Jacob Felsenstein, 6, Lord-street, Liverpool. (Complete specification.)

20384. Variable-pressure electric current transformer. Conrad J. Ritzer, 40, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 11, 1901, being date of application in United States.) (Complete specification.)

Oct. 12.

20406. Improvements in trolley heads for electrically-propelled vehicles. Edward Yates Walsh and John Leigh, 6, Bank-street, Manchester.

20423. Improvements in transformers and the like. William Ernest Burnand, 428, London-road, Sheffield.

20435. Improvements in electric signalling device for railways. Richard Els, 81, High Holborn, London. (Complete specification.)

20462. Improvements in electromagnetic clutches. Hardman Arthur Earle, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

20473. Improvements in the manufacture of insulated or covered wires, and in machines therefor and for like purposes. Charles Martin, 139, Queen Victoria-street, London.

20476. Improvements in or pertaining to electric incandescence lamps. William Joshua Phelps, 46, Lincoln's-inn-fields, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 2.

1900.

17951. Process for producing chemically active rays from electric lamps. Kjeldsen.

18036. Thermo-electric generators. Boult. (Tissier.)

18058. Magnetic rotary motors. Dinoire.

18282. Junction boxes for electric cables and forming branch connections therefrom. Jeckell.

18357. Apparatus for taping insulated conductors. Heyl-Dia.

18397. Electrolytic decomposition of alkaline chlorides and apparatus employed therefor. Gilmour.

19499. Systems for controlling electric motors and electrically-propelled railway trains. British Thomson-Houston Company, Limited. (Case.)

19809. Trolley arm standards for electric railways or tramways. Hutchins and Fry.

20758. Dynamo-electric generators and motors. Van Haanen.

21144. Electric motor-starting apparatus. Watson and Preece.

21338. Illuminated advertising device for attachment to incandescent electric lamps and the like. Connor.

22316. Electric cables or conductors. Glover.

22406. Decomposition of alkaline salts by electrolysis and apparatus therefor. Greenwood.

22678. Means applicable for use in transmitting energy to electrically-propelled trains or tramcars. Short.

23877. Insulators for electrical purposes. Atkinson.

1901.

702. Accumulator system of electric traction. Joseph. (Date applied for under International Convention, July 5, 1900.)

1224. Receiving apparatus for electro-dynamic so-called Hertzian waves. Schaefer.

10887. Electric arc lamps. Schmidt.

10988. Telephone circuit systems. Frost.

11214. Wireless telegraphy. Shoemaker. (Date applied for under International Convention, Jan. 17, 1901.)

11922. Electric meters, motors, and phase compensations for electric currents influencing them. Gutmann.

11951. Ampere-meter for the registration of the maximum consumption of electrical current. Helberger.

12220. Electric telegraphy. Justice. (Rowland Telegraphic Company.)

12816. Wireless telegraphy. Shoemaker. (Date applied for under International Convention, Jan. 22, 1901.)

13626. Push switches for electric bells. British Thomson-Houston Company, Limited, and Cubitt.

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13940. Systems of vacuum tube lighting and dynamo machine for use in connection therewith. Wise. (Moore Electrical Company.)

17567. Combination of electric motors for starting and operating them. Burke.

17877. Trolley wires for electric tramways and the like. Thomas.

18179. Electric cables. West.

18180. Electric cables. West.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	—	—	—	—	—	—
Birmingham Tramways	Oct. 12	4,778	4,698	+ 80	184,999	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 11	510	460	+ 50	20,664	18,493*b*
Blackpool Corporation	,, 10	435	466	+ 69	34,281	25,613
Blackpool-Fleetwood Tramways	,, 12	328	334	- 6	18,869	18,405*b*
Bolton Corporation	,, 13	1,511	1,279	+ 232	59,861	48,392*b*
Bradford Corporation	,, 13	1,158	539	- 618	36,285	18,011
Bristol Tramways Company	,, 11	3,850	3,329	+ 521	—	—
Carlisle Tramways Company	,, 12	161	180	- 19	3,069*b*	3,008
Central London Railway	,, 12	6,291	5,421	+ 870	86,435	—
City and South London Railway	,, 13	2,061	1,647	+ 414	28,300	22,884
Cork E. T. and L. Company	,, 10	467	427	+ 40	19,271	17,053*b*
Darwen Corporation	,, 11	195	178	+ 17	7,679	6,258
Dover Corporation	,, 12	222	218	+ 3	9,136	8,676*b*
Dublin & Lucan Electric Railway	,, 13	103	91	+ 12	1,998	1,724
Dublin U. T., electric cars	,, 11	3,765	3,819	- 154	—	—
Dublin S. District, Electric	,, 11	787	834	- 47	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 12	13,255	9,191	+ 4,064	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	,, 12	921	700	+ 221	27,115	20,174
Hull Corporation, E. S.	,, 12	2,294	2,151	+ 143	26,404	20,652
Liverpool Corporation	,, 5	9,820	8,688	+ 1,132	359,674	314,853*b*
Liverpool Overhead Railway	,, 13	1,425	1,510	- 85	24,985	25,782
Oldham-Ashton-Hyde Tramways	,, 11	488	†10	+ 478	20,606	18,863*b*
Portsmouth Corporation	—	—	—	—	—	—
Potteries Tramways	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 13	3,676	—	—	—	—
Southampton Corporation	—	—	—	—	—	—
Southport Corporation	—	—	—	—	— *d*	—
Swansea Tramways	—	—	—	—	—	—
Wolverhampton Corporation	—	—	—	—	—	—

* Fortnightly. *b* From Jan. 1. *d* From April 1. 1901.
† Receipts low because of strike.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £75 decrease.
Barcelona Ensanche y Gracia, £22 decrease. Barcelona, £189 increase.
Brisbane, £11 decrease.
Buenos Ayres and Belgrano Electric, £591 increase.
Calcutta, £134 increase.
Cape Town (month of Sept.), receipts, £12,467; expenditure, £6,373.
La Capital Traction and Electric, Buenos Ayres (month of Sept.), £5,880 increase.
Mexico Electric (month of Sept.), receipts, £17,70).
Perth Electric, £127 increase.
Port Elizabeth (month of Sept.), receipts, £2,934; expenditure, £1,746.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¾-¼
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	9 16-11/16
—— Ordinary, 1-125,000	1 ..	⅜-¾
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6¾
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4¾-5¼
Brush Electrical Engineering, Ordinary	2 ..	1¼-1¾
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	15-16
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	1-1¼
—— 5 per cent. Debentures	5 ..	1¾-2¼
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	97-100
W. T. Henley's Telegraph Works, Ordinary	5 ..	16¼-17¼
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	22-23
—— 4 per cent. Debentures	100 ..	100-103
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10¼-11¼
—— 5 per cent. Cum. Pref.	5 ..	5¼-6¼
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11 xd
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6¾ xd
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	95-100
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¾-10¼
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	7⅞-8¼
—— 7 per cent. Preference	5 ..	8¼-8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7¼-7¾
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅝
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	4¾-5¼
—— 40,501-50,936	5 ..	4¾-5¼
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	8¼-9½
—— 6 per cent. Cumulative Pref.	10 ..	11¼-12½
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	104-107
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¾-6¼
—— 6 per cent. Cum. Pref.	5 ..	5¾-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¾-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5⅜
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8 xd
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	12¼-13½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	113-116
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15½-16½
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7⅜-8¼
—— £4½ Shares, New	4½ ..	7-7½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11¼-12½
Electric Railways.—		
Central London, Ordinary	100 ..	102-105
—— 4 per cent. Pref.	100 ..	105-108
—— ,, deferred	100 ..	99-102
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	51-54
—— Ordinary	10 ..	5-5¼
—— 4 per cent. Debenture Stock	100 ..	113-118
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-128
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¼-⅜
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¾-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6-6¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	101-103 p.c. xd
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14-15
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11¾-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	121-124
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¼-2⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
—— Prov. Cert., all paid	100 ..	100-103
Cape Electric Tramways, Nos. 1-400,000	1 ..	1¼-2⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼ xd
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104 xd
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 x d
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	105-107
New General Traction, Ordinary	5 ..	2¼-2⅜
—— 6 per cent. Cum. Pref.	10 ..	4-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10⅜
—— 5 per cent. Cum. Pref.	10 ..	11¼-12½
Potteries Electric Traction, Ordinary, 25,667-40,000	10 ..	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-10¼
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8s. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	4¼-4⅜
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¾-5
—— 4 per cent. Deb. Stock, Red.	100 ..	96-99
—— 3½ per cent. Deb. Stock, Red.	100 ..	95-98
Oriental Telephone and Electric Company	1 ..	15/16 1 1/16 xd

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NOTES.

Dublin Section.—We understand that there will be a meeting of this section of the Institution of Electrical Engineers on the 14th prox., at the Royal College of Science, St. Stephen's Green, at which a paper will be given by Mr. P. S. Sheardown, entitled "An Acccount on the German Tour of the I.E.E."

Obituary.—We regret to note the death of Mr. Carl Frederik Pietgen, who passed away at Copenhagen on Saturday last at the ripe age of 72. Besides being a councillor of State, the deceased gentleman was the founder of some of Denmark's greatest commercial enterprises, including the Great Northern Telegraph Company.

Electrical Engineers Volunteers.—We are asked to state that a smoking concert will be held at the head-quarters of the Electrical Engineers Volunteers on Nov. 2, at which all members of the corps are requested to attend. The regulation dress for the occasion is blue serge and forage caps. Major Erskine will take the chair at 8 o'clock.

Liverpool-Paris Direct Telegraph.—Reuter's correspondent in Paris announces the issue of a semi-official note to the effect that the French and British telegraphic administrations have just established direct telegraphic communication between Paris and Liverpool. The new service was opened on the 1st inst., and is sure to greatly facilitate correspondence between the two centres.

Bexley Tramway Order.—In passing the Bexley Tramways Bill through Parliament, a most sensible arrangement was come to between the promoters of the scheme and the London County Council. This is that in the event of the London County Council obtaining powers to extend their lines out to Bexley within the next two years and actually putting these powers into operation, the order granted to the Bexley Urban District Council to construct electric tramways in the district shall then lapse. Although, of course, this arrangement hangs up the scheme for a year or two, it is decidedly to be commended as allowing the introduction of a system eventually working under one control, which is undoubtedly the best practice in tramway work, especially in and around large cities like London.

Theft of Telephone Wires.—Cable thieves have been busy on the Continent of late, the most recent case reported being from Sweden, where telephonic communication between Stockholm and the Swedish provinces has been seriously interrupted. The cause of the stoppage remained a mystery until the workmen sent out to look for faults discovered that whole lengths of copper wire had been removed. The sagacity of the thieves is evidenced by the fact that the iron wires were not touched, and this fact has led to the belief that the miscreants must be looked for among the employés of the administration itself, as no other persons are credited with being able to discriminate between the iron and copper wires at night time. New wires have now been laid, and a reward offered for the apprehension of the thieves.

Automatic Fire-Alarms.—The policy taken by the Fire Brigade Committee of the London County Council is that they will not recognise any of the undertakings such as Pearson's Fire-Alarm System or the May-Oatway Fire Appliances Company, although they are both working under licenses from the Postmaster-General. The decision of the Fire Brigade Committee is that in no case shall any electrical communication between business premises and the fire stations of the county of London be otherwise than telephonic. This decision will, of course, not prevent these companies mentioned from organising automatic stations, and then sending the alarms they get over to the fire stations in the immediate neighbourhood by means of the telephone. It will, however, ensure that the fire brigades will not assist in removing the faults which are likely to arise with such new systems of fire-alarms.

American Engineers in Europe.—The experience of the electric railway systems of Europe is sought by the Rapid Transit Commission and the company having the contract for the rapid transit tunnel in the city of New York, to decide upon plans for operating the cars in the tunnel when completed. We gather from a note in *Electricity* of that city that Mr. Wm. Barclay Parsons, the chief engineer of the commission, left for England a little over a fortnight ago, and if previous arrangements were held to he is now engaged in examining the underground systems in our Metropolis. Later, Mr. Parsons, Mr. August Belmont, who financed the tunnel company, and other gentlemen interested in the concern, will go to Paris for the purpose of studying the electric roads and electric plants of that city. It is expected that while on the Continent the party will visit other cities where electric railways are now in operation.

Fruit for the Market Delivered by Trolley Car.—The lack of enterprise shown by some of our English railway companies in the carriage of fruit and vegetables from agricultural centres to the London market has always been a sore point with our market gardeners, who complain of the great waste of time which is allowed to occur, and the high tariffs usually enforced. Our Kentish gardeners, although nearest to London, are, perhaps, worse off in this respect than any others, but it is hard to find a remedy under existing conditions. In the States, however, the trolley car routes are so numerous and extensive that in some cases the steam railways are dispensed with, and fruit often reaches the principal cities by trolley car. A case in point is reported from Buffalo, N.Y. Peaches from the Lake Ontario peach district are now being delivered in that city by trolley car. The fruit arrives in fine condition, fresh and unbruised, and this prompt access to a large market, it is said, is deservedly much appreciated alike by the public, the dealers, and the growers. On one day alone 350 baskets of peaches thus arrived at the Buffalo market over the trolley routes.

Electricity in Coal Mining.—Concerning the utilisation of electric power in coal mines, the United States Consul at Brussels furnishes some useful information as to what is being done in Belgium by one of the most important collieries in the Charleroi district. It seems that arrangements have been concluded for the erection of a central generating station which will presently supply electrical power for three large coal mines now in operation. The collieries are situate several miles distant from each other, which will call for the erection of considerable lengths of transmission line. The intention is to conduct the electric current from the power station by means of three small wires only a few millimetres in circumference mounted on poles, and then to take it into the pits by a cable sheathed in steel. Electric pumps will be installed at the bottom of the pits at a depth of about 550 yards. In concluding his report, the consul says that the centralisation of motive force in coal mining—that is to say, the suppression of numerous boilers and steam-engines—will result in great saving of fuel. This, however, is only one of the many obvious advantages of the use of electricity in coal mining.

Accumulator Trials.—We have referred before to some accumulator trials which are to be made in France under the auspices of the Automobile Club of that country.

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We now understand from one of our French contemporaries that a great secret trial of accumulators, made by French manufacturers only, is shortly to be undertaken by the naval authorities of France. Although it is not expressly stated, we can quite understand that these trials will have for their object the selection of those makes of accumulators which are the most suitable for work in the submarine boats of the "Holland" type. We understand that 14 firms have entered, and that there will be some 22 types of accumulators experimented with. The capacity of these will vary between 1,000 and 2,000 ampere-hours. A large number of charges and discharges are to be made on each of the types, so that really accurate results are to be expected. We think that a similar course of experiments might be carried on by our own Admiralty in the event of submarine boats proving to be worth trying in time of war. In our case, however, we believe a course would be adopted of only experimenting with what are known to be good makes of accumulators, from the fact that they have stood the test of extended service in land installations.

Electricity in the Navy.—We recently mentioned in these columns that the new cruiser "Hogue," which is now being prepared for her steaming trials before being taken over from her builders, Messrs. Vickers, Sons, and Maxim, would likely be the centre of a series of experiments which the Admiralty propose to carry out on the application of electricity for various purposes on warships. This is now confirmed, and the cruiser in question is being fitted temporarily with electric motors for the driving of all fans and various auxiliary machinery, such as the steering gear, the capstans, and the windlass gear. Up to the present electricity has had a very restricted use in the navy, and it will be most interesting to watch the result of the impending tests with a view to determining the relative economy between electricity and steam for the purposes mentioned. Abroad, however, the naval authorities have not been so chary about the use of electricity as a motive power on warships. Russia, for instance, has gone in strongly for electrical power, and in the new battleship "Retvizan" nearly 100 electric motors are installed, the total plant capacity being as high as 600 kw. Among other objects to which the Russians are putting electricity on board ship is the working of bilge pumps, ash hoists, steering gear, and the driving of the workshop machinery. The capstans, however, are still operated by steam in the Russian navy.

Electrical Conductivity of Air and Salt Vapours. The relation between the current and the E.M.F. in air depends very much on the direction of the current—viz., whether the outer electrode is positive or negative. Mr. Harold A. Wilson in a recent paper on the subject, which is abstracted in the last issue of the *Journal* of the Chemical Society, explains that with salt vapours the relation between current and E M.F. is not much affected by reversing the current. At low temperatures the current attains a saturation value, but above 1,000deg. it increases more nearly in proportion to the E.M.F. For air the relation of current and temperature at constant E.M.F. may be expressed by a formula of the type $C = A\ \theta^n$, where C is the current, θ the absolute temperature, and A and n constants, the value of n depending on the E.M.F. used. The energy required to ionise one gramme-molecule of air between 1,000deg. and 1,300deg. is estimated to be 60,000 calories. For salt vapours, the relation between current and temperature is complicated. The current shows a maximum value about 900deg., and increases very rapidly about 1,150deg. The energy required to ionise one gramme-molecule of potassium iodide is estimated to be 15,000 calories at about 300deg. The maximum current carried by the salt vapour (at 1,300deg. and 800 volts) is nearly equal to that required to electrolyse the same amount of salt in solution—a fact in favour of the view that the ions are of the same nature in the two cases.

Electric Tramway Traction.—On the occasion of the autumn meeting of the members of the Northern and Midland Counties Association of Tramway Officials at Leeds last week, Mr. W. Wharam, manager of the Corporation tramway system of that city, gave an interesting address on the different methods of traction as applied to tramways. These comprise the steam-engine in various shapes, compressed air, compressed gas, the cable, and, finally, electricity. Mr. Wharam, who is president of the association this year, was in favour of the overhead trolley system, which, he said, had proved the most satisfactory, and although there were dangers connected with it, it was quite feasible to provide remedies for all of them. As regards the cost of producing electricity, he could not see how it could be generated at less cost than at present. Moreover, large sums must be charged for depreciation, for wear and tear, as well as for alterations, and the constant improvement in electrical plant: so that, on the whole, the expenditure must be heavy. All these things pointed to one especial fact—that even electric traction would not be so cheap as to permit such a lowering of fares as the general public seemed to anticipate. Touching upon the problem involved in the extension of tramways into thickly-populated districts, the president, in conclusion, deprecated the competition which was talked about between tramways and railways, and stated his opinion that such competition could result in no good to either party.

Space Telegraphy Without Coherers.—Mr. E. Ruhmen makes an instructive communication to *Physikalische Zeitschrift* in which he shows that coherers are not absolutely necessary in space telegraphy. An ordinary telephone answers the purpose well enough for considerable distances. In the experiments the author carried out he used a Righi oscillator, with induction coil and turbine interrupter. One ball of the oscillator was earthed, while the other was attached to a mast wire about 27 yards long. The receiver consisted of a mast wire just over five yards long, earthed through an ordinary postal telephone. The distance covered by the experiments was 1½ miles, and Morse signals were easily communicated from the one station to the other. It was found, however, that the telephone answered only to the first of the damped oscillations proceeding from the oscillator. The author therefore concludes that it is desirable to increase the capacity of the oscillator as far as possible. It was also found advantageous to insert a condenser in parallel with the oscillator. As regards the receiver, it was found best to put a condenser in the receiving circuit, and read off the signals by means of a transformer. Such was the loudness obtained that it seems quite feasible to convey signals in this manner over 20 miles or so, which would mean a great simplification and extension of space telegraphy. Automatic records could be made by telephone relay or by the Polák-Virag system, and syntonism could be obtained by using Mercadier mono telephones. It would seem from the above that the telephone really acted as a coherer.

Glasgow Automobile Trial Awards. — Just published is the judges' official report on the 500 miles' trial of motor vehicles, organised by the Automobile Club of Great Britain and Ireland, in connection with the International Exhibition at Glasgow. In the first class, which was restricted to cars declared at a selling value not exceeding £250, the judges have decided to duplicate the

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award, in consequence of the difficulty of making a full and complete complete comparison between steam cars and those driven by internal-combustion motors. Thus a gold medal is awarded for the steam car of the Locomobile Company of America, and another for a 5-h.p. Wolseley car. Silver medals in this class are won by a 7-h.p. New Orleans and a 4½-h.p. De Dion voiturette. In the class for cars declared at between £350 and £500, the gold medal is taken by a 10-h.p. Wolseley car; while in the class for cars not exceeding £500 selling price, Messrs. George F. Milnes and Co. are awarded the gold medal for their 16-h.p. motor. The Motor Manufacturing Company's 6-h.p. van has carried off the gold medal in the class for delivery vans; and in the section devoted to private-owned vehicles driven by the owner or his servant no awards are made, although there were 11 entries. Again, the judges do not recommend that any award should be made for pneumatic tyres, for which a gold and a silver medal were offered. They suggest, however, that a certificate should be given to the Dunlop Pneumatic Tyre Company, and that an opportunity for a prolonged trial with a vehicle weighing over 21cwt. should also be offered the company.

Electricity in St. Marylebone.—We have now had an opportunity of perusing the conditions which the St. Marylebone Borough Council have to fulfil before they can purchase the undertaking of the Metropolitan Electric Supply Company, Limited, under the order which has been provisionally granted. The conditions referred to are embodied in the clauses of the Act of Parliament conferring the electric lighting order on St. Marylebone, and it is to be especially noted that the Council are only authorised to supply electric light in the borough after the purchase of the company's undertaking, which dismisses all fear of competition in the future between the Corporation and the existing concern. One of the most important conditions of the purchase is that notice to treat shall be given by the Council within six months after the passing of the Act — July 26 last — unless this period be extended with the consent of the company. The Council have, therefore, until Jan. 26 next year to consider whether they will proceed with the acquisition of the undertaking or not. In the event of the parties being unable to agree as to the price to be paid for the electric lighting concern, there is to be a reference to an arbitrator under the Lands Clauses Act. The Council have the right to acquire the whole of the undertaking of the company in the entire area of supply at present covered by the company's business. On completion of the purchase it is for the Board of Trade to fix the date for the commencement of the running of the order. We had recently to complain in these columns of the way in which the Council were treating the company as regards the extension of mains, etc., and we are therefore pleased to find a clause inserted in the order protecting the company against such obstruction, and binding the Corporation until after they have purchased the undertaking to afford all reasonable facilities to the company for laying, maintaining, and altering their trunk mains through the district which lead to other areas, and which will not be taken over.

Wireless Telegraphy on Mountains.—The Allgemeine Elektricitäts-Gesellschaft, which some time ago was commissioned by the Bavarian Postmaster-General to make an attempt to establish a connection by wireless telegraphy between the meteorological observatory on the Zugspitze—the highest summit in Germany—and the postal station at Eibsee at its base, is reported to have solved the problem in the face of many difficulties. The altitude of the observatory in question is nearly 3,290 yards above sea-level, and the meteorologist who permanently occupies it is completely isolated during the winter months, when the roads are impassable. The telephonic communication could not be depended upon, owing to the liability of the cable to become damaged against the sharp edges of the rocks. We learn from the Berlin correspondent of the *Morning Standard* that it has now been found possible to apply the Slaby-Arco system of wireless telegraphy in such a way that the deflections due to the nature of the slopes—which heretofore have been an unsurmountable difficulty in establishing a wireless connection between mountains and valleys—act favourably instead of unfavourably. Another difficulty which had to be overcome was the absence of any electrical generator, which necessitated the use both on the Zugspitze and at Eibsee of dry batteries, which give comparatively a small supply of electricity. Thanks to the system used, this was not a serious drawback, for it is said that communication can be maintained between the two stations with only a minimum of electrical energy. The instalment of the transmitter and receiver on the Zugspitze also proved very difficult. Owing to the frequent storms and frosts it was necessary to use steel wire, and since it was impossible to set up poles, the wire was fastened to the rock without insulators. The whole installation is said to have satisfied all requirements, and has been declared workable by the Bavarian Postmaster General, who is now turning his attention to a proposal to connect the observatory with Partenkirchen, a place about three times as far away as Eibsee.

The Question of Trusts.—The export trade of the United States of America is rapidly on the increase, and the formation of the huge trusts that has taken place during the past few years has all tended towards the increase in the foreign trade done by these combinations. As we have frequently pointed out, however, it does not follow that the advantages which we, amongst other recipients of American goods, receive in consequence of the formation of these trusts are shared by the inhabitants of the United States themselves. According to the correspondent of the *Daily Mail* in Washington, a United States industrial commission has recently discovered a fact which has been known for years to electrical engineers in this country. This is, that a large number of the commodities manufactured by these various trusts are exported and sold at much cheaper rates than the same articles are sold for in the United States. The 30 commodities especially mentioned include steel plates, machine tools, steam-engines, boilers, electrical instruments, electrical motors, and agricultural implements. We do not know what the composition of this industrial commission is, or how far they are connected with the Government, but the chairman of the commission strongly favours active steps being taken to remove the above anomaly. He proposes that all import duties should be abolished on the articles mentioned above, so as to encourage foreign competition for the internal trade of the United States. This we have also advocated, and only a month ago assured the editor of one of our electrical contemporaries in that country that he would witness a flood of German goods into the States if this were done now. It is stated that the matter of the abolition of import duties is to be brought before Congress next session, but unless there is a strong public opinion raised on the subject the trusts wil easily defeat any such proposed alteration in the tariff laws. In the meantime we are enjoying the benefits of cheap electrical motors for tramways at the expense of the citizens of the United States, and it remains to be seen how far the present low prices will be affected when the new works

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organised by the two largest manufacturing companies of America in this country are in full working order.

An Electro-Mechanical Tramway Switch.—The *Electrical World* of New York in its issue for the 5th inst. illustrates what is termed an electro-mechanical switch for suburban lines, for which a patent has lately been granted to Mr. Gwynne E. Painter, of Baltimore, Ind. The main features of the switch are that it is operated by the passenger and electrically reset by a passing car, and that it not only signals to a car to stop at night, but also lights a lamp while waiting. The apparatus is encased in an iron box at the side of the trolley route, and by means of a handle an intending passenger may light the lights above. The illumination thus obtained serves the double purpose of furnishing light for the passenger while waiting, and of warning the motorman of the approaching car that he is required to stop. The lamps being lighted, they cannot be put out except by the passing of the car itself, which automatically resets the switch. The switch, enclosed in the iron box as it is, is so thoroughly insulated as to be impossible of giving a shock. It consists of only one magnet and an armature. When it is in shunt with 500-volt railway current passing through five 16-c.p. lamps in series, there is only a difference of potential of three volts. The short-circuiting device on the trolley car which resets the switch after it has served its purpose consists of a U-shaped piece of brass, and is fastened to the car by laying the wire in the bottom, then placing a bar on it, which is made fast to the U by screws. This bar will then clamp as well as support the trolley. A part of one side of this U piece is insulated both from itself and the car. A wire from the car leads to one end of the magnet in the switch box; the other end is made fast to the frame and magnet core. It will be seen that the circuit is broken until the armature is raised up and touches the core, and the current then passes through the armature to the lamps, thence to the ground, completing the circuit. At the same time it causes the magnet to hold the armature to itself, and thus maintain the lights in operation. When the car arrives and the passenger is on, the trolley wheel runs on a short-circuiting device; as has been before stated, a part of the U is insulated from the other, and the trolley wheel connects these both together. This will cause the current also to go through a wire from this insulated part to the frame and core of magnet, which practically short-circuits it. Hence the magnet is made so weak that it will not hold the weight of its armature, which drops back to its original position, thereby opening the circuit and putting out the lamps.

Cost of Technical Education. — Sir George Kekewich's return showing the application of funds by local authorities in England, Wales, and Ireland for technical education last year, has just been issued as a parliamentary Blue-book. In point of money expended, technical education in this country during the year 1899-1900 has progressed somewhat considerably since the previous year. The total amount expended by local authorities in the period under review was £915,134, against £870,612 in the year 1898-1899. Although this increase is decidedly modest, it points to advancement, although this is practically confined to England. In Wales, for instance, only £33,526 was spent last year, against £35,658 in the previous year, but it must be noted that these figures do not include the levy under the Intermediate Act. As regards Ireland, the figures are not encouraging, although an increase in expenditure of £623 is shown over the year 1898-99. The amount expended on technical education in the whole of Ireland last year was only £5,172, against £876,436 in England! Apart from the actual totals, however, it is interesting to see how the residues received under the Local Taxation (Customs and Excise) Act by county councils and the councils of county boroughs in England have been applied. The total amount raised in this manner, which is sometimes known as "whisky money," was £980,928 in respect of the financial year 1889-1900, and of this sum £886,329 has been devoted to education, and £93,364 (including £55,720 in London) to the relief of the rates. Of the 49 county councils, 39 are applying the whole of the residue to technical education, and the remaining 10 only a part. Of the councils of 61 county boroughs, 55 are applying the whole and six only a part in the same way. In addition, two county councils and the councils of 20 county boroughs, 86 boroughs, and 181 urban districts are making grants out of the rates under the Technical Instruction Acts, and 20 local authorities are doing the same under the Public Libraries and Museums Acts. Sums have also been raised by loans under the Technical Instruction Acts by 25 local authorities in 1898-99, and by 23 in 1899-1900, the total amount expended on technical education in 1898-1899 being £830,404. 17s. 2d., and in 1899-1900 £876,436. 6s. 11d. In Wales and Monmouth 13 county councils and the councils of three county boroughs received out of the residue £41,608. 12s. 9d. in 1898-99, and £47,072. 17s. 11d. in 1899-1900. In all cases the whole amount received is being devoted to intermediate and technical education, and, in addition, the councils of 10 counties, three county boroughs, four boroughs, and 10 urban districts are making grants out of the rates. As regards Ireland the residue is not applicable to technical education, but in that country 12 local authorities are making grants out of the rates under the Technical Instruction Acts, and two of these authorities are also applying part of the rate levied under the Public Libraries Acts to technical education.

Coventry Electric Lighting.—The new electrical engineer to the Corporation of Coventry has the hard task before him of bringing a non-paying undertaking into a state of financial prosperity In such a case it is only the bold measure which succeeds, and we think it will interest our readers to see how Mr. Joseph A. Jeckell is tackling the problem. On taking over his duties at Coventry Mr. Jeckell made a thorough investigation of the undertaking from its financial aspect, and presented a report to his committee, only touching upon engineering matters so far as they affected the commercial side of the question. He pointed out that the capital spent amounted to £75,813, and that the plant at the station was 550 kw., but as it was necessary to keep one plant in reserve, the earning capacity of the station was 350 kw. The capital spent per kilowatt of earning capacity therefore was very high—viz., £217. Reckoning the capital charges at 5½ per cent., the capital charges per kilowatt of earning capacity would amount to £12. The committee might count on selling 1,000 units per kilowatt of earning capacity; therefore, under present circumstances, the capital charges work out at 2·8d. per unit. The only way that Mr. Jeckell could see for reducing this amount was by increasing the capacity of the station, and by doubling the capital to treble the earning capacity. Thus the capital costs per unit would be brought down to 1¾d. instead of 2¾d., as now. Much would, of course, depend upon whether the committee were able to tap the industrial demand, because in that case more units would be sold per kilowatt of earning capacity. The engineer pointed out in his report that it was impossible to make the undertaking pay with the present capacity, because even if they reduced the station

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costs to the average in about five stations of the same size, the station charges at Coventry would then stand at 2·52d., added to which would be the capital charges of 2·8d. Therefore the cost of manufacture with the present output would amount to 5 32d., whereas the average price obtained was 4·22d. Even when the present extensions are completed, and the works have an earning capacity of 600 kw., they could then only expect to bring down the station costs to 2·5d., which is an average cost, added to which would be the capital charges of 2·068d., bringing the cost of manufacture up to 4½d.; and as they only obtain 4¼d., they should be still losing, whereas it would mean that they should practically have to double the present number of customers without extending the mains or reducing the price. This, of course, would naturally be impossible. Mr. Jeckell therefore advised the committee that the works could not pay until they had trebled the capacity, when they might expect the capital charges to reach 1·75d. per unit and the station charges 1·75d., making a total of 3½d. per unit. The problem amounted to this: whether by reducing the price from 4¼d. to 3½d., they would be able to treble the output from the station. The margin of profit as observed is very small. In order to try and do this, Mr. Jeckel recommended the committee as follows: to treble the capacity at the station by doubling the capital; to only spend money on productive plant, and as and when required by increased number of consumers. As the best means of increasing the number of consumers, he recommended the committee to reduce the price of the third and subsequent hours to 1d., in place of 3d. as now, on Jan. 1, 1902; that the rebate should be calculated quarterly instead of half-yearly, which would simplify the accounts from the consumer's point of view and would slightly reduce the price of current; and that current for other than lighting—namely, for power, heating, cooking, etc.—should be reduced to 1¾d. per unit flat rate. These recommendations, we are pleased to hear, were adopted unanimously by the committee at their last meeting. We have to congratulate Mr. Jeckell on the clearness of his reasoning, and also on the fact that he has persuaded his committee that his recommendations are sound. We quite agree with them, and trust that the Corporation of Coventry will endorse the opinion of the Electric Lighting Committee. We are sure that Mr. Jeckell not only has the technical skill to expend money on the extensions economically, but also the requisite energy to secure the additional consumers required.

The Aluminium Industry.—A convention between the principal producers of aluminium on the Continent, in England, and the United States has been held in Germany to consider the best course to adopt to the improvement of the industry generally and the opening up of new fields for the sale of the metal. We believe that originally the convention was called for the purpose of discussing an all-round increase in the price of aluminium, by which means it was hoped to stimulate the industry and promote business. As we have before urged in these columns, it is undoubtedly far the better policy to try to increase the output by the general adoption of low prices than to seek to augment the profits by enforcing high tariffs, and these counsels would seem to have prevailed at the recently concluded international convention. The principal firms represented on the occasion were the Pittsburg Aluminium Reduction Company, of Niagara, U.S.A.; the Neuhausen Aluminium Company, of Neuhausen, Switzerland, together with the Baden works owned by the company at Rheinfelden; the Lend works in Austria; and the British Aluminium Company in England. The result of the convention is to place prices on a common basis, and it is pleasing to note that those agreed upon by the above-mentioned firms are less than those prevailing a year ago. At the beginning of 1900 small parcels of aluminium cost 2s. 6d. per kilogramme (about 2½lb. English), but contracts were often accepted at 2s. 3d. for large orders. A reduction was made at the end of last year, and again at the beginning of the present year. According to the decision of the convention, however, the prices to-day stand at 2s. 4·8d. per kilogramme for small parcels and 2s. 2·4d. for large contracts, and it is stated that no advance on these prices is contemplated. In view of the above, it is interesting to note the progress which the aluminium industry has made during the past 15 or 16 years. We find in the *Electrical Review* of New York for the 12th inst. some interesting information on the subject from the pen of Mr. J. B. C. Kershaw, who is contributing a series of articles to our contemporary on the practical applications of electricity in the production of chemicals and metals or their alloys. From what Mr. Kershaw says concerning aluminium, it appears that the production of the metal in America by electro-metallurgical methods dates back from 1886. In that year the brothers Cowles established works for the production of alloys of aluminium with copper in the electric furnace at Lockport, and this factory was operated until 1892, when various causes led to its being shut down. The process of aluminium reduction now worked by the Pittsburg Reduction Company—which is the only company producing the light metal in America to-day—was first employed by Hall in 1888. Since 1895, when the works of the Pittsburg Company were removed from New Kensington to Niagara, the output of aluminium from the factory has enormously increased. The total aluminium production in the States in 1890 amounted to only 27 tons out of a total production of the world of 174 tons. In 1895, however, the American production had increased to 379 tons, while in 1900 it is stated to have amounted to 3,190 tons. The fall in price which accompanied this great increase in output is no less remarkable. In 1889 aluminium was selling for 10s. per pound in the States, whereas seven years later the price had dropped to under 2s. per pound, and in 1898 the Pittsburg Company commenced to sell aluminium for special purposes for about 1s. 6d. per pound. It will thus be seen that the prices agreed upon at the international convention are not nearly so high as were in force two or three years ago. The method worked out by Hall, by which aluminium is reduced from its oxide, differs little from that used in Europe and patented under the name of Herault. A purified form of alumina is continuously charged into a bath containing fused cryolite, and the molten mass is submitted to the action of an electric current, using carbon electrodes. The aluminium separates at the cathode, in the molten condition, and is drawn off at stated intervals from the bottom of the bath. It is usual to make use of the electric current for maintaining the bath in the liquid condition, and to use the carbon lining in the bath or "pot" as cathode in the operation of the process. As regards the applications of aluminium in the arts and industries, during the last two years the greater portion of the output of the Niagara factories has been utilised for electrical purposes, and there are a considerable number of aluminium transmission lines now in operation in the Western States. The latest example of this use of aluminium is the new line for transmitting Niagara power to Buffalo. So far, these aluminium lines have given satisfaction, but time will alone show whether aluminium possesses all the characteristics required to render it a satisfactory substitute for copper in power-transmission schemes.

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SLEAFORD ELECTRICITY WORKS.

The Urban District Council of Sleaford recently inaugurated their works for the commercial supply of electrical energy. The district controlled by this authority has a population of 5,000, and the Council recognise that a good electric lighting system is essential to the comfort and welfare of the inhabitants, and that the lighting of a district should be in the hands of the Council rather than in those of a private company. Messrs. E. Bremner-Smith and Bremner were appointed consulting engineers in 1899, and on their advice a scheme was, after deliberation, accepted by the Council. A Local Government enquiry was accordingly held in October of last year, and sanction obtained to a loan of £7,000 for the carrying out of the scheme. Since then the various works have been successfully completed by the respective contractors, under the supervision of the consulting engineers, with Mr. R. Spencer Yates as resident engineer.

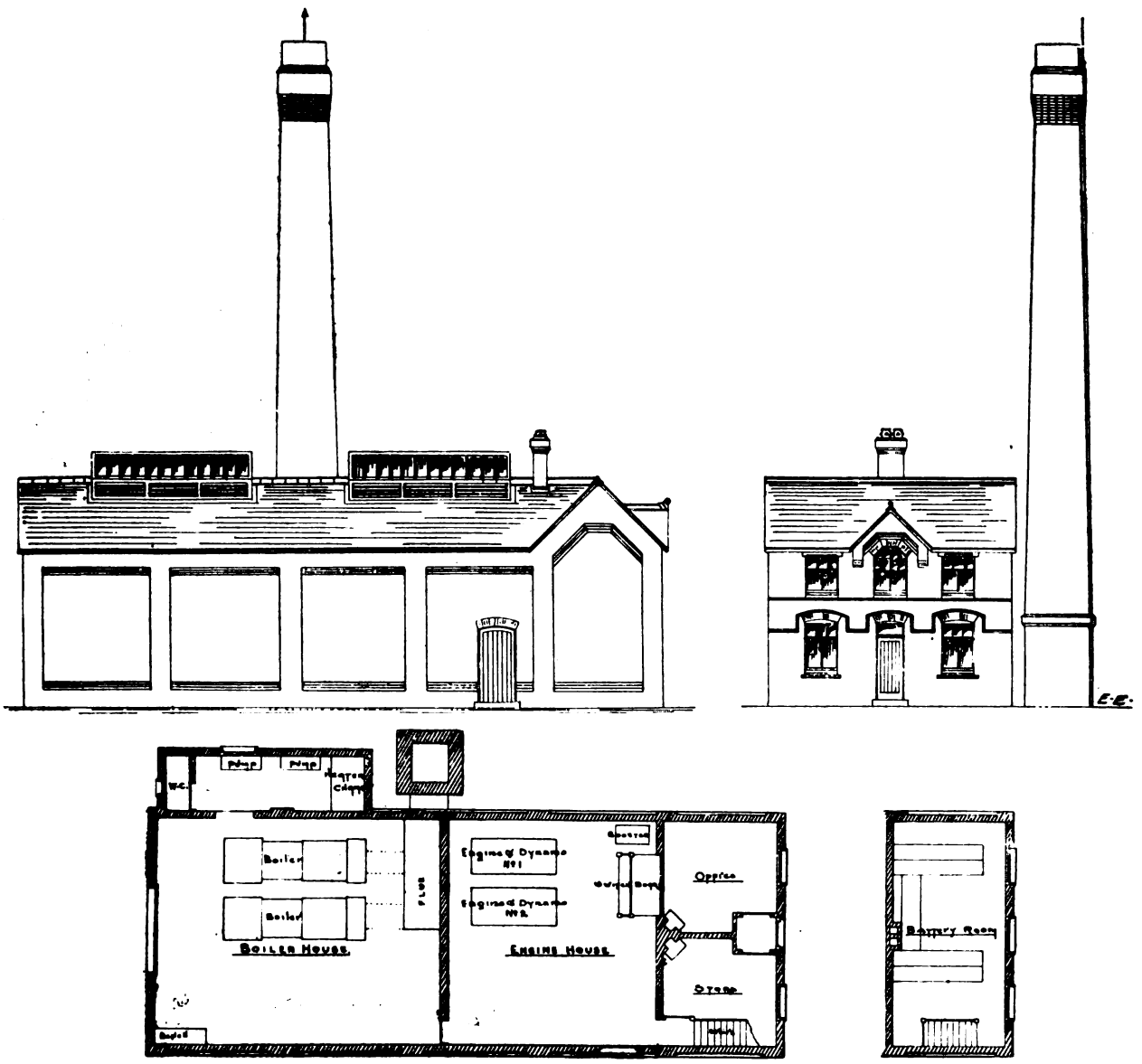

FIG. 1.—Plan and Elevations of the Sleaford Electricity Works.

The works (Fig. 1) are conveniently situated on the "West Banks" and adjoins the River Slea, from whence water is obtained for feed purposes. The building plans were prepared by the consulting engineers, and the building contractors were Messrs. Tapster and Benstead, of Sleaford. The buildings comprise boiler-house, engine-room, pump and heater house, test-room, and offices, with battery-room over the offices, provision being made for extensions.

The steam generating plant comprises two multitubular boilers by Messrs. Robey and Co., of Lincoln. Each boiler is 15ft. in length and 4ft. in diameter, with a heating surface of 403 square feet, working at a pressure of 160lb. per square inch. They are provided with the necessary safety valves and steam-pipes and two easily accessible check-feed valves, and are so arranged that either engine may be steamed from either boiler. The boiler feed pumps are supplied by the Worthington Pumping Engineering Company, and comprise two of their "Standard" pattern sets, each capable of delivering sufficient water for both boilers against the boiler pressure. The feed-water heater has been supplied by the Wheeler Condenser and Engineering Company. The generating sets consist of two 45-kw. steam dynamos, and the engines supplied by Messrs. Willans and Robinson, of Rugby, are of the two crank vertical type, enclosed, and self-lubricating, capable of developing 90 i.h.p. each at a speed of 450 revolutions per minute with a steam pressure of 160lb. per square inch in the steam-chest.

The engines are coupled direct to dynamos manufactured by Messrs. Laurence, Scott, and Co., of Norwich. Each dynamo has an output of 45 kw., the current output as a shunt-wound machine being 190 amperes at a voltage variable between 220 and 250 by means of a shunt resistance. The dynamos are bipolar. The outputs given are normal maximum outputs, but each set is capable of developing 10 per cent. more on emergency. The booster set, supplied by the same firm, consists of a motor-transformer capable of giving on secondary circuit 70 volts and 40 amperes when supplied with current on the primary at 220 volts and running at a speed of approximately 1,000 revolutions per minute.

The switchboard, which was supplied by the General Electric Company, has four enamelled slate panels

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mounted on iron framing and provided with the necessary instruments, one panel being exclusively used for street-lighting.

The battery, supplied by the Electric Power Storage Syndicate, contains 118 cells, including six spares. They are capable of giving a discharge of 127 amperes for one hour, the E.M.F. of each cell being not less than 1·87 volts at the end of discharge. They are mounted on neat stands, and form a convenient and accessible arrangement.

Over 12½ miles of mains have been laid by Messrs. Callender's Cable and Construction Company under the supervision of Mr. Edward Salthouse. The cables are lead covered, armoured, and laid in the ground direct, separate cables being laid for street-lighting. By the end of this month between 40 and 50 consumers will be connected to the mains. The street-lighting is done by means of 10-ampere long-burning open-type arc lamps in the more populated parts of the town; and the outlying districts are lighted with incandescent lamps, erected and supplied by the Prism Globe Company, of London, upon ornamental pillars 8ft. high. The arc lamps and pillars, which are 20ft. high, were supplied and fixed by Messrs. Crompton and Co. The electricity works was opened on Aug. 31 by Mr. Charles Smith, chairman of the Council, and has continued the supply without a hitch since that date.

SOME UP-TO-DATE TRANSFORMERS.

BY W. E. WARRILOW.

In the early days of alternating-current system of electric supply but little faith could be placed in the transforming apparatus, which, though in principle an extremely simple arrangement, in practice was quite incapable of meeting the demands upon it for any length of time. The failure of the device was an undesirable event, as the extinction of a number of consumers' lights would result from the occurrence, while the effect on the growth of the undertaking was not one conducive to progress. The pioneers of high-pressure alternating-current working were, however, hindered in many ways from supplying reliable apparatus. Their experience was naturally limited, and their material resources were equally so, consequently their early difficulties were harder to face by reason of the scanty supplies to overcome them. The dearth of material referred to was the lack of efficient insulating substances, both for covering the conductors and for the protection of terminals which then obtained, while the primitive nature of the appliances for the construction of the apparatus meant no small loss to the manufacturers. However, patient working at the problems then presented has born good fruit, and improvements in transformer design have been effected, which speak well for the labours of those engaged in the work.

The principle of the converter has undergone no change, the chief departures from the old types which are most noticeable being in the improvement of the insulation both of windings and terminals, in the reduction of the iron and light-load losses, and in the higher degree of reliability. Combined with these are small cost and low maintenance, items which do much to increase the all-round efficiency of the transformer. In the construction of this class of apparatus there are many restrictions which make the course of the manufacturer a difficult one, in that these boundaries cannot be overstepped. A medium must be struck between mechanical design and electrical efficiency, between cheapness and reliability, and in no case should any one be sacrificed for any other. Above all, the safety of those who will have to handle the apparatus under high pressure must be considered, as the neglect of this important feature has cost many good men their lives, as well as damaging the prestige of the industry. Such circumstances, unfortunate though they be, have proved severe lessons to contractors who have been compelled to give greater attention to the protection of charged metal. Other mistakes in manufacture have taught their lesson so well that a great change for the better can be said to have come over the appearance of the transformer.

The design of olden types have become well known ere this, so that a glance at some recent examples will serve to illustrate the advances made both in the construction of the transformer proper and of those accessories which have made it a much more useful adjunct to electricity supply undertakings. In most cases standardisation has been possible on account of there being a greater tendency to adopt a common periodicity, but the manufacturer has still, unfortunately, to meet the demands of the "go-betweens," whose orders cannot be supplied from stock material. The number of stations with a frequency between 50 and 100 are, however, fewer than those which have adopted the two mentioned, so that standard transformers are generally made to work on circuits of 50 or 100 cycles. The types illustrated herewith are of British manufacture, this class of apparatus differing considerably from American or Continental design by reason of the particular conditions which obtain in Great Britain as to the laying of mains. The Board of Trade regulations enforce the burying of all conductors in the ground, so that the transforming apparatus has been arranged to meet these conditions, the resultant design being somewhat superior to that usually adopted for service on overhead lines.

The practice of laying the mains under the roads or pavements has caused the converting apparatus to be placed either in a brickwork sub-station (above or below

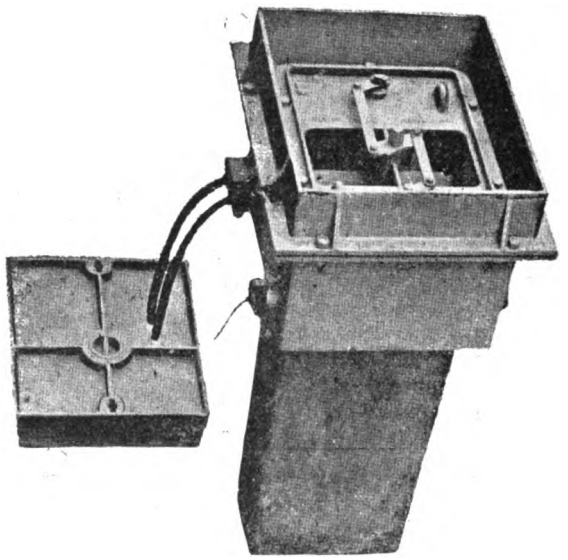

FIG. 1.—Brush Transformer in Street Tank.

ground) or in a pit dug out beneath the causeway. The former has been most generally adopted, as, in spite of its high first cost, the advantages gained are great. First, the connections from the transformer or transformers can be easily dealt with and absolutely isolated without undue complication; second, the operations of connecting cables, switching, and fusing can be carried on in strict privacy, consequently without annoyance, a great convenience when handling high-pressure mains or contacts; and thirdly, the sub-station when once built will accommodate several transformers and their accessories. In the case of small undertakings, however, the sub-station is a costly item, especially if future extensions cannot be estimated with a fair degree of accuracy. In such instances it is advisable to put the converters in street tanks under the pavements. Like the sub-stations, these pits have their advantages, though in a less degree. Their first cost is low, as is their maintenance, while a certain flexibility in design is obtainable, in that the tank can be made to take transformers up to 50 kw., changes up to this limit being effected by replacing a smaller converter with a larger one without any disturbance of the tank. Of course, the same privacy in operation is not obtainable with this arrangement as with sub-stations, while in wet weather it is sometimes impossible to continue work, but these circumstances do not prevent the introduction of the system into both large and small towns.

It is, however, questionable whether the pit transformer should be adopted in crowded areas of supply, as the

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sub-station deals with such problems in a more satisfactory manner in spite of its first cost, but for small towns and outlying districts the street tank can always be used. Where the pit system has been first adopted, and it is found advisable to build one or two sub-stations in the principal thoroughfares, the tanks can be made use of in the outlying areas as extensions become necessary. The types of transformers illustrated are examples of both the street tank and sub-station systems, and they should serve to illustrate the principal advances made in construction.

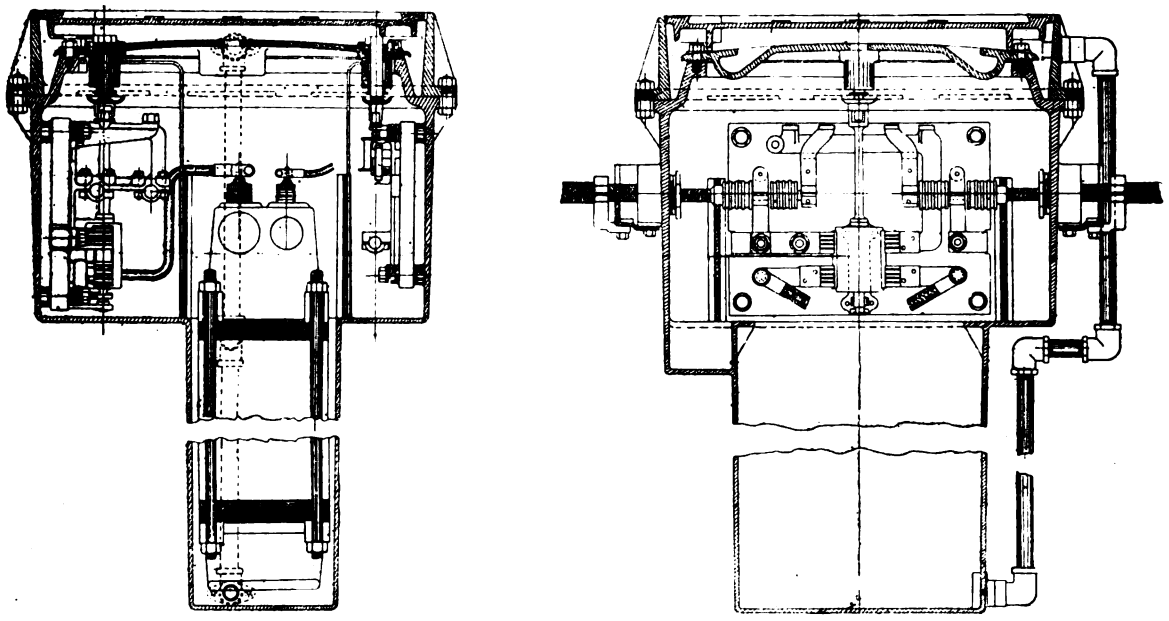

FIG. 2.—Sections through a Brush Tank Transformer.

The manufactures of the Brush Electrical Engineering Company in the direction of transformers have done much to establish the single-phase system of supply on a commercial basis, so that by reason of their experience considerable interest attaches to their more recent types of converter. The increased demand for pit transforming stations has caused a number of designs in this direction to be brought out, and in Fig. 1 may be seen the arrangement adopted by the Brush Company. A cast-iron tank accommodates the transformer, and two chambers at the upper part of the tank provide for the cables and switching devices, the whole being kept watertight by the covers, which are securely bolted down. A hole in the road frame cover allows of the insertion of a key to operate the switches, the hole in question being closed by a small cover which drops level with the pavement. The switches—high and low tension—are linked together and operated from the centre of the box by the one key. A section through the box is shown by Fig. 2, where it will be seen that the high-tension switch and fuse are on the right and the low-tension on the left of the box, the transformer occupying the centre, though at a lower level. The switches in each case are mounted on slate bases, the high pressure having special attention in the way of insulation. Two primary cables can enter the box, and a safety plug may be inserted to maintain the continuity of the high-pressure feeders, should it be necessary to move the converter under current at any time. The box will allow of the entrance of four low-tension cables, the armouring of which is connected to the case outside the gland. The double-pole switch and fuses for these are on the opposite side of the tank to the high-tension contacts, so that confusion is impossible and greater safety assured. Space is provided inside the case for the inser-

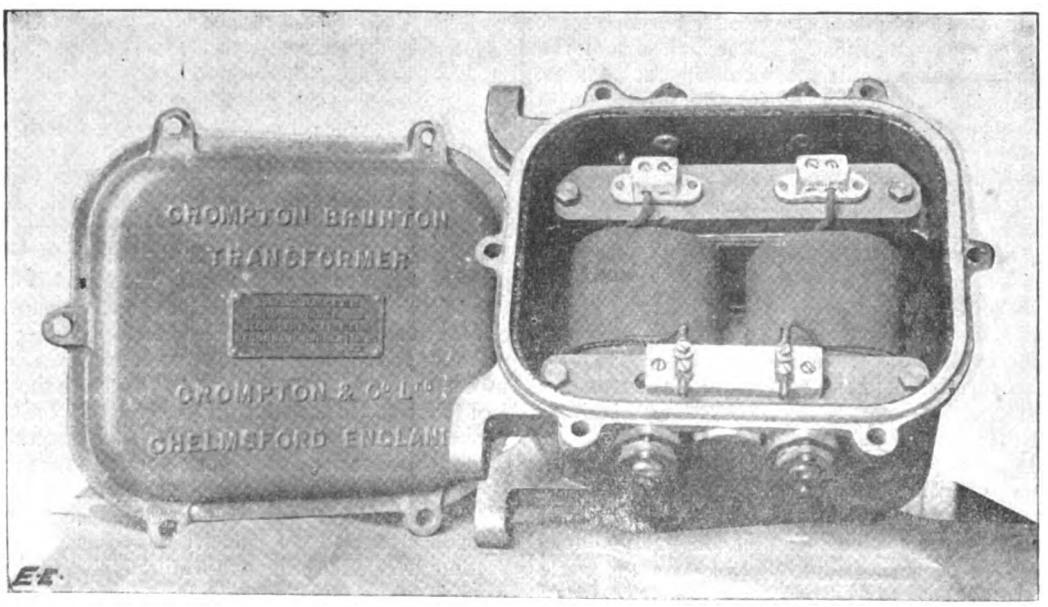

FIG. 3.—A Crompton Transformer in Case.

tion, if desired, of a maximum demand indicator (Wright's pattern) to register the greatest output of the transforming centre. The converter can be removed without in any way disturbing the cables or switches, it being only necessary to disconnect the leads from the transformer terminals. To exclude moisture, and to maintain the insulation of all parts, the tank is filled with oil, for the circulation and cooling of which an outside pipe is fitted. Concentric cables are provided for throughout, and they can be brought direct to their respective places without the

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use of bifurcating boxes. The tank will accommodate transformers up to 30 kw.

For use in sub-stations the transformer is placed in a cast-iron case, and it can be provided with high-tension switch and fuse if desired. These are generally mounted on porcelain bases cemented into the top of the transformer, or the switches of both circuits in this case can be arranged external to the transformer. Teak glands permit

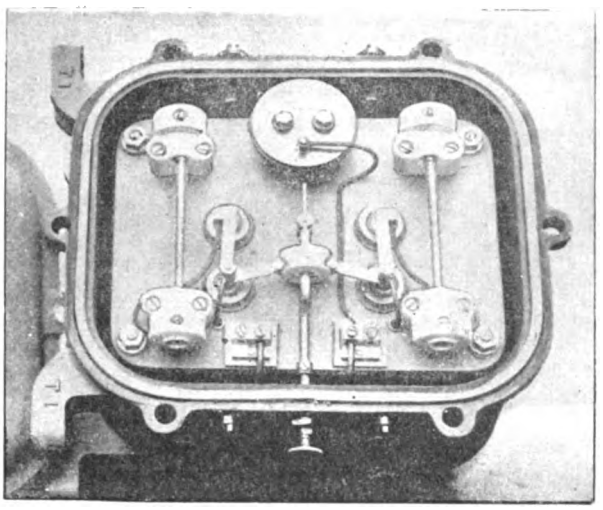

FIG. 4.—Crompton Transformer with High-Tension Double-Pole Switch and Fuses.

of the safe passage of the cables into the case, a necessary precaution with the high-tension leads especially. The secondary voltage can be varied from 100 to 200 volts, or for three-wire distribution, by alterations to the low-tension terminals. An earthing device placed between the primary and secondary windings is fitted to all the transformers of the Brush Company's make unless otherwise ordered, and the method adopted has the approval of the Board of Trade.

caution, as the insulation of the primary leads may become chafed, and were there no protection in the gland, a short-circuit would no doubt result when the cable became bared. The glands are packed to exclude moisture, and the lid also is bolted down on to a rubber insertion for a similar purpose. With this type of converter a separate switch and fuse are necessary, these being mounted in a cast-iron box in the case of a consumer's installation. The general design of the transformer can be well seen from this photograph, which shows both coils and core. The latter is of rectangular shape, and is built up of straight stampings with

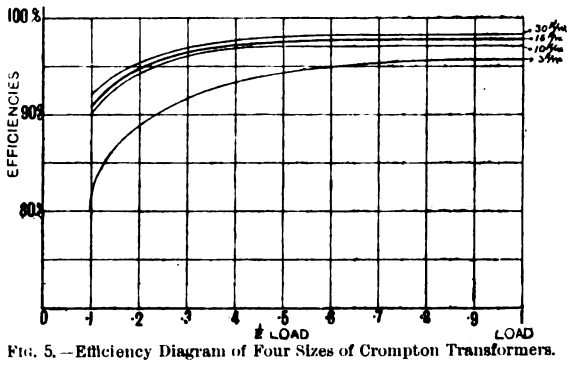

FIG. 5.—Efficiency Diagram of Four Sizes of Crompton Transformers.

alternate butt and lap joints at the corners, an arrangement which tends to reduce the magnetising current while ensuring low magnetic reluctance. The windings consist of two coils, each of which comprises half the primary and secondary circuits, the latter usually of rectangular copper strip being wound completely over the former. This subdivision of the two circuits on each coil is carried still further in large transformers, when a greater number of sections are used, to reduce as much as possible the effect of magnetic leakage. The high pressure is well insulated from the low-pressure winding by a considerable thickness of mica, the extra space occupied being regarded as of less importance than precautions to obtain absolute freedom from breakdown in this respect.

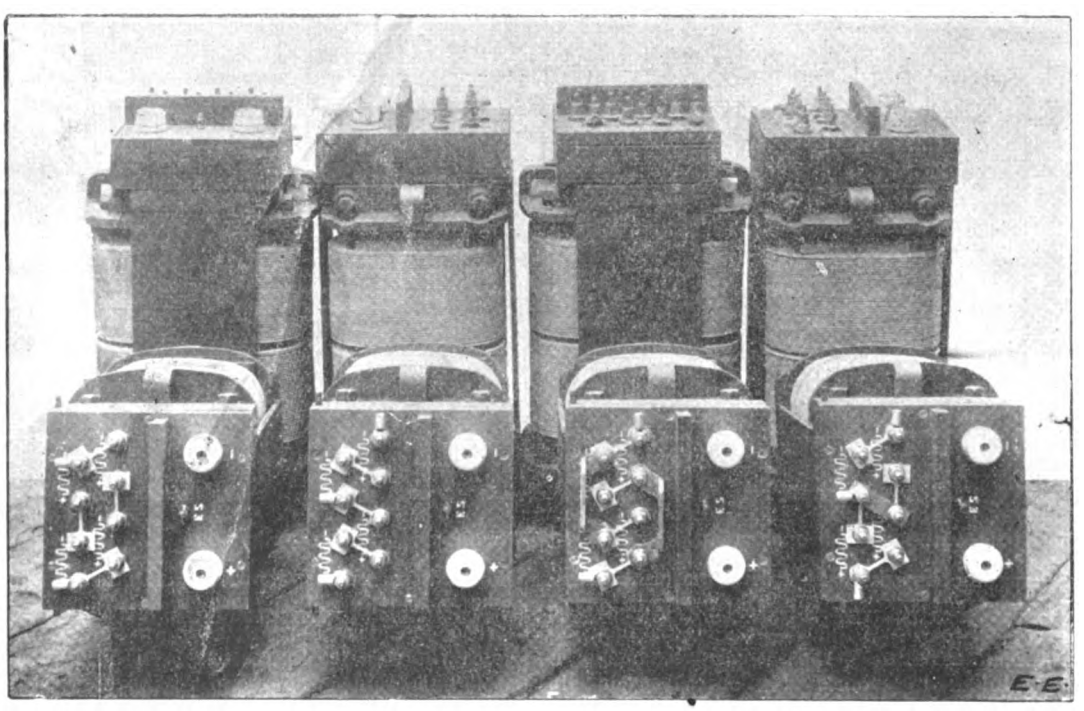

FIG. 6.—Group of Lowrie-Hall Transformers.

Messrs. Crompton and Co., of Chelmsford, can lay claim to a very neat design of transformer, as will be seen by a glance at Fig. 3. They are of neat appearance and occupy a small space. Fig. 3 is a photograph of a transformer with the cover removed, to expose the high and low tension terminals, which are respectively mounted on either side of the transformer body. The cables are led in through glands with stoneware bushes, the latter protecting the cable from contact with the case. This is a necessary pre-

A transformer with high-pressure double-pole switch and fuses is shown by Fig. 4. This arrangement is very compact, and can be used either in sub-stations, street pits, or on consumers' premises. The switch is operated from outside the case without the removal of the lid, the switch rod passing through a gland by the side of the box. This feature renders the transformer very useful when the circuit needs opening in a hurry. The fuses are well under cover, the wire, enclosed in a glass tube, being of

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such length that the circuit will be safely opened by it when occasion arises. A Cardew earthing device for the protection of the secondary winding is also fitted on the same terminal base as the high-pressure switch. The current and flux densities used in the design of these transformers are such that a high all-day full load efficiency

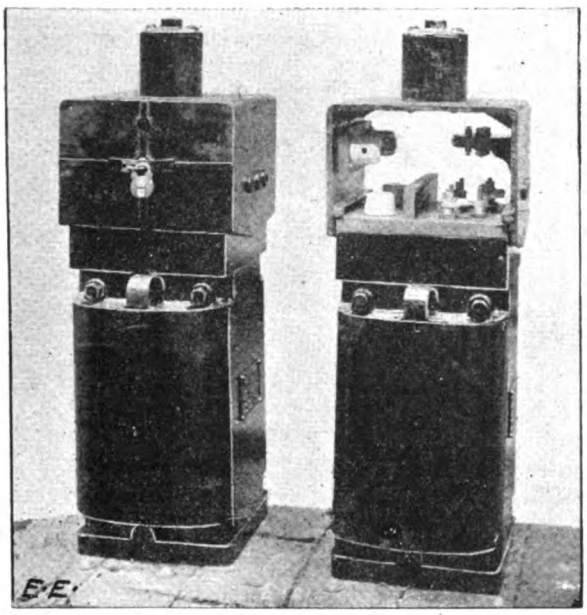

Fig. 7.—Lowrie-Hall Transformer for placing in Consumers' Houses.

is assured, circumstances well illustrated by the adjoining curves which make up Fig. 5.

A group of Lowrie-Hall transformers is shown by Fig. 6, which illustrates eight transformers, four of these being laid down to make clear the terminals, both high and low tension. Each set of contacts is mounted on one base, and the primary terminals have ample covering for protection, while they are separated from the secondary

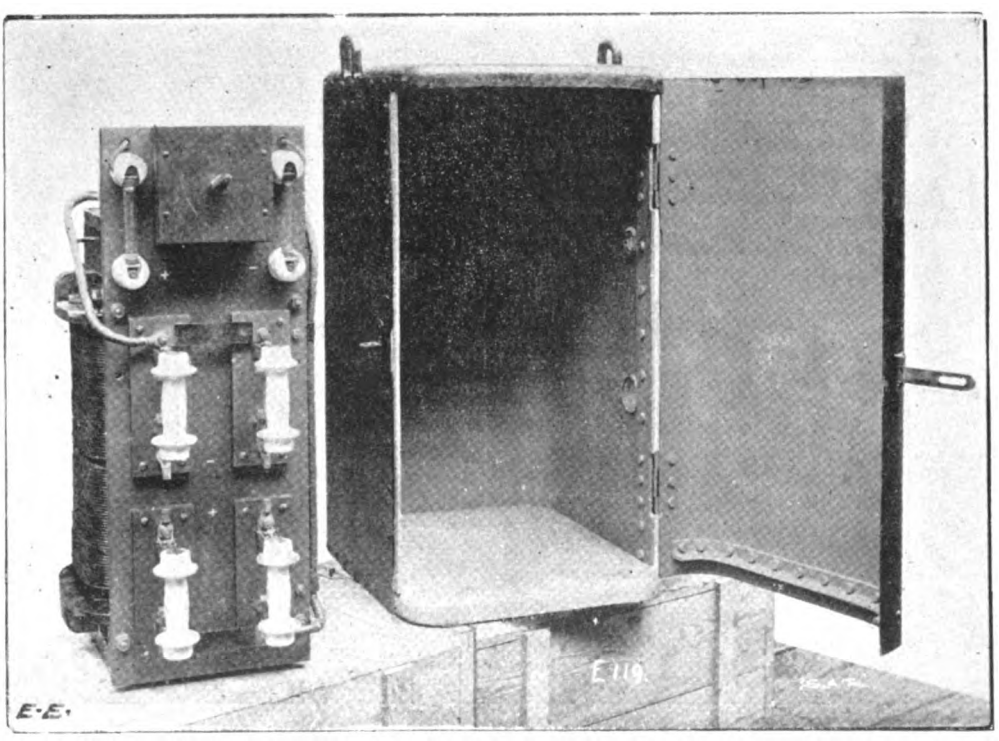

Fig. 8.—Sub-Station Transformer with Fuses.

connections by an insulating division. The low-tension contacts are eight in number, and by a combination of bar and fuse connections a number of methods of distribution can be obtained from one transformer. The transformer on the left of the figure is arranged for 200-volt two-wire, its neighbour on the right for 400-volt three-wire, and the remaining two on the extreme right are coupled for 100-volt two-wire and 200-volt three-wire respectively, while a fifth (not shown) can be arranged for 400-volt two-wire. The convenience of this arrangement is well exemplified on those undertakings which are of necessity changing their pressure of supply to the consumers, more especially should a breakdown occur, and it be found imperative that the supply be re-established at short notice by an interchange of transformers. When these converters are installed on consumers' premises a very convenient arrangement is made up (as shown by Fig. 7), the object in view being the dispensing with an outer case. The windings of the transformer are carefully protected by wrought-iron guards securely fixed to the main castings, and the

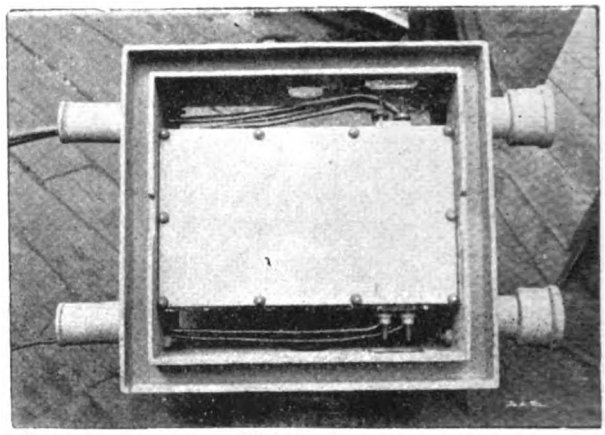

Fig. 9.—Street Transformer of the Lowrie Hall Type.

contacts are enclosed in a Wilkinson's patent terminal cover. No alteration to the standard arrangement of the connections is necessary, as the cover, which acts like a four-sided box, fits entirely over them. Two of the sides are loose to permit the examination of the earthing device, fuses, etc. The high-tension cables when concentric enter the transformer by way of the special gland seen at the top of the cover, and in this gland the transformer case is earthed. The low-tension leads are brought in through bushed holes in one of the fixed sides of the cover, and the two loose sides are held in position by a through bolt secured by means of a padlock, so that only authorised persons can have access to the terminals. For use in small sub-stations, the converter is placed in a wrought-iron case (Fig. 8) with hinged door fastened by a padlock. The primary and secondary leads are brought out to a base-

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plate fastened vertically to one side of the transformer, where they terminate in switch fuses, the high-tension fuses occupying the upper portion of the base-plate, while the low-tension fuses are fixed to the lower portion. In large sub-stations the transformer is placed in a cast-iron tank. The terminals are then mounted on one base, separated as before by an insulating guard, and provision is made for the entrance of two high-pressure and three low-pressure cables, the addition of the latter providing for the use of the transformer on a three-wire system of distribution.

In Fig. 9 will be seen an underground transformer box for connection to a pipe system of mains. The tank,

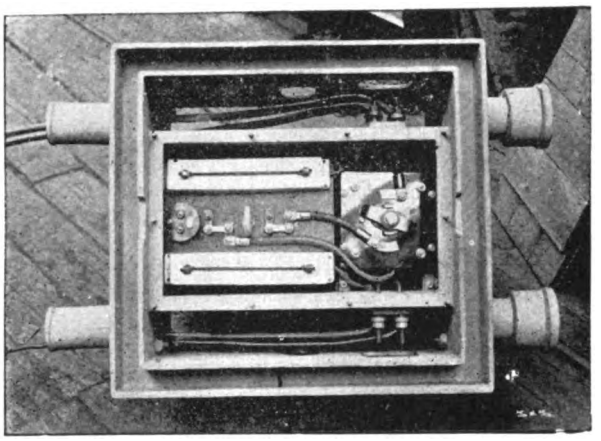

FIG. 10.—The same Transformer with the Cover Removed.

which occupies the centre of the frame, is separate from the road cover, the latter being more easy of adjustment to the pavement surface. The lid, which is not shown, is provided with recesses for the reception of concrete, wood, or asphalte, according to the construction of the pathway. In Fig. 10 the tank cover is removed to expose the terminals, fuse, switch, etc. In the centre are the low-tension fuses and earthing device, and to the extreme right is the switch. On either side of the base are the high-tension fuses, fitted to incombustible holders and chambers, these confining any arc which may form and preventing damage by fire. The high-tension switch is mounted below

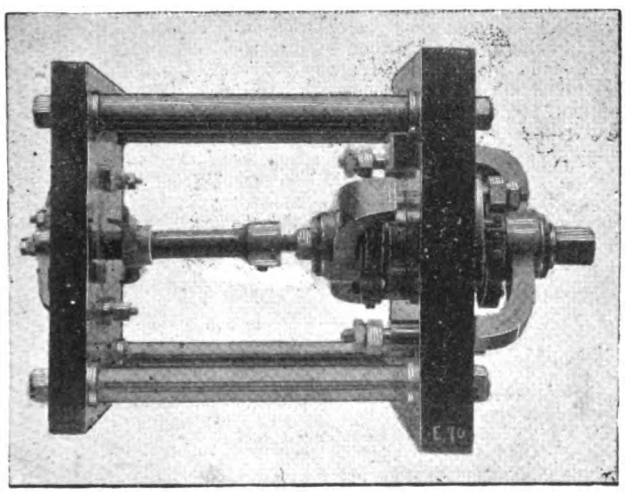

FIG. 11.—The Switch Gear, both High and Low Tension, of the Lowrie-Hall Street Transformer.

the low-tension, each circuit being opened at one and the same time. A better idea of the arrangement can be gathered from Fig. 11, which shows both the switches. Mounted on an ebonite base are the high-tension switches, there being a switch on each pole fixed on opposite sides of the ebonite. The low-pressure switch is fitted in a similar manner to a slate base, and the two switches are spaced apart by pillars, which also serve to hold the complete switch quite solid. The low-tension switch is of a very massive character, by reason of the heavy currents dealt with. Double breaks are provided on both the circuits, which are also opened quickly to reduce sparking as much as possible.

(To be continued.)

THE RELATIVE ADVANTAGES OF THREE, TWO, AND SINGLE PHASE SYSTEMS FOR FEEDING LOW-TENSION NETWORKS.*

BY MICHAEL B. FIELD, M.I.E.E., A.M.I.C.E

(Concluded from page 557.)

Generators.—I have obtained from different makers, for the purpose of this paper only, prices of three-phase and single-phase generators corresponding in type and output to the Glasgow 2,500-kw. units. The particulars given to each maker were as follows: output, 2,500 kw.; voltage, 6,500; efficiency—full load, 96 per cent.; three-quarter load, 95 per cent.; half load, 93 per cent.; speed, 75 revolutions; cycles, 25; fall of pressure between full load and no load, at constant speed and excitation, and power factor unity, to be not more than 7 per cent.; generator to be supplied without outboard bearing or shaft, but with bed-plate rheostat, etc. In Table VI., I have attempted to tabulate the figures obtained from the various makers, from which it is at once evident that the three-phase generator is cheaper and lighter than the single-phase.

TABLE VI.—Generators to Specifications as above.

	Three-phase.		Single-phase.	
	Weight.	Cost.	Weight.	Cost.
(1)	123 tons	£6,000	184 tons	£8,900
(2)	120 tons	£5,400	140 tons	£6,200
(3)	110 tons	£4,600	125 tons	£5,200

While the foregoing considerations, in my opinion, point conclusively to the fact that a three-phase plant is the best for operating a large tramway system such as that of Glasgow, I confess that I am not such an out and-out advocate of the three-phase principle as to recommend its adoption where the principal load consists of light pure and simple. The single-phase motor has of late made great strides, and is now a thoroughly practical and fairly economical machine, so much so, in fact, that taking into account the improved design of single-phase generators and methods of automatically compounding the same, a very considerable motor load may be connected to single-phase lighting circuits without detriment (Notes II. and III.). At the same time improvements are going on all round, and while a considerable motor load may be attached to single-phase lighting circuits without injurious effects, lights may perfectly well be, and in a large number of cases are, connected to three-phase motor circuits with excellent results. It is interesting to note, however, that the saving of copper in the low-tension network where the three-phase system is adopted is, contrary to expectation, practically nil.

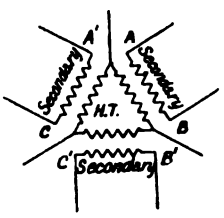

FIG. 2.

Fig. 2 represents a three-phase transmission with three single-phase distribution circuits on the low-tension side. The low-tension network then exactly corresponds, as regards weight of copper, to a single-phase distribution network. Now imagine that A and A', B and B', C and C', are grouped together, the area of each of the three mains now being 1·73 times that of A, B, C, A', B', C' taken separately. In each of the three mains we shall have 1·73 times the current—that is, the same current density as before, and hence the same drop per mile; in other words, while we distribute the same amount of power we reduce our weight of copper 13½ per cent., and lessen the distribution losses by an equal amount. This consideration seems to point to a great advantage in the three-phase distribution; but this is not really the case, for in the single-phase distribution a three-wire system would certainly be adopted. The corresponding three-wire three-phase system, as represented in Fig. 3, would, it is true,

* Paper read in Section IX. of the Glasgow International Engineering Congress, 1901.

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compare favourably as to saving of copper with the single-phase three-wire system. It is, however, an impracticable method, owing to the multiplicity of inter-connected circuits and the difficulty involved in the independent regulation of the same. The only method which corresponds to the three-wire single-phase, and is at the same time at all feasible where independent regulation of the various circuits is desired, is represented in Fig. 4, where R_1, R_2, and R_3 are series shunt regulators.

If, then, the lamp voltage or voltage across one leg of the system be made equal to the voltage between the outers and the neutral of the single-phase three-wire system, the total voltage between the outers of the latter system will clearly be greater than the voltage per phase in the three-phase distribution; in other words since the lamp voltage

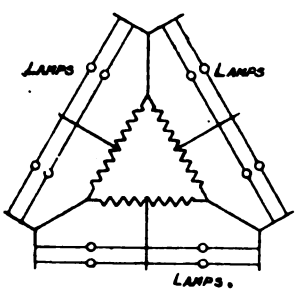

FIG. 3.

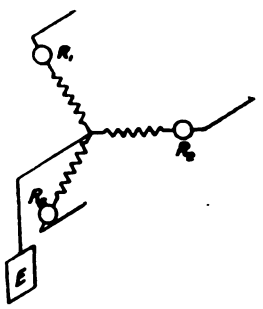

FIG. 4.

is to be the same in either case, the voltage per leg must also be the same, which means that, provided the neutral wire in each has the same cross-section, the total weight of copper for a given output and percentage loss will be the same for each. On these grounds I think that the adoption of two-phase plant where the transmission losses are necessarily small, and where both power and light are supplied from the same circuits, is warranted. A further advantage is that it is possible to regulate the phases independently of each other in the generating station, if this be required, with the two-phase system, while with the three-phase system it would be necessary to insert regulators in the low-tension mains at the sub-stations (see Fig. 5).

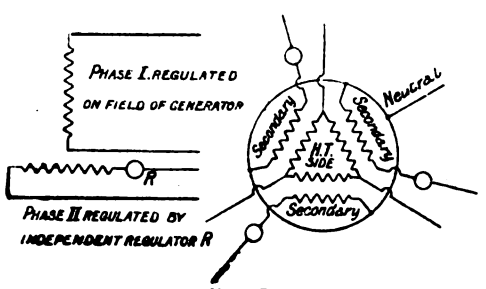

FIG. 5.

The effect on the one phase by the variation of load on the other is, as far as I have been able to ascertain, not materially different with a two-phase or three-phase generator. Roughly speaking, if X per cent. is the drop on a non-inductive full load of a two-phase machine, and one phase be suddenly switched out, the voltage on the other phase will not alter by more than ·7 of X per cent., or if Y be the drop on full-load inductive current, the variation will be ·8 of Y per cent. In America a three-phase system has been adopted of late with considerable success where, to avoid all regulation in sub-stations and the like, the voltage of one phase alone is kept constant in the generating station, and the whole of the incandescent lights of the system are connected across this one phase. In such cases all incandescent lamps are connected across phase I., which is kept at constant pressure by regulating the field of the generator. Phases II. and III. will be used, say, for series arc lighting or for other purposes where a constant voltage is not an essential, while motors are connected across all three phases. In such a case the incandescent lighting may be supplied from a three-wire system, the neutral wire being connected to the middle point of the regulated phase, thus giving twice the lamp pressure as the working voltage between the motor terminals. When such a system is adopted, no attempt is made to obtain anything like balance of load on the three phases, it being claimed that any well-designed three-phase generator may be used up to 75 per cent. of its rated output as a single-phase generator, using two of the legs of the winding as the single phase; this means that when used as a single-phase generator, 30 per cent. more current may be taken from the loaded phase than the normal current rating per phase. It appears to me, however, that as we begin to use two conductors as a single phase, we destroy the essence of the economy of the three-phase transmission, and hence that a two-phase transmission with four-core cables would be just as advantageous. In this case the regulation might be done only on the one phase, all incandescent lighting being supplied from this phase, or both phases might be independently regulated in the generating station.

It is worthy of note that two and three phase motors and transformers, if connected to circuits of unbalanced load, will tend to equilibrate the same—that is, they will tend to draw more load from the unloaded and less from the loaded phases. For instance, if a number of motors be connected to a two-phase circuit supplied from a two-phase generator, and while a number of motors are running one phase circuit be opened at the generator, the motors, while in reality only receiving single-phase current from that phase still connected to the generator, will apparently run as two-phasers; that is to say, they will be self-starting and found to have about ·8 of the normal voltage across the switched-out phase—in fact, the lightly loaded motors will be generating and circulating among the more heavily loaded motors the necessary currents in the switched-out phase, to enable them to work more as two-phase motors than as single-phasers.

NOTE I.

It appears to me that if ever three-phase motors are to be successfully employed for tramway work in crowded cities, the solution of the problem will be found in the combination of two shallow conduits of the slot-rail type with surface contacts: by this I mean such shallow conduits as would avoid contact with underground gas and water mains, but sufficient to afford protection to a number of contact studs laid, let us say, every 2ft. or 3ft. apart in the floor of each conduit. These studs would be of the simplest character possible, involving no mechanism whatever, with the exception, say, of every fortieth, which would be of the present automatic surface-contact type, and would control the succeeding 39. The automatic switches need not necessarily be placed under the road bed at all, but might be enclosed in boxes under the pavement, or several grouped together and erected in switch pillars and placed at intervals along the route, where their accessibility would be a great point in favour of the scheme. Each car would carry two short skates of, say, 3ft. length, which could be easily introduced into the conduits at special boxes, and, owing to their shortness, would ride easily round curves. Such a system, in my opinion, promises to obviate the dangers of the surface contact, and the difficulty of maintaining good insulation in the conduit system, together with the necessity of removing gas, water, and other mains.

NOTE II.

In Frankfort at the present time there are from 500-600 single phase motors connected to the mains, with an average of about 10 h.p each. The total kilowatts output may be classified as

Motors	3,427 kw.
Motor-generators	1,736 ,,
Lighting	6,482 ,,
Street ditto	123 ,,
In station itself	91 ,,
Total	11,859 ,,

The variation does not exceed ± 3 volts, the supply voltage being 120, and the frequency 45.

The lamps and motors are all connected to the same machines, feeders, etc. The motor-generators for traction purposes are usually operated separately—*i.e.*, from separate machines and separate feeders—but on Sundays the whole load, including traction load, is taken from the same generators, switchboard, and feeders.

NOTE III.

Table showing comparisons of best single-phase motors and three-phase motors of small sizes:

Power Factor Single-Phase.	Full.	Half.	Power Factor Three-Phase.	Full.	Half.
1 b.h.p.	10·7	0·53	1 b.h.p.	0·8	0·63
5 ,,	0·75	0·6	5 ,,	0·84	0·68
10 ,,	0·8	0·62	10 ,,	0·85	0·69
20 ,,	0·8	0·62	20 ,,	0·87	0·70

NOTE IV.

Experiments on a three-phase generator loaded on three-phase motor, two phases being loaded on a non-inductive resistance as well. Generator and motor both Y connected; speed and excitation of generator kept constant.

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Volts on generator.			Motor load, amperes.			Non-inductive load in
Phase I.	Phase II.	Phase III	Phase I.	Phase II.	Phase III	Phases I. & II.
133	132·8	130·5	0	0	0	0
127·6	126·5	136·1	—	—	—	90
126·4	126·0	137·0	—	—	—	104
126·5	126·5	126·0	77·4	78·2	78·2	—*
124·2	122·5	130·5	28·2	31·8	15·0	91·5†
121·5	122·5	128·5	87·4	70·8	67·8	87·0*

* Motor loaded. † Motor running light.

DISCUSSION.

Mr. E. Kolben congratulated the section on the valuable contribution they had received from Mr. Field. He had looked through the figures in the paper, and agreed with them as indicating that the three-phase system was the most advantageous. He had for a good number of years advocated this system wherever electric light and power had to be distributed from the one station. He also agreed with the author that while this three-phase system was the right thing for long lines of railways, it was not suitable for lines such as the Metropolitan District Railway of London. In fact, when speed regulations had to be carried out frequently too much energy was lost. In the early days of electric tramways in the United States not much progress was made until the series-parallel controller was designed to enable the regulation at low speeds to be carried out economically. Until this was done the power-houses had to contain at least 30 to 40 per cent. more plant than at present for a given number of cars. He had introduced at Prague the three-phase system for electric lighting and power distribution, using a frequency of 50. They connected the lamps, however, directly across the three phases, and did not use the central wire, as suggested in Mr. Field's paper. He found that an unequal division of load amongst the three phases was not an objection, as if the load was even 30 per cent. out on one phase the alteration in voltage was inappreciable.

Prof. Carhart said that almost all the new power works in the United States was done by three-phase current, and that he did not know much work that was being undertaken on the two-phase system. From recent observations he saw no reason why the frequency for lighting should not be below 50. He had been looking at the lights at the Buffalo Exhibition, which were supplied at 25 frequency from the Niagara works. It was difficult to detect any fluctuation in the lighting unless one really looked for it. Of course, he knew that this frequency was not suitable for arc lighting. An innovation in the States was the substitution of alternating-current arc lamps in series in the place of series direct-current lamps. Also they were now using almost entirely the enclosed type of arc lamp.

Mr. W. B. Esson agreed with Mr Field that there was no advantage in a three-phase system with a neutral wire over an ordinary three-wire system. He believed that the last new single-phase system had already been erected in this country, and that all new work would be carried out on the multiphase system, or else by means of continuous current.

Prof. S. P. Thompson expressed a hope that the members would not think they should all have the same opinion as to the best system to be used, as there was still every reason not to crystallise on the subject. In changing over from the single-phase to a multiphase system there was a considerable advantage in adopting the two-phase system, as had been done by the Metropolitan Electric Supply Company. He noted what the author had to say as to the advantages of the single-phase system, and wished that they had there that day Mr. Ferranti, who was such a strong supporter of that system. This gentleman condemned the multiphase systems on account of the supposed large increase in the switch gear required, as involving a great extra complexity. He (the speaker) believed that this idea was not correct.

Mr. Blathy pointed out that where accumulators were used on the continuous-current network, the motor-generator had a great advantage over the rotary converter. It was exceedingly difficult to get the voltage required for charging accumulators with the latter system. For all cases where accumulators were not used the rotary converter should be employed. He personally believed that alternating-current motors and direct-current motors had about the same qualities as regards efficiency, and that on neither system could any substantial claim for economy over the other be substantiated. As regards railway working, 67 miles of railway working on the three-phase system would be opened in Italy in about six weeks' time. On this line the passenger trains would be run at 40 miles per hour, and the goods trains at 20 miles per hour. The electric locomotives would have practically the same weight as the steam locomotives, but they gained an advantage from their even torque. In consequence of this they could do some 30 to 40 per cent. with the same weight on the driving wheels than the steam locomotive. Again, the electric locomotive did not require a tender, which often weighed 30 tons, and formed 10 per cent. of the whole weight of the train. This meant that the electric locomotive could draw 10 per cent. at least more than the steam locomotive for the same power. He thought that on the Continent a frequency of 42 was now more often used than the so-called standard frequency of 50. They had found that even with 22 cycles incandescent lighting was satisfactory, and a three-filament lamp entirely prevented any fluctuation in lighting. He agreed with the author as to the difficulty of changing over from single-phase to three-phase currents, especially if ordinary concentric cables were used.

Mr. Stoney said that the author's remarks respecting Frankfort were not quite in accord with his own information. In that stronghold of single-phase working they were now introducing turbo-alternators of the three-phase type for supplying the traction load. By so doing they were able to improve the power factor from between 0·7 and 0·8 up to as much as 0·95, which enabled a considerable increase of load to be given by the older plant. Only one phase of the new machine was used for lighting, and the improvements in the power factor came from the use of synchronous motors in connection with the tramway plant.

Mr. W. Geipel also spoke as to the small alterations in voltage which a want of balance between the lamps on each of the three phases made.

Mr. M. B. Field, in reply, pointed out that his paper was devoted to the consideration of the feeding of low-tension network, hence that the supply of energy to main-line railways was hardly within the range of the paper, as high voltage would have to be employed for these. He reiterated his opinion that when the power required was small as compared with the demand for light, there was little advantage in going to a multiphase system. It was said that the connections shown in Fig. 3 were too complicated, but he believed they were actually used at Milan. Another point which had to be borne in mind was the fact that the Board of Trade regulations and the conditions imposed by the Postmaster-General might sometimes give an advantage to the two-phase system over the three-phase one. As regards the working of their rotary converters in Glasgow they had had practically no trouble, and found that they held in step even when the alternators failed to do so. When they first started up the engines with the valves unadjusted, they did not work well in parallel, and in one case, owing to a valve becoming stuck, two of the alternators actually got out of phase. After they had got them in again, he was surprised to find, on telephoning to the sub-stations, that only one rotary out of all those on the circuit had got out of step. They had now got the engines properly adjusted, and were having no trouble. Of course the rotaries could be made to hunt, but it was somewhat difficult to do so unless they had four or five working on the same sub-station. As regards regulation they found that there was not on the average more than a 2 per cent. variation of voltage on their whole low-tension system in the sub-stations, although they did absolutely no regulation in the sub-stations, but only at the Pinkston works. The extreme variation was 4 per cent. He agreed with Mr. Blathy that it was an awkward matter to charge an accumulator from rotary converters.

THE ECONOMY OF ELECTRICITY AS A MOTIVE POWER ON RAILWAYS AT PRESENT DRIVEN BY STEAM.*

BY PROF. C. A. CARUS-WILSON, M.A., A.M.I.C.E.

This paper deals briefly with the question of the economic considerations which will probably govern the substitution of electricity for steam as a motive power on railways. It is generally acknowledged that the branch lines are the least profitable part of a railway system, and that in many cases the receipts per mile are barely sufficient to pay expenses. There is also evidence that in the near future the unremunerative character of the branch lines will become still more marked, since the traffic they at present carry is being seriously menaced by the network of electric tramlines that is spreading in all directions throughout the country. To pay expenses with steam traction it is necessary to make up trains of considerable length, so that where the traffic is small, as on branch lines, the interval between trains is large. This results in a poor service between towns and districts connected only by branch lines, and gives rise to considerable difficulty and delay in making connections at main-line stations. Thus, while main-line travel is popular, cross-country travel is unpopular.

The infrequency of the service on branch lines is responsible for much of the unpunctuality that exists. The limited traffic does not permit of an adequate staff being maintained to deal with it as it might, and should be dealt with if it were more evenly distributed over the day. The employés are not uniformly occupied, and the infrequent arrival of long trains with large numbers of passengers and corresponding quantities of luggage renders prompt handling of the traffic very difficult, and causes delay and unpunctuality which often affects the main-line traffic itself. If the train service on the branch lines could be broken up into smaller units moving more frequently, cross-country travel would be greatly facilitated and the punctuality improved. An increase in the frequency of any given service of trains at once affects the intimate relation which exists between facility of travel and the traffic resulting therefrom. While it is an accepted axiom that increased facilities create traffic, yet the increase may be obtained at too great a cost. It is thus of importance to ascertain upon what the cost of any given increase in the train service depends, so as to be able to deduce the minimum traffic required to pay for such increase. To do

* Paper read in Section I. of the International Engineering Congress, Glasgow.

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this the cost of working the line under the existing conditions with steam must be divided into two parts, and the running expenses per train mile, which vary with the number of trains run, must be distinguished from the fixed expenses, which do not so vary. The former will include principally coal, drivers' and conductors' wages, and repairs, while the latter will include the maintenance of the permanent way, traffic expenses, rates and taxes. The fixed expenses per train mile multiplied by the number of trains per day on any given line under the existing conditions gives the contribution of that line per day mile to the general fund for purposes of maintenance, etc. This will then constitute a fixed sum per day mile to be provided for under the new conditions, together with the increased running expenses. The traffic per day mile must exceed this amount, plus a sum required to pay the interest on the electric installation, before the line can be said to pay. The working expenses of the principal English railways, taken from the Board of Trade returns for the year 1900, are given in Table I. In these returns no distinction is drawn between the cost of operating passenger trains and goods trains, neither is there any indication given of the weight of the trains hauled. It seems very desirable that the railway companies should furnish the passenger and goods ton mileage as they now furnish train mileage, for these figures, taken conjointly with the cost of working, must be the true basis of all endeavour to reduce the proportion of unprofitable mileage.

TABLE I. — Working Expenses and Proportion of Goods and Passenger Traffic for the Principal English Railways for the Year 1900.

—	A. Train miles. Goods.	B. Train miles. Passenger	C. Goods. Tons per train mile.	D. Expenses per train mile. Fixed.	E. Running	F. Total.
	%	%		d.	d.	d.
London and North-Western	46	54	1·97	31·4	11·1	42·5
Great Western	50	50	1·62	25·1	11·0	36·1
Great Northern	50	50	1·45	22·9	11·4	34·3
Great Eastern	41	59	1·31	28·0	10·3	38·3
Midland	60	40	1·43	22·6	11·6	34·2
London and South-Western	27	73	1·34	31·6	10·6	42·2
Lancashire and Yorkshire	35	65	3·33	30·1	11·5	41·6
South-Eastern and Chatham	22	78	2·00	34·4	13·0	47·4
London, Brighton, and South Coast	19	81	2·10	32·5	12·8	45·3
Cheshire Lines	44	56	2·80	28·8	13·9	42·7

In Table I. the total working expenses per train mile given in column F are divided into two parts in columns D and E. In column D are given the fixed expenses, including maintenance of way, etc., repairs and renewals of carriages, traffic expenses, rates and taxes, miscellaneous and legal. In column E are given the running expenses, including wages, coal, water, and locomotive repairs. Columns A and B give the goods and passenger train miles respectively, in percentage of total. Column C gives the goods tons carried per goods train mile. Columns B and D show how the fixed expenses increase with the passenger traffic. Thus with the Midland, where the passenger train mileage is 40 per cent. of the whole, the fixed expenses are only 22·6d. per train mile. With the Great Western and the Great Northern, where the goods and passenger train miles are equal, the fixed expenses vary from about 23d. to 25d.; while on the southern lines, where the passenger traffic is about 80 per cent. of the whole, the fixed expenses amount to as much as 32d. to 34d. per train mile. An increase in the passenger traffic need not, however, be accompanied by a rise in the fixed expenses, for if the traffic were evenly distributed over the working day, a considerable increase could be dealt with by the existing staff. For this reason the amount of the fixed expenses assumed in the following comparison will be taken for a line with an average amount of passenger traffic, as, for instance, the Great Northern, where the fixed expenses are 22·9d. The figures in column C indicate the character of the goods traffic on each line, *qua* weight. Taken in conjunction with column A, they give some idea of the relative weights of the goods trains hauled on the different lines. Comparing these columns with column E, it will be seen that in spite of the variation in the weights hauled, and in the proportion of goods and passenger traffic, the item for running expenses is very nearly the same on the first seven lines. Thus the Midland, with 60 per cent. of goods train miles and 1·43 tons per train mile, has the same running expenses as the Lancashire and Yorkshire with only 35 per cent. of goods train miles, but with 3·33 tons per train mile. On the Great Eastern and on the London and South-Western a low percentage of goods train miles and a low weight per train mile combine to give the lowest figures of all the lines for running expenses. The South-Eastern and the London and Brighton are about equal to the Great Eastern in the matter of goods traffic, and the running expenses would also be nearly the same were it not for the high price both the former lines had to pay for coal last year. The figures for the Cheshire Lines illustrate still further the fact that the running expenses do not rise above the average unless there is a large proportion of unusually heavy goods traffic.

Taking the Great Northern again as a representative line, the running expenses may be sub-divided as shown in Table II., which gives the actual figures in the report for the last half-year of 1900, the total differing slightly from the returns for the whole year. The coal item is, of course, abnormally large, the average price of coal during 1900 having been about 10s. 9d. Reducing this figure to the equivalent for coal at 8s. a ton we get 3·36, bringing the cost per train mile down to 10·33d.

TABLE II.—Running Expenses of the Great Northern Railway for the Last Half-year of 1900.

Wages	3·81d.	per train mile.
Coal	4·50d.	,, ,,
Water, oil, etc.	0·77d.	,, ,,
Repairs, wages	1·34d.	,, ,,
,, materials	1·05d.	,, ,,
Total	11·47d.	,, ,,

The wages of the guard of the train should be included in the above figure in order that it may represent the whole of the expenses, which vary with the number of trains run. Taking the wages of a driver at 42s. per week, of a fireman at 22s., and of a guard at 25s., the item "wages" under running expenses should be increased by 1·52d. This amount must be also deducted from the fixed expenses, giving us finally 21·38d. per train mile as the expenses which do not, and 11·85d. as the expenses which do, vary with the number of trains run.

We can now take the case of a branch line with, say, six trains each way per day. The running expenses will be $12 \times 11{\cdot}85$, or 142d., and the fixed expenses $12 \times 21{\cdot}38$, or 256d. per day mile. Hence, if the line in question is to pay expenses—that is, to contribute to the general revenues a sum proportional to the number of trains run, and to the average cost per train mile for the whole line—the receipts per day mile must amount to 398d., or the traffic, estimated in equivalent numbers of third-class passengers, must be 398 per day mile. Instead of a steam-driven train every two hours, we may have an electrically-driven train every half-hour, or 24 each way per day instead of six, each of the new trains having seating accommodation equal to one-fourth of one of the original trains. The new trains may consist of motorcars driven by motors under the car, and ordinary carriages trailing. By getting rid of the locomotive, about 20 per cent. of deadweight is saved, and since the weight of the carriages will be one-fourth of that in the original train, the new trains will weigh one-fifth of the old trains. This will reduce the coal item in the running expenses to 0·68d. per train mile, and that for water, oil, etc., to 0·15d., as shown in Table III.

The coal consumed per ton mile is here taken to be the same for an electric generating station driving electric motors on the cars as for steam locomotives. This probably does not give the electric system full credit for the economy obtained by using large engines in the power-house and motors of high efficiency, but there is not as yet sufficient experience to warrant any material reduction being made in the coal item when comparing the two systems. The

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cost of repairs will be reduced. On the City and South London Railway the cost of wages and materials for repairs to electric rolling stock and generating station is 0·92d. per train mile—about 38 per cent. of that on the Great Northern. Taking 50 per cent. as a moderate estimate, we get 0·67d. per train mile for wages and 0·52d. for materials for repairs to electric motorcars and to the generating station. A large reduction can be made under wages. The great simplicity of the electric equipment enables us to substitute for the highly-paid driver and his fireman one motorman, say, at 32s. a week, thereby halving the wages item on the locomotive. Further, as the electric motor is ready to start at any moment, a great deal of time is saved during the week, when compared with the steam locomotive, which has to spend a considerable amount of time in the shed and in getting up steam. Also, with the increased service a larger proportion of the actual working hours will be usefully employed. In consequence of this economy of time the men can put in about 50 per cent. more train miles than before, and the wages item is reduced to 2·25d. per train mile. To this must be added the wages of the men engaged in the generating station, which may be taken at 50 per cent. of the motorman's wages, or 0·62d. per train mile, making the wages per train mile altogether 2·87d. The total cost per train mile for running expenses with the electric train is thus 4·89d., as compared with 11·85d. for the original steam train.

TABLE III.—Running Expenses in Pence per Train Mile.

—	Steam.	Electricity.	Liverpool Overhead Railway.
	d.	d.	d.
Coal	3·36	0·68	0·85
Wages of driver and assistant	3·81	1·24	1·15
,, conductor	1·52	1·01	1·01
,, at generating station	—	0·62	0·69
Water, oil, etc.	0·77	0·15	0·42
Repairs, wages	1·34	0·67	0·40
,, materials	1·05	0·52	0·65
Total	11·85	4·89	5·17

The running expenses on the Liverpool Overhead Railway for 1899 are given in Table III. Comparing these with the figures already obtained it will be seen that the item for wages is almost the same, while the items for coal, oil, etc., are higher on the Liverpool line, and for repairs slightly less. The item for conductors' wages has been taken to be the same in both cases. The trains on the Liverpool line are made up of motorcars and trailers, weighing together about 40 tons loaded. About 180 trains are run each way per day, with a total of 403,000 train miles in the year (1899). This large train mileage, of course, reduces the fixed expenses per train mile to a low figure, but does not affect the running expenses. With the new system the fixed expenses would be the same as before, while the running expenses would increase in proportion to the increase in the frequency of the service—that is, in the case assumed, fourfold. Hence the fixed expenses will be 256d. per day mile, and the running expenses 48 × 4·89, or 240d., making a total of 496, so that in order to pay expenses the traffic would have to increase from 398 per day mile to 496, or 25 per cent. This increase, however, would not pay the interest on the capital required for the electrical equipment. The cost of the electrical generating station, with distributing system and rolling stock for a half-hour's service of 40-ton trains on a line not exceeding, say, 15 miles in length, would probably be about £8,000 per mile. At 3½ per cent. interest this would mean an additional 184d. per day mile, making the total increase of traffic required to pay all expenses and interest 70 per cent. In Table IV. similar figures are given for services of three and four trains in the hour. The capital required increases slightly with the number of trains. The increase of traffic resulting from a given increase in the frequency of the service depends upon local conditions, but if a four-fold increase in the number of trains per day were to double the traffic, the profits per day mile would be 10s. If the traffic were trebled the profits would be 43s. The average profits per day mile for the whole of the Great Northern Railway system is about 124s., so that the use of electricity on branch lines is certainly worth consideration as a means of making them yield a more substantial proportion of the total profits than they do at present.

TABLE IV.—These Figures give, in Pence per Day Mile, the Cost of Working an Electrical Line as compared with a Steam Line.

—	Steam.	Electricity.		
No. of trains each way per day ...	6	24	36	48
	d.	d.	d.	d.
Fixed expenses	256	256	256	256
Running expenses	142	240	360	500
Interest on electrical installation..	—	184 (*a*)	230 (*b*)	276 (*c*)
Total	398	680	846	1,032
Increase in traffic to pay expenses.	—	70 %	110 %	158 %

(*a*) At £8,000 a mile. (*b*) At £10,000 a mile. (*c*) At £12,000 a mile.

SOME EXPERIENCES AND RESULTS DERIVED FROM THE USE OF HIGHLY SUPERHEATED STEAM IN ENGINES.*

BY R. LENKE, ERITH.

In no branch of heat-engine building has such an amount of study been spent as in steam-engines, from Watt's time up to to-day. The economy of the steam-engine is, in spite of all efforts, not the best, and the steam-engine in its highest perfection attainable at present cannot claim the first place in comparison with other heat engines. And so the problem of generating and using superheated steam has become a question, from the solution of which a considerable stride in improving economy has been expected and really made.

Superheated steam is generated by the addition of heat to saturated steam. The behaviour of superheated steam is similar to that of gases; it is a very bad conductor of heat, and has the special peculiarity of being able to lose a certain amount of heat without becoming saturated or wet steam. The thermal capacity of steam is only 0·48, therefore very little heat is required to superheat steam; but as the steam loses the heat as quickly as it acquires it, every passage conveying superheated steam must be well covered with non-conducting material. Although there are some losses when using superheated steam on account of the heat radiation, they are very much smaller, because the loss of heat from superheated steam has lower calorific value than the latent heat of saturated steam. Superheated steam has a greater volume per unit of weight than saturated steam at the same pressure, hence one advantage, and the higher the temperature, the greater this advantage. At various pressures and temperatures the increase of volume may be taken from the following Table I.:

TABLE I.

Pressure.	390deg. F.	570deg. F.	750deg. F.
70	1·1	1·33	1·57
115	1·06	1·29	1·52
170	1·02	1·24	1·46

Table I. shows that the higher the pressure is, the smaller the increase of volume; and it is proved from practice that the advantage with lower pressure is indeed greater in proportion than with higher pressures.

The question may arise whether the increase of volume does not require more additional heat than the benefit derived from it is worth. To show this clearly, Table II. has been prepared expressing how many B.T.U. less are required to produce one cubic foot of superheated steam than of saturated steam at the same pressure. For various pressures and temperatures the total heat per cubic foot is as follows:

TABLE II.

Pressure.	Saturated.	390deg. F.	570deg. F.	750deg. F.
70	233	219	192	175
115	350	337	297	267
170	492	485	432	398

* Paper read in Section III. of the International Engineering Congress, Glasgow, 1901.

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i.e., to produce, for example, one cubic foot of steam at 115lb. pressure and a temperature of 570deg. F.,

$$\frac{350 - 297}{350} = 15 \text{ per cent.}$$

less heat is required than to produce one cubic foot of saturated steam at the same pressure. With saturated steam-engines, 20 to 25 per cent. of admitted steam is condensed during the admission period, consequently the practical steam consumption is very much in excess of the theoretical. Superheated steam does not condense during this period if sufficiently superheated, hence another advantage.

The economy effected by using superheated steam in engines is very remarkable, and, acknowledging this fact, a great number of steam users all over the world superheat the steam, although in many cases only a few degrees, yet a considerable saving in steam and coal is always the result. To obtain the full benefit the required temperature of steam is 660deg. to 700deg. F., and to stand this temperature the engines must be specially designed. It is not sufficient to use mineral oil with a very high flash point, and anyone who tries to supply an existing engine of any kind with steam at that temperature will have a very unpleasant experience, even when using the above-mentioned oil.

The introduction of superheated steam into engines largely influences the expansion of the heated parts. Engines always gave great trouble when the distribution of metal in the cylinders was not uniform, as parts with more metal expanded most, and forced the cylinder walls towards the inside and made the cylinder out of shape. When using liners in the cylinders, they were squeezed in at the ends, decreasing the diameter, and jamming the piston body if sufficient clearance was not provided. With steam jackets heated with steam of 500deg. F., the lubrication ceased as the cylinder walls became too much heated, consequently it was found necessary to do away with jackets, or if jackets were already provided, not to pass steam through them. Pistons constructed on the Ramsbottom type always worked satisfactorily, except in the case of pistons fitted with steel springs when they were in contact with highly superheated steam. Any kind of gunmetal gets brittle after a very short time, therefore valves, seats, and all parts in direct contact with superheated steam, must be made of cast iron or other suitable mixture. Copper also loses about 40 per cent. of its strength at that temperature, consequently copper bends in pipes are not practicable. The best material for piping has proved to be wrought iron and steel, each pipe being as long as possible, to have the least number of flanges. For long, straight pipe connections, provision must be made to meet the expansion, which is, at 700deg. F., 0·0037 of the length, so that, for example, 100ft. of pipe extends 0·37 of a foot, or nearly 4½in.

Glands and stuffing boxes at first frightened users, so the engines were constructed single-acting to avoid the use of glands, but no serious difficulties have arisen on that account. It is advisable to place the stuffing box as far as possible from the cylinder end to keep it well away from the hottest parts, and to allow of as much radiation as possible. Sufficient clearance in the neck bush should be made to allow for the expansion of piston rod, and no metal with a melting temperature below that of the steam should be used.

Valves and valve gears are influenced in the same way by superheated steam. Valves containing many ribs or different thicknesses of metal (in section), such as plain slide valves or Corliss valves of the usual construction, are not suitable for high temperatures. A Corliss valve of medium size will stand 480deg. to 500deg. F., but no more, and the latter temperature very seldom. The smaller the plain slide valves are the higher temperature they will stand; large slide valves will hardly stand even slightly superheated steam if no provision is made for forced lubrication of the valve face.

Piston valves have proved to be most suitable for the highest temperature, owing to their uniform distribution of metal, but even with this sort of valve certain experience is necessary to get them in good working order. With ground valves the ribs holding the boss for the valve spindle must not begin within the working surface of the valve, but have to be placed beyond that, because they expand and make the valve polygonal. The valves must be ground in other liners to those in which they are to work in the engine; the former liners have to be smaller in diameter to secure more clearance to provide for the expansion of the valves: all ribs must be placed beyond the working surfaces of the valve. The cylinder expands in length more or less than the steam-chest, causing thereby deformation of the latter, which must be carefully considered in design. It is best to work the valves in liners fixed in the cylinder and with a small clearance, sufficient to allow for the deformation of the steam-chest. With this construction it is of course necessary to make steam-tight joints between the several ports, and this is best done by stepping the liners and seats and using narrow asbestos rings for each step. The liner is then forced on to the small seats by set screws in the cover, these asbestos rings making a lasting joint. Long valves cast in one piece become scored, whether they are cooled from inside with exhaust steam or not, consequently all valves should be made as short as possible. Rings and springs in valves cannot be recommended, as the steam comes behind the rings and increases the pressure, causing friction, and therefore increased oil consumption. As it is impossible to rely on tightness of piston valves, they must be made as small in diameter as possible. It may be stated here that superheated steam can travel at 30 to 40 per cent. higher speed through steam ports than saturated steam, and this fact has to be considered during construction. Two piston valves working one in the other, as the Rider or Meyer valves, are impracticable for superheated steam. If engines of that type are intended to be worked with superheated steam, each valve must work in a separate chamber. Double-beat valves can also be recommended as being safe, but they require a special arrangement, which is not always obtainable with every gear. Very often it happens when warming up the engines that the valve spindles get hotter than the gland boxes, and on starting the engine the friction between spindle and stuffing-box is greater than the power of the spring, and if the valves are not positively driven, they remain open during the full stroke.

An engine constructed in accordance with the principles just explained, is as safe with superheated steam as any other engine with saturated steam. From the experience over several years, it is not necessary to be bound to single-acting engines. Besides the economy, the use of highly superheated steam has some other advantages which are also important. It makes the steam consumption nearly independent of the size of engine, as a small engine has about the same steam consumption as a large one; as for example, an 80-h.p. compound condensing engine uses 10·45lb. of steam at 160lb. pressure, and a 1,000-h.p. engine uses 9lb. of steam per indicated horse power per hour. The use of highly superheated steam does not require high boiler pressures—160lb. is the highest to be recommended, as no advantage can be derived by exceeding this. As the amount of heat transmitted from the steam to cylinder walls, and *vice versâ*, is much lower with superheated steam than with saturated steam, the whole range of temperature from boiler pressure to vacuum can take place in one or two cylinders, so that the use of a triple-expansion engine does not make the slightest improvement in economy. It is not intended to be understood that the author proposes to do away with all triple-expansion engines for very large plants; their use will be necessary for constructive reasons.

With regard to economy obtained from engines working with superheated steam, the gain is derived from the larger volume of steam and the doing away with initial condensation. Generally the steam consumption of modern engines working under good conditions may be taken as follows: Single-cylinder condensing engines, with saturated steam and a pressure of 90lb. to 100lb. per square inch, use 19lb. to 25lb. of steam per indicated horse-power per hour, corresponding to 373 to 490 B.T.U. per minute. The great difference in temperature between admission and exhaust steam causes much waste by initial condensation, and consequently this type of engine especially favours the use of superheated steam. With superheated steam

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the consumption has been lowered to 13½lb. to 15lb., corresponding to 290 to 335 B.T.U. Non-condensing single-cylinder engines gave consumptions of 15lb. to 18lb of steam per indicated horse-power per hour, which is about the same consumption as an average compound condensing engine with saturated steam. The non-condensing compound engine decreases the consumption to 14lb. to 16lb. per indicated horse-power per hour. The compound condensing engine is the most economical, and the economy obtained can hardly be reached by a quadruple-expansion engine working at a pressure of 300lb. The steam consumption of such an engine either compound or tandem, at 140lb. pressure only, never exceed 10lb. per indicated horse-power per hour, and usually remains below, many tests having proved 8·5lb. and 8·8lb. consumption per indicated horse-power. To utilise better these temperatures, and to work with various loads with safety and nearly uniform economy, Mr. Schmidt has introduced the receiver heater with automatic valve. The idea is to keep a steady mean temperature of cylinder walls not higher than will make the lubrication unreliable for different rates of expansion.

A few words may be said with regard to the cost of a superheated plant. Superheated steam-engines use on an average 30 to 40 per cent. less steam than saturated steam-engines of the same type. Consequently boilers can be made 30 per cent. smaller, and the difference in price will nearly cover the cost of the superheater. For the same steam consumption the superheated steam-engine is cheaper, as it may be worked with a lower boiler pressure, and it is simpler—*i.e.*, instead of a compound engine with saturated steam, a single-cylinder engine with superheated steam may be used, giving the same or better results than the former. With regard to oil consumption, it was found not to be more than that of an ordinary saturated steam-engine. For example: a 120-i.h.p. engine used in 24 hours 4lb. of oil, and a 300-i.h.p. Corliss compound engine 2·2lb. in 10 hours for both cylinders.

In view of the great advantages of steam superheating, and the great number of engines running at present satisfactorily, it is astonishing that a few failures have caused prejudices amongst some engineers, who make the general introduction of the use of superheated steam very difficult. It will be worth mentioning that the result of a great number of trials have always proved a great saving in steam and coal, and even with small plants and simple piston-valve engines, almost the same good economy is obtainable as with large engines with most exact valve gears. It is therefore recommended that superheated steam should be used in connection with *all* engines; the only question to be settled is the degree of superheat, which largely depends on local circumstances and the construction of the engine, and this matter should be left to the judgment of an experienced engineer.

THE WINN WATER-GAUGE.

We are able to bring before our readers the following details of automatic water-gauges for boilers and engines, which are being made by Messrs. Charles Winn and Co., of Birmingham. The feature in these gauges is the automatic closing of both steam and water outlets in the event of the glass going. The arrangements for this are such that no false reading of the gauge can be obtained. Moreover, the automatic valves in no way interfere with the free working of the gauges, and form no obstruction to a test or cleaning rod being passed into the boiler through straight passages, which is an important feature frequently overlooked in other so-called "safety" fittings. The valves (Fig. 1) are attached to their respective inspection plugs in such a way that although perfectly free to seat themselves on the glass breaking, they are removed with the plugs to which they are attached, and, therefore, not liable to be lost. The safety arrangement in the top or steam arm differs in construction to that in the water or bottom arm. In the former it consists of a ball fitted freely upon a supporting spindle, and attached by means of a link and angle swivel to the top inspection plug, the link and spindle being of such a length as to cause the ball to lie against one or other side of the body clear of the steam passage (as shown in the cross-section view). In the bottom, or water arm, a large ball is fitted loosely upon a horizontal spindle, with the seating immediately below the glass. In the event of the glass breaking, both valves are instantly driven to their respective seatings by the rush of steam and water. The arrangements for blowing through are such as enable this operation to be performed without interfering with the automatic valves. To provide for blowing through the steam arm only, the water arm being shut off and the drain open, a by-pass is arranged in the steam arm in such a way that, by reversing the handle from the working position, a clear blow through the glass is obtained. In respect to the protector (Fig. 2) this is of novel design, hinged at the front so that it can be removed from the gauge (also the plate glasses, which are ½in. thick, can be taken out of the frame of the protector) in an instant without the aid of any tools whatever, the whole operation being performed by opening the clips with the fingers. Both the top-glass and bottom-glass packing nuts can be adjusted with the protector in position, which is a great advantage, for, as is well known, gauge glasses frequently fail during this operation. The protector has four glasses and almost encloses the gauge glass, but has an opening approximately ½in. wide at the back to prevent any accumulation of pressure.

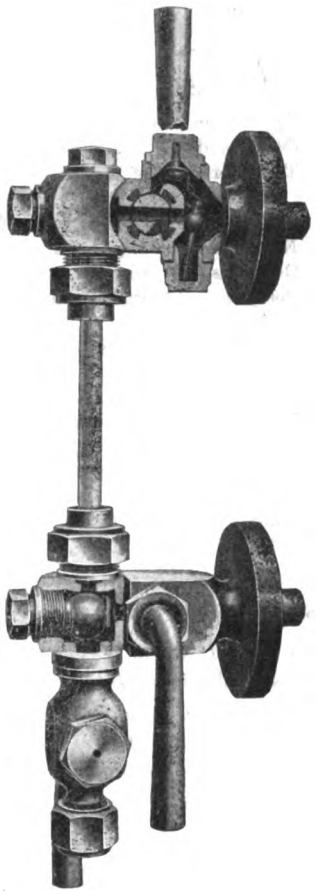

FIG. 1.—Sectional View of the Winn Water Gauge with the Guard Removed.

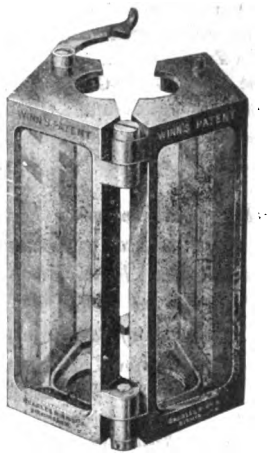

FIG. 2.—The Detachable Guard of the Winn Water Gauge.

FORTHCOMING EVENTS.

FRIDAY, OCT. 25.

Institution of Junior Engineers.—At 8 p.m., at Westminster Palace Hotel, annual general meeting for presentation of report of council and election of officers for twenty-first session.

SATURDAY, OCT. 26.

Manchester Association of Engineers.—At 7 p.m., ordinary meeting. Paper: "American *v.* English Methods of Conducting Engineering Establishments," by Mr. Edward Wood.

TUESDAY, OCT. 29.

Arbitration.—At 11 a.m., at the Offices of the Board of Trade, Whitehall, S.W., opening of enquiry as to the system of electric traction to be adopted on the "Underground" Railway.

THURSDAY, OCT. 31.

Chemical Society.—At 8.30 p.m., ordinary meeting.

Hackney.—At 3 p.m., opening of Corporation electricity and refuse destructor works at Milfields-road, Lower Clapton.

Exhibition.—Opening day of Exhibition of Scientific Instruments, under the auspices of the London School Board, at the Examination Hall, Victoria-embankment.

FRIDAY, NOV. 1.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Sir John Jackson, F.R.S.E., will deliver his presidential address.

Institution of Mechanical Engineers.—At 8 p.m., adjourned discussion on "The Second Gas-Engine Research Report," by Prof. Frederic W. Burstall.

SATURDAY, NOV. 2.

Electrical Engineers' Volunteers.—At 8 p.m., smoking concert at Headquarters.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BAITING THE PUBLIC.

Fishermen understand the art of baiting perhaps better than any other class except the promoters of public companies. Just at the present moment, we should say, another company connected with "wireless transmission" is in process of incubation. The process is extraordinarily simple, but, wonderful to relate, is ofttimes successful, at any rate so far as the promoters and their plunder is concerned; then the unfortunate shareholders—but that is another question. The recipe is something after this style. Given a successful invention, experts or other men immediately try to get round that invention by another patent. These second comers may or may not know something of the science they are attempting to apply: they generally are very ignorant of the whole subject. By-and-by they rig up some apparatus and show some effects. It would be surmised that when these practical effects are obtained, the technical Press would be the first to be invited to witness all the wonderful things said to be done. But such a course of proceeding would by no means suit the book of the promoter, and instead of members of the technical Press being invited to "Come and bless," it is the members of the untechnical Press who are invited, and they are primed physically and mentally with pabulum which for the body may be strong, that for the mind is usually exceptionally weak. The results they see they are told are only first fruits, yet sufficiently satisfactory to prove the inventors to be on the right track, and with careful attention to details to be certain of a magnificent success. Then come the glaringly unscientific articles and reports in the daily and weekly papers, all redolent with the cramming the writers have received, and all good for a sentence or more in the prospectus which is to follow. There is the inevitable statement that the patentee or patentees came across phenomena they did not understand, and that this led to subsequent investigation, and, of course, in the end to the wonderful discovery. Well, in ninety-nine per cent. of cases the phenomena witnessed are well known to every real student, but many said to have been seen, in these astounding articles, are absolutely impossible, so far as our present knowledge of science enables us to judge. Thus, so far as science knows, it is absolutely impossible to obtain energy out of nothing—all we can do is to transform one form of energy into another form of energy; yet patentees persist in stating the contrary, and political newspaper writers are flagrant examples of ignorance upon this fundamentally important topic. We are led to make these remarks because of a variety of notes and articles upon a so-called important discovery in "wireless transmission for electrical energy." We say "so-called" advisedly because there is nothing as yet which we have seen in these articles that is new or that is important. The articles may not all be headed with exactly the same words. We take the heading of one of the longest. We are not going to decry the possibility of invention, nor even the possibility of an outsider inventing or improving on what is already known. What we do declaim against and emphatically condemn is the ignorance of the writers in the non-technical Press who, unintentionally or otherwise, play into the hands of wily company promoters, ofttimes to the great detriment of the public. During the past fifteen or twenty years scores, if not hundreds, of patents have been taken out for things well understood half a century ago, and many of these are electrical patents, and bear internal proof that the patentees are unacquainted with even a cursory knowledge of the subject. Unfortunately, a technical journal gains no repute in warning the public

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against wild-cat schemes; it gets no thanks either from the speculating part of the public or from the promoting fraternity; but putting this on one side, it has a duty to living and dead investigators, and is well within its privileges when stating that a mass of laudatory puffs give the scientific man no new information, and describe nothing that is not part and parcel of common knowledge.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LIGHTNING CONDUCTORS.

SIR,—In the first and second answers given in your issue of 18th inst. *re* objection to sharp bends in lighting conductors, reference is made to the damage done to All Saints' Church, Nottingham, by "side flash" from the conductor through the masonry of the tower to the gas-pipe. In these answers due prominence is given to the inductance of the conductor, but one circumstance which I venture to consider as by no means immaterial is omitted. In a lecture I gave before the members of the Clerks of Works and Builders' Foremen's Association at the Municipal Technical School, Birmingham, some years ago I, after describing this occurrence, stated that the lightning conductor was run from one of the corner pinnacles of the tower to the ground, where it terminated by being *coiled round a stone buried a few inches in dry soil*. A similar case occurred, I believe, at Newark, in this instance the end of the conductor being led into a gravestone. I shall be pleased to have the opinions of your correspondents as to whether it was inductance or absence of good earth that caused the damage in these two cases.—Yours, etc.,

Birmingham, Oct. 22, 1901. W. H. WHITEHOUSE.

[Without a doubt the bad earth connection referred to by Mr. Whitehouse may have played some part in the Nottingham case, but it is extremely difficult to estimate how far the consequent high resistance was more directly the cause of the side flash than the inductance of the conductor. Seeing that a wall 4½ft. thick was pierced, we are inclined to doubt if the discharge took the path of least resistance —ED. *E. E.*]

THE APOTHEOSIS OF THE WORKING-MAN.

BY R. D. SUMMERFIELD.

Time was when the working-man, using the term in the conventional sense, was a working-man pure and simple. He had no voice in the government of the country, or of the town or village where he lived; no one asked his opinion about anything, and he was contented to work long hours for small wages, doing his work to the best of his ability, and not aspiring to be anything but a good workman. With the advent of trades unions, however, men began to become discontented with their lot, and they soon found that if a sufficient number of men in any one trade refused to work, and could hold out for a few weeks, the employers were compelled to accede to their demands for shorter hours or higher wages; they took, in fact, the only means they knew of to better their condition, and no one can blame them for doing so, except that the means they took in the early days of strikes were too often violent and destructive. From those early days right up to the present time strikes have nearly always been in progress among one or other of the trades of this country, the concrete result being a large increase in wages and a considerable shortening of the hours of labour. Of course the higher wages are not due entirely to strikes, as cheaper money has a great deal to do with the matter; nor are short hours the outcome of strikes alone, as the general tendency among all classes of workers, from the highest to the lowest, in highly civilised countries is towards shorter hours of work and more frequent holidays.

When working-men were given votes, however, they got a better weapon than strikes, as they got the great body of politicians on their side—at election times, at any rate. Who ever heard a candidate for Parliament (no matter what his political opinions) make an ordinary election speech of which nine-tenths did not refer directly or indirectly to "the working classes." At such times the cry is "education for the working classes," better housing, cheap trains, cheap beer, etc., for the working classes, and when the candidates become members of Parliament they are obliged to redeem some of their promises, if only in view of the next election, with the result that the working-man—by which term I mean more particularly artisans, or workers in metal, wood, brick and stone, etc., and not the workers in lower-paid employment—have come to be a most pampered class, as a little consideration will show. They pay no taxes yet, their children are well educated in palatial schools at other people's expense, reading-rooms, libraries, picture galleries, museums, parks, and recreation grounds are provided for them free, and baths and wash houses at nominal fees, and a paternal Government compels employers to carefully fence in all moving machinery, and to pay substantial compensation to their workmen if, through their own carelessness, they sustain any injury while at work. The railway companies are also obliged by law to carry the working-man to and from his work at the rate of ½d. per mile, or even less, the third-class carriages used for ordinary passengers being placed at his disposal. The clerk or shop assistant, who gets no more and probably less money than the workman, and who makes less mess of the carriages, has to pay the full fare because he goes to business an hour or so later. In many towns early trams are run for the convenience of workmen at half the ordinary fares. If the workman prefers to live in town, however, he will find blocks of model dwellings, erected for his use by philanthropic persons close to his work, where he can obtain three or four rooms fitted with modern conveniences at a very moderate rent. If the workman falls ill, or gets injured in an accident, he has free hospitals to go to, where he will receive, especially in London, the latest treatment at the hands of skilled specialists, and this applies equally to his wife and children.

If with all these advantages the character of workmen as a class had steadily improved one would have nothing to say, but it is to be feared that this is not the case. Are workmen more honest, more polite, more self-dependent than they used to be? They may be; but if they are, they certainly are still a long way from perfection. The writer has come across scores of cases of workmen stealing each other's tools, clothes, food, and money, and he believes that the majority of workmen, especially London workmen, would scamp their work if they thought it would escape notice. On the score of manners and language, there is no need to say anything, while as for independence, the British workman is as keen after tips as a waiter or railway porter. Most engineering pupils can bear this out, and any mill owner who has had new machinery installed. Although the workmen alluded to by the writer earn in London and some other districts from 35s. to 38s. per week at least, and in some cases, such as with certain classes of moulding, turning, and forge work, etc., as much as £5 and £6 per week, they do not practice thrift to anything like the extent they might do compared with their French or German brethren. It is hardly the right kind of thrift, for instance, to draw £60,000 out of the savings banks, as we read of the Oldham operatives doing, in order to go holiday making. Invested at 4 per cent., this sum would yield old-age pensions of £1 a week each to 46 men.

The writer has no quarrel with the working-man; he has pleasant recollections of many a good-natured mechanic he worked with while going through the shops, but he is of opinion that the prosperity of this country does not depend upon what are termed the working classes—in fact, rather the reverse, and that too much attention is paid to their opinions and demands, a state of things largely brought about by the speeches of self-seeking politicians. There are many classes of people in England who are more in need of the help of philanthropy and legislation than the artisan, and about whom we hear practically nothing, and it seems to the writer that the workman, having been brought to his

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present comfortable position, might well be left to work out his own further salvation, and attention turned to his poorer paid and more hardly used brethren.

ELECTRO-CHEMICAL INDUSTRY.*

BY J. W. SWAN, F.R.S.

(*Concluded from page 312.*)

The Outhenin-Chalandre cell consists of a bell-shaped anode chamber of suitable material, into the sides of which a large number of porous tubes are fixed in a position slightly inclined from the horizontal. These tubes act as diaphragms, and contain the sheet-iron cathodes. The caustic soda solution formed at the cathodes passes to the lower ends of the tubes, and then collects at the bottom of the cell by gravity. The Le Sueur cell contains a horizontal diaphragm, with the anode compartment on the upper side. According to Weightman, the diaphragms are of asbestos, and last from three to six weeks. Each cell takes 890 amperes at six volts, and has a current efficiency of 70 to 80 per cent. Although the principle of cell construction in which gravity is allowed to effect the separation of the sodium hydrate formed at the cathode, and in which, therefore, a diaphragm, or mercury, is dispensed with, has been discredited by the failure of the Richardson and Holland process at St. Helens, yet a cell on that principle is said to be working with satisfactory results at Aussig, in Austria, and, according to Hausserman, this works is producing alkalies and bleach at the rate of 2,640 tons per annum. A recent laboratory research by Adolph has shown that, under carefully regulated conditions, a current efficiency of over 80 per cent. can be attained in these cells with continuous work; and, as the saving in cell construction and E.M.F. is considerable, it is possible that "gravity" cells may once again come into use. There are now 23 electrolytic alkali works in operation in Europe, disposing in the aggregate of 50,000 h.p. I have figures in my possession for the production of many of these works, but in some cases I am not allowed to make use of them for publication.

Hypochlorites.

As regards the production of hypochlorites, limits of space will only allow me to state that there are a very large number of firms in Europe using electrolysis for production of bleaching solutions containing sodium hypochlorites. The cells are patented under various names, and differ in details of construction, but the principle of the method employed is common to all, and depends upon the chemical action that takes place when chlorine gas is passed into a solution of sodium hydrate at a temperature below 20deg. C. The solution obtained may contain up to 10 grm. available chlorine per litre. Bleaching liquids prepared in this way are being utilised in the textile and wood-pulp industries of the Continent to an increasing extent. The installations are in many cases small, and it is impossible to obtain details of all; but I am informed that 1,600 h.p. is being utilised in Southern Germany by one form of apparatus alone, so that the aggregate power utilised by the six different types must be comparatively large. One of the most notable installations of this kind is at Lancey, Isère, where Messrs. Corbin and Co. are employing 700 h.p. for the bleaching of cellulose, using their own form of apparatus and cell. The Kellner-Partington Paper Pulp Company have also a large installation at Sarpsfos, in Norway.

Chlorates.

The production of chlorates by the electrolysis of solutions of potassium or sodium chloride is one of the older electro-chemical industries, Gall and Montlaur having commenced to manufacture chlorates in this way on a small scale at Villers-sur-Hermes, in France, in 1889, and on a large scale at Vallorbe, in Switzerland, in 1890. There are five different types of cell now in operation for the production of electrolytic chlorates; but, as in the case of hypochlorites, the principle of the method employed is the same in all these cells, and the differences are simply in details of cell construction. The diaphragm principle is still employed in the original process of Gall and Montlaur, but elsewhere this feature appears to have been abandoned. The number of works producing chlorates by the electrolytic method is now ten, seven of these being in Europe, and 28,000 h.p. is available for this manufacture. The prices of chlorate have fallen greatly since the electrolytic process was adopted on a large scale. Whereas 10 years ago chlorate of potash was selling at 6d. per lb., it is now quoted at only 3½d. The manufacture having become less remunerative, some of the electrolytic chlorate factories are being used for other products. Table VI. in the appendix gives all the available information relative to power and output in condensed form. Before leaving this branch of my subject I may state that the manufacture of ammonium persulphate and perchlorate has now become a sub-branch of the electrolytic chlorate industry, and I am informed that these chemicals are being produced by Messrs. Corbin and Co. at Cheddie, and by the Swedish Company at Mansboe. In this case electrolysis has given a convenient method for producing compounds of high oxygen value on a commercial scale. These products are used in photography, and in the manufacture of some of the modern high explosives.

Organic Products.

Besides the larger uses made of electricity in connection with the chemical processes I have spoken of, there is considerable experimental activity in the field of organic chemistry. Up to the present time it cannot be said that any very large or important section of the field is being successfully cultivated, but there is actual achievement of a substantial kind. In proof of this I give the following list of organic compounds, all of which have been produced in the chemical laboratory by aid of electrolytic methods. The first five have been produced in this way, I am informed, on a commercial scale, but I am not in a position to positively state that their manufacture by electrolysis is still continued: iodoform, vanillin, chloral, azo and hydrazo compounds, oxidation products of fusel oil, dyes of triphenylmethane type, aniline blue and aniline black, Hofmann violet, alizarine, Congo red, oxidation products of the alcohols, sulphonic acids, piperidine, dihydrochinoline, benzidine, amidophenol. As these products are nearly all of industrial importance, it is possible that some of these methods may eventually be adopted for regular use. Messrs. Shering, of Berlin, the Badische Anilin und Soda Fabrik; Meister, Lucius, und Brüning; and the Farbenfabrik vormals Fried. Bayer und Co., are all, I believe, using electrolytic methods, but definite information upon this point is lacking. In all factories where organic products are made on a large scale, chromic acid is the usual oxidising agent. Meister, Lucius, and Brüning are now using an electrolytic process for renewing exhausted chromic solutions, and this process is said to have many advantages. The electrolytic production of inorganic colouring matters has not developed into a recognised industry, but I am informed that there is a firm at Cologne producing white lead and other chemicals of this kind by electrolysis. Unfortunately, I have not been able to obtain any details as to the extent or character of these products. In relation to the subject of electrolytic colour-making, it is an interesting reminiscence that so long ago as 1852 a patent for the production of colours as by-products in connection with the generation of electricity in a new form of voltaic cell was granted to Watson and Slater, and that about 1880 Goppelsroeder showed that indigo could be produced at the anode and reduced at the cathode of a voltaic cell.

Ozone.

The odour that pervades the atmosphere during a thunderstorm, due to the formation of ozone, is one of the most ancient of observed electrical phenomena. It is not surprising that, with the large means we now possess of generating electricity and ozone, uses should have been sought and found for this powerful oxidiser. Accordingly we find that in the field of organic chemical manufacture it has been utilised with great effect, especially in the transformation of oil of cloves into vanillin and into heliotropine, also in bleaching operations in conjunction with hypochlorite of soda. Vanillin is produced by ozonisation of iso-eugenol in acetic acid solution, and some of our members will no doubt remember with pleasure their visit last year to the works near Paris where this process is carried out. I am informed that the quantity manufactured yearly of these two valuable substances amounts to 10,000 kilos, and that 350 h.p (steam) is used in their production. The ozoniser used at this works was designed by Nerley. There are numerous types of ozone apparatus in use, and Otto, Marmier and Abrahams, Siemens and Halske, and Andreoli have all patented particular forms that have received practical trial. Among the more important uses proposed for ozone, the sterilisation of water must be mentioned as occupying the attention of hygienic engineers. The principle of water sterilisation by ozone has been definitely adopted for the water supply of Lille. The decoloration and defecation of syrup in the sugar manufacture, and the rapid production of the effect of "ageing" on alcohol, are among the many other uses proposed for electrically-produced ozone.

The Fixation of Atmospheric Nitrogen.

In close relationship to the electrical generation of ozone from atmospheric oxygen, is the important question of the production of nitric acid from atmospheric air. At a Royal Society soiree in 1892 Sir William Crookes exhibited the flame of burning nitrogen; and in the address given at the Bristol meeting of the British Association in 1898 he pointed out the great possibilities latent in atmospheric air as a source of nitrates for the fertilisation of the soil. Basing his calculations on figures given in a paper read before the Chemical Society by Lord Rayleigh in 1897, Sir Wm. Crookes found that 14,000 B.T.U. would yield sufficient nitric acid to form one ton of nitrate of soda; and that at Niagara this quantity of power would not cost more than £5. Since then Messrs. McDougal and Howles have made further experiments, and obtained even better results. A full account of these experiments will be found in a memoir communicated to the Manchester Literary and Philosophical Society last year (No. XIII., vol. 44, part 5). The following is an abstract from that paper, which gives the best results so far obtained: "An experiment was conducted with a mixture of oxygen and nitrogen in the proportion of 2 to 1. The gaseous mixture was passed through the apparatus at the usual rate. A quantity of acid almost double that previously obtained (that was when atmospheric air pure and simple was used), amounting to 590 grm., was produced." With the same power and time—viz., 12 horse-power hours—Lord Rayleigh's result was only 440 grm. The manufacture of nitrate of soda in this way is still undeveloped industrially. The idea is nevertheless alluring, for surely chemical science and chemical industry can be put to no higher or fitter use than to help to increase the fertility of our fields. Those immense sources of motive power, the waterfalls of the world, which are now for the most part running to waste, require some great employment such as this, the production of nitric acid. If the quantity of nitric acid produced per kilowatt of power expended can be increased yet a little further—and such a development seems to be far from hopeless—this immense application of electricity would become profitable. The subject is certainly worthy of the serious attention of chemists.

The Electric Furnace.

I now come to a section of the subject of more recent date, and one that has forced itself into a position of great importance with surprising rapidity—the section in which, not the electrolytic, but the

* The presidential address to the Society of Chemical Industry delivered at Glasgow on July 24.

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thermic power of electricity is operative. We are largely indebted to the initiative of Sir William Siemens for the idea of turning the heat effect of electricity to practical account, so as to obtain chemical effects not otherwise possible. Sir William Siemens exhibited his electric furnace in action before the Society of Telegraph Engineers in June, 1880, and lucidly pointed out its many advantages. The employment of electricity in this way to generate extremely high temperatures has, within the last 10 years, been greatly developed. Yet it may be anticipated with much confidence that the industrial use of the electric furnace has not nearly reached its practical limit, although for the moment there appears to be a check along at least one of the lines of operation, the result of over-haste and excessive production. But in several directions progress is still being made. Regarded from a narrow point of view, to carry on a chemical process by electric heating seems, at first sight, of all methods the most wasteful. As we all know, in generating heat electrically, so many energy-expending transformations have to be passed through that only a small fraction of the whole energy expended is finally effective in the furnace. Where the electrically-produced heat is derived from steam power, there are, at the outset, the losses incidental to the transformation of heat energy into motive power. These losses amount to 85 per cent., and often more. Before the remaining effective 10 or 15 per cent. is electrically re-transformed into heat through the operation of a dynamo other losses, mechanical and electrical, have to be incurred, so that before the end is reached a still smaller fraction of the actual energy of the coal remains to be finally utilised. Hence from a superficial consideration of the question it might well be concluded that to carry on large chemical operations economically by electrically-generated heat was of all hopeless projects the most hopeless and extravagant, but on a close examination of the case it will be seen that there are many compensations for these great losses, the chief one being that when at last you have obtained your electrically-produced heat, you obtain it in a form so convenient for applying to the exact place where it is wanted that in many cases the wasteful mode of production is more than compensated for. For example, in the reduction and distillation of zinc by the process in general use it is not uncommon to consume five tons of fuel in producing from the ore one ton of metal. If the statement lately made in a foreign journal in relation to the electrical extraction of zinc be true (and I see no reason to doubt it), only two tons of fuel would be required if the power had been generated by an economically working steam-engine employed to generate electricity, to be afterwards transformed into heat and properly applied to the reduction of a mixture of calcined ore and carbon in the electric furnace. In the presidential address delivered before the society two years ago by Mr. Beilby, the great waste of heat common in our factories and in our houses was clearly pointed out. Wasteful of energy as the transformation of motive power into heat through electricity is, it is not so wasteful as are many of the ordinary chemical and metallurgical operations. The electric furnace not only has the merit of making very good use of the heat developed in it, but it has the further merit that much higher temperatures are attainable than in ordinary furnaces; consequently a new group of high-temperature products has been brought within the range of industrial use by its means.

Electric Furnace Products.

The most conspicuous members of this new series of electro-chemical products are calcium carbide, carborundum, and artificial graphite. All these demand temperatures for their formation so high, that their industrial production is only possible by means of the electric furnace. There is also another class of electric furnace products assuming importance at present, the class which, while not demanding the highest temperature of the electric furnace, yet requires a temperature exceedingly high; and in reaching, maintaining, and applying it, electric heating has several advantages. I refer to the reduction of the more refractory metals and their alloys. In the hands of Moissan the electric furnace has proved a most effective instrument of chemical research. The results of his operations, as set forth in his treatise, "Le Four Electrique," and as illustrated at the Paris Exhibition by the large and splendid collection of new and rare products, were in striking contrast to the simplicity of the apparatus by which the results were achieved. Calcium carbide, carborundum, and artificial graphite are, in their origin, as industrial products, all more or less accidental results of the experimental operation of the electric furnace. The way in which the new industries, the manufacture of carborundum and artificial graphite, have been built up in America by Acheson deserves our unstinted admiration. Useful as artificial graphite has already been found to be in electrolytic operations, it would not be suprising if even more important uses for it were yet to be found. Prof. Chandler in his address last July gave details of these two very interesting industries. Chromium, tungsten, molybdenum, and titanium, and their alloys with iron are through the electric furnace now for the first time producible in such quantities and with such economy as to allow of their entering into the larger schemes of the mechanical engineer.

Calcium Carbide.

After electrolytic copper refining, there is no branch of electro-chemical industry so large as that of calcium carbide. I am credibly informed that the European production in 1900 was about 60,000 tons, and that works exist with power to produce three times this amount if the demand and price warranted such an increase of production. In nearly every case the power by which the electric heat is generated is derived from water, and considering the smallness of British water power, the manufacture of carbide is a matter of less interest to ourselves than to some of our foreign *confrères*. The only considerable production of calcium carbide in Britain is at Foyers, where there is a factory for the production of between 2,000 and 3,000 tons a year. As a convenient means of generating acetylene, calcium carbide is interesting to all technical chemists, and it is not improbable that it may play an important part as a reducing and carbon-carrying agent in metallurgy. Of late there has been most serious disproportion between the supply and the demand, with the result that only those factories that are most favourably situated in relation to cost of power and raw material, and also cost of carriage of the product to the place of consumption, have been able to carry on the manufacture with profit. Calcium carbide is one of those products not well able to bear long and difficult carriage. Not only has the immediate cost of carriage to be considered, but also troublesome restrictions of freedom of transport. These restrictions tend to embarrass and lessen manufacture. The anticipations of an almost unlimited demand have not been realised, and there are in consequence many carbide works idle, with water running to waste, and fully-equipped power plants ready to be applied to some more immediately profitable use. Such use may possibly be found for some of them in connection with an extension of the alkali and chlorine manufacture. New electro-metallurgical processes, such as those for the production of steel, ferro-manganese, ferro-chromium, ferro-silicon, or other alloys of the more refractory metals, which are either already in demand or which promise to supply new requirements, may also be taken up by these works.

Chromium and its Alloys.

The production of chromium and of chrome-iron at Essen by means of the Goldschmidt-Vautin process—indirectly depending on an electro-chemical product (aluminium)—has already been mentioned. The Wilson Company in America have also been producing ferro-chrome alloy by a direct electric furnace method, and in 1898 they were stated to be making 60 tons of this alloy per month. Chromium is reported to be made at Bitterfeld in Germany, and also by several of the French electrometallurgical companies, but I have not been able to obtain any very reliable figures for the output of these works.

Ferro-Silicon.

Ferro-silicon is one of the newer class of alloys now being produced on a commercial scale by the electric furnace. At present the demand is small, and the production exceeds the requirements, but it is hoped that in time there may be a large demand for this alloy in connection with the manufacture of iron and steel. It has been proved that where there is no excess of carbon, silicon improves some of the physical properties of steel, and that its thermal energy is of value in steel casting. Ferro-silicon is at present being manufactured at Meran, in the Austrian Tyrol, and at other carbide works in France. Scrap iron, quartz, and coke are used as raw materials of the manufacture. The daily yield of each furnace is 1,200 kilos. The product contains 77·5 per cent. Fe and 21·5 per cent. Si, and costs at Meran £8 per ton. The yield in the electric furnace is one ton per 5,000 kilowatt-hours.

Ferro-Titanium.

The manufacture of ferro-titanium is carried on at Niagara. Scrap iron, titaniferous ore, and aluminium are heated together in a resistance furnace, and the product is sold for use in the manufacture of iron and steel. Demand for this alloy has to be created, but it is expected that in time a large industry will be developed.

Steel.

One of the latest and most startling developments in the field of electro-thermal applications, is the proposal to use electricity in the manufacture of steel direct from the ores of iron. The Stassano process, which has already received experimental trial near Rome, is about to be tested on a considerable scale at Darfo, in Northern Italy, where 1,500 h.p. is available, and an output of 4,000 tons of steel per year is expected. In Switzerland, and in Sweden also, the application of the electric furnace to the direct smelting of iron ores is being discussed. In the latter country it has been stated that a works is in actual operation, and is producing 10 tons per day; but I have not been able to obtain any confirmation of this report. I may, however, say that it seems to me that in those countries where coal and coke are extremely dear, and water power, and hence electricity, are extremely cheap, it is conceivable that the electric furnace may in exceptional circumstances find a very limited economic employment in the reduction of iron ores.

Phosphorus.

The manufacture of phosphorus, the last electro-thermal industry of which I shall speak, is another case where an old process has been modified and improved by the use of electricity. I have not been able to obtain special information as to the production of phosphorus by works using the electric furnace method. As in the case of sodium, it is probable that in a few years the older method of manufacturing phosphorus will be entirely superseded. In 1899 Tatlock stated that one-half of the phosphorus production of the world (estimated at 1,000 tons) was produced by the electric furnace, and now every country of importance possesses phosphorus works depending on the use of electricity. In this country the Readman furnace is in operation at Wednesfield, and uses about 500 h.p. Electric furnace phosphorus works are also said to be operating at Niagara, Paris, Vernier, and Griesheim.

Miscellaneous.

There remain to be noted a few miscellaneous uses of the electric current, which fall outside the classification I have adopted. One of the most interesting of these is the industrial production of oxygen and hydrogen by electrolysis of water. Several forms of cell have been patented, and are in actual operation at Rome, Brussels, Montbard, Toulouse, Milan, Zurich, Lucerne, Hanau, and other places. In most cases a solution of sodium hydrate is used as electrolyte, with sheet iron electrodes; but in one instance a dilute sulphuric acid solution is employed with lead electrodes. The cost of the gases obtained in this way, of course, varies with the cost of power, but at Rome, where current generated at the Tivoli power station is utilised in this manufacture, one cubic metre hydrogen and ½ cubic metre oxygen are said to cost only 20 cents. As the cost of hydrogen genera

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from zinc and sulphuric acid is stated by Schoop to be 2s. per cubic metre, the gain in economy is striking. Electrolytic hydrogen gas is used for inflating military balloons, and the two gases together are used for blow-pipe and furnace work of all descriptions. The application of electricity to tanning has been much discussed, but, so far as I can learn, only one system of electric tanning, that of Groth, is now in actual use. Groth's process is in operation at Wernersborg, in Sweden, and at Wem, in Shropshire. The system combines mechanical movement of the hides in the tanning pits with electrolysis of the tan solution. Other large tanneries in Germany, Russia, and Austria are stated by the inventor to be about to adopt his system. The present capacity of the plant at Wem is 200 hides per week. The gain in time varies from half to two-thirds of that required by the older method, but some doubts still exists as to the durability of the finished leather. Sugar refining by means of ozone has been already referred to. Other processes, however, have been tried (at Port Salut, in France, and Stefanowka, in Russia), in which the destruction of the colouring matters in the sugar juice is brought about by electrolysis of the syrup, with zinc or aluminium electrodes. The results as regards colour are good, but the economy of the method is not yet proved. Finally, I must allude to the use of electricity in the chemical laboratory. The following metals can be quantitatively determined by electrolytic methods: copper, nickel, cobalt, lead, antimony, bismuth, iron, zinc, cadmium, manganese, silver, mercury, tin, gold, platinum, and palladium. The first six of these metals are, in fact, more quickly and conveniently determined in this way than by the ordinary gravimetric or volumetric methods of analysis. Electrolysis can also be used with advantage to prepare standard acid solutions for volumetric analysis. Standard sulphuric acid is now being made in some laboratories by electrolysis of copper sulphate solutions. The chemical laboratory of the present day cannot therefore be considered fully equipped unless provided with the fittings and apparatus required for electrolytic work.

The Future.

So far I have spoken of the past and present; allow me now for a few moments to direct your thoughts to the future. We have seen that electricity has revolutionised the process of copper refining, made aluminium one of the common metals, and so far reduced the cost of sodium that new and large uses have been found for it, and dependent industries created. Electricity has successfully invaded the domain of the alkali and chlorine manufacture, and now threatens to encroach on the province of the blast furnace and the Bessemer converter, and to become an increasingly important factor in the reduction and treatment of metals in general. Are these achievements of the last decade of the nineteenth century but the prelude to still greater developments in the century upon which we have just entered, and will electricity become a yet greater power in the chemical and metallurgical processes of the future? This question requires earnest consideration; it involves interests of national importance, for chemical manufactures occupy, and have always occupied, a leading place amongst the industries of our country. One of the larger questions brought into view by the prospect of a more extended use of electro-chemical processes, with their immediate dependence on power for the generation of electricity, is that of the position of those countries which possess coal but do not possess waterfalls. Unfortunately, though we have an abundance of coal, we have very little water in the form available for the economical generation of motive power. Therefore the question comes home to us, whether with coal only we can carry on electro-chemical industries with profit, in competition with the countries which possess a large supply of easily engineered water power. The question is complicated in many ways. In the first place, it is necessary to find what is the cost of power developed by coal and what the cost of power developed by water. The cost in neither case is uniform; the cost of water power, and the cost of power generated by coal, both vary exceedingly, under different conditions. It is even a fact that water power in some cases (no doubt exceptional cases) is more expensive than the power obtained from gas or steam. The difference in cost in different circumstances is extremely great. From data gathered from many sources I find that there is one place (it is in Norway) where power is generated at a cost of 20s. per horse-power year. This cost is chiefly interest on capital expenditure on the works. But, on the other hand, there are cases where water power costs 10 times, or more than 10 times, this amount. The capital outlay at Lyons has been £84 per horse-power developed, as compared with £3. 9s. 3d. at Vallorbe, in Switzerland. Niagara power is a mean beween high and low water power costs; there the charge to large consumers is at the rate of £4 per electrical horse-power year. Difference of cost is equally wide in the case of coal-produced power. I am informed on good authority that there are steam-power plants in operation in the United Kingdom which yield the power at a cost equivalent to £5 per electrical horse-power year, and certainly there are many where the cost will be twice, and even four times that amount. Such figures are for power generation on a large scale (not less than 1,000-h.p. units), and also, of course, continuously and uniformly delivered. One other essential condition for obtaining a low cost for steam power is obviously low-priced fuel. In the case where the electrical horse-power year is said not to exceed £5, fuel cost only 4s. 10d. per ton delivered at the boilers; but notwithstanding the fact that under extremely favourable conditions electrical energy can be generated from coal at a comparatively low cost, the fact remains that the greater number of electro-chemical and electro-metallurgical plants are operated by water power, and returns sent to me show that 50 works in Europe have 149,000 h.p. available from water, 16,700 h.p. available from steam, and 250 h.p. from gas.

In considering the bearing of these facts upon the actual position, it is to be borne in mind that the last word has not yet been spoken as to the cost of power developed by coal. Great advances have in recent years been made in the direction of reduction of cost by improvements in the steam-engine, the gas producer, and the gas-engine. In the best modern steam-engines a heat efficiency of 15 per cent. is obtained. There is great reason for hope that help in the more economical generation of power for electro-chemical work may come from the further development of the gas-engine. Already much has been done both in the improvement of the gas-engine and also in providing it with cheap gas. Our honoured past-president, Dr. Mond, has made a valuable contribution in this direction. One of the drawbacks to the employment of gas-engines for large operations has been that they were not adapted for large units of power, but now engines of 500 h.p. and even 1,000 h.p. are manufactured, and work with successful results. Perhaps it is not wholly futile to enquire whether there is any other way of generating the electricity required for electro-chemical operations. The perfection to which dynamo-electric generators have been brought, both mechanically and electrically, is now so high that almost the utmost possible limit of economy in the transformation of power to electricity has been reached. When there is put in comparison with this most convenient and effective means of generating electricity mechanically the cost of obtaining the same results by the best chemical means now known, the question of displacing the mechanical method of generation, by the voltaic method, seems almost useless. The difference is extreme. In comparing the cost of electricity produced by mechanical and chemical means it has been usual to emphasise the difference between the cost of coal and of zinc. But even if the high price of zinc were not a hindrance and if zinc were as cheap as coal, or if it could be had for nothing, it would still be practically impossible to carry on the electro-chemical industries of the world by means of the voltaic cell as it exists to-day. The cost of the labour, and the complication of handling the gigantic cells, and keeping them in operation, would so far exceed the cost of producing electricity as we now produce it, that we should still continue to use the far more convenient water-turbine, and steam-engine, and dynamo, which yield us such great effects, with comparatively small apparatus, and with very little manual labour. But that somewhat sweeping statement does not wholly dispose of the question so far as it applies to the case in which cheap water power is unobtainable. We know that the best of our heat engines utilises but a small proportion of the potential energy resident in the fuel it consumes. Hence there is the possibility of a more economical way being found of transforming the heat energy of the fuel into electric energy, possibly even on the voltaic principle. But in order to obtain what is required that principle must be employed in a manner widely different from that hitherto attempted in the so-called carbon-consuming cells, or in any of the forms of cell where the electrolyte is a liquid, and the elements are plates that require renewal. I do not pretend to say how it can be done, or that it can be done in any way, but it seems to me that if there is a way in any direction it is in the direction of a gas-consuming cell. A bold attempt at the solution of the problem in that way was made some years ago by Mond and Langer, when they produced a gas battery, on the principle of Groves's gas battery, that yielded a considerable current in proportion to its size, and consumed nothing but hydrogen and atmospheric oxygen. Unfortunately, since one of the essential materials in its construction was platinum, the apparatus, whatever its other merits, was too costly to be of practical use. There is one other attempt of the kind which deserves to be remembered in this connection. I refer to the experiments of Kendall and his very ingenious gas cell, with fused glass as the electrolyte and hydrogen and atmospheric oxygen as the source of energy. Here, too, the high price of platinum was an insurmountable bar to its practical utility.

For the present, it is to be feared and realised that electricity cannot be generated in the British Islands by means of coal as cheaply as in those countries where abundant, accessible, and easily engineered water power is available; and hence it is necessary to consider what is best worth doing with the little water power and the more costly steam power or gas power at our disposal. Some of the new industries I have been discussing cannot be carried on with profit in our almost water-powerless island—those industries, I mean, which use a great quantity of power in proportion to the value of the product. An extreme example would be the electric furnace production of iron and steel, and the alloys of the more refractory metals. Such uses of electricity in this country are, in the present state of things, nearly out of the question, but I trust that gas-engines in conjunction with cheap gas may ameliorate the situation, and that at no very distant date blast furnace gases may be generally utilised for power production in conjunction with some complementary or auxiliary electro-chemical manufacture. We cannot do everything, but it is certain that within the limits of our capacity there is yet ample scope for the profitable exercise of our energies. There are many electro-chemical industries in which the ratio of cost of power to value of product is such that the cost of power, at a rate which we know to be attainable in many of our manufacturing centres, is not prohibitive. We must concentrate our attention on these. The alkali manufacture is in a state of unstable equilibrium. The electrolysis of brine from a commercial point of view must, under existing circumstances, be considered as a process for the production of chlorine rather than as a process for the production of alkali, because it is only to the extent equivalent to the chlorine required in commerce, either directly or incidentally to chemical operations, that soda can be manufactured by electrolysis as economically as by other means. Electrolytic soda must therefore be treated as the by-product, and chlorine as the principal product, of the electrolysis of chloride of sodium. It is with the Le Blanc process chiefly that it comes into competition, to the extent to which the muriatic acid is used for chlorine generation, and that, of course, is to a very great extent. The scope of the one process is limited by the same disability as the other—viz., the demand for chlorine in some form; and that demand is, according to Dr. Lunge, only about one-eighth part of the demand for the equivalent of soda. But yet that one-eighth is a very large quantity, and within that limit electrolytic production appears to have a fair prospect of commercial success, under favourable conditions. Chemical industry is, almost

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beyond any other industry, liable to change. Twenty-five years ago we possessed well-nigh a monopoly of the manufacture and export of alkali. The Clyde, the Mersey, and the Tyne were the supply markets of the world for this typical and indispensable chemical product. We well know that that state of things no longer exists. The causes of the transformation are many, and most of them in the natural order of things. Taking a large and liberal view of the subject, they seem to be in the direction of progress, and for the general good; and yet it is a kind of progress in some respects detrimental to our interests, and not to be contemplated with perfect equanimity. Among what I term natural causes is the spread of knowledge, and especially such knowledge as we are so effectively helping to diffuse—a knowledge how to build, equip, and manage chemical works. Then, too, there is general increase of wealth abroad, and great development of commercial enterprise. But one of the less satisfactory of the causes of change, from the point of view of the British manufacturer, is that non-natural, that quite artificial, cause—prohibitive tariffs, the force of the principle of boycott. But that is a difficult and many-sided question, which cannot be discussed on this occasion. I mention it because it is necessary to explain, or partly explain, the falling off of our exports in heavy chemicals. And I suggest that probably the want of the open door has been one of the contributing causes.

Then there is the great question of education in its bearing on the future prosperity of chemical industry and industry in general. It was refreshing to hear from our late president how thoroughly the advantages of technological teaching, and education of the highest kind, are appreciated in America, and how generously educational institutions are supported. Speaking in one of the lecture theatres of this great university, which has lately reverberated with the acclamations of the world in honour of its long and splendid services to education, I cannot but congratulate Scotland and the Scottish section of the society on the very advantageous position it occupies in this respect. In England and Ireland we are suffering acutely from dire educational neglect and destitution, and that worst kind of poverty, insensibility to our deficiencies. Our English system of scientific and technical education is not equal to the present needs of the country, seeing how severely we are pressed on every side by the most energetic and intelligent competition. We are giving to the classes at the bottom of the industrial ladder a disjointed smattering of miscellaneous science, of no great value, though probably good so far as it goes, while we are neglecting to thoroughly educate those upon whose shoulders will soon rest the weight of the management of our great manufacturing industries. In the present state of things a competent knowledge of the science of the business a man is engaged in, at well as an active interest in it, whether it be chemical industry or any other, are essential conditions of any large degree of success in meeting the emergencies of a highly competitive and progressive time. A scientific training of university standard for our manufacturers and for our technical chiefs is an absolute necessity. Surely public money cannot be better spent than in providing adequate facilities for the educational equipment of the men of the future with this essential means of national defence. Our country possesses great stores of mineral wealth, a precious heritage that we are lavishly spending. That gift of nature will certainly not avert and cannot go far to compensate for the consequences of neglect of the scientific training necessary to turn our fast diminishing mineral wealth to the best advantage. One of the most pressing requirements of the moment, demanded not only in the interest of chemical industry, but in that of our manufacturing industries generally, is *adequate endowment and encouragement of research*. Original scientific research is the fountain-head of new knowledge, the vital stimulus of industrial growth, the originator of new industries and sustainer of old. Yet, nationally, in the organisation of our educational and industrial system, we give to scientific research no hospitality—we barely pay it the respect of recognition. The advances in knowledge, and the consequent revolutionary changes that have taken place in almost every branch of chemical industry during the last 100 years, are probably not greater than those further changes that will be seen at the end of the present century; for change brought about by scientific discovery grows ever swifter and more sweeping. But change is in the natural order of things, and so long as it is in harmony with progress and improvement, it is to be welcomed—it cannot be resisted. We must prepare to meet it, and we had better meet it on the threshold. But to benefit by it, and to take complete advantage of it, demands the fullest measure of assistance that education, energy, and enterprise can unitedly give. The chief object of our society, when it was founded, was to help the progress of the chemical industries of the country by means of the interchange of technical information through association of its members and the publication of its journal. It was an educational object, and it has in a large measure been realised. But now, after 20 years, at the beginning of a new decade and a new century, we see that the need of such assistance is no less urgent than at the outset, though, happily, the means and opportunities of help are greater than ever before. It rests with us to avail ourselves of them. If, as we enter the darkness of the future, we firmly grasp the guiding hand of science, and, with full faith in her leading, follow her with an alert step, we may go on with the full assurance that we shall be led in the way of prosperity.

NEW COMPANIES REGISTERED.

Union Construction Company, Limited.—Capital, £200,000 in £20 shares. Object: to undertake and carry into effect the application of electric equipment and traction to any railways or tramways in the United Kingdom or elsewhere, and the substitution of electric traction or power for steam power on any such railways or tramways, etc.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

423. How would you set about to prepare a specification for a country house electric lighting plant, comprising oil-engine, dynamo, accumulators, and the wiring?—C. I. S.

424. Discuss, with sketch, what you consider to be the simplest and best method of ascertaining the brake horse-power of small motors from ½ h.p. to 6 h.p.—T. M.

ANSWERS.

Question No. 417.—What is the usual procedure in changing over the network of an electric supply station from 230 to 460 volts?

Best Answer to No. 417 (*awarded* 10*s.*).—The usual procedure in the case of a small station seems to be to make all preparations and get everything ready for the change, and then rush it through in one day. This method is as unnecessary in the case of small stations as it is impossible when large areas have to be dealt with. Bradford was changed over from 115-volt two-wire system to 230-volt three-wire in 1896, and the procedure there was as follows: First, a third wire was laid all over the town, and also into each consumer's premises. The lamps were then gradually changed, and the services connected up on the outers at 230 volts. When all the lamps had been thus changed, and at the time of minimum load in summer, the third wire, or neutral, was connected to one of the outers both at the station and at the feeder boxes, and all the services changed on to the neutral and one outer; the other outer was then freed from the neutral and connected up at the station and at the feeder boxes on the three-wire system. It now only remained to distribute the load on each side of the system, which was done by changing the connections in consumers' premises at the Corporation fuse boxes. About 500 consumers were thus changed over.

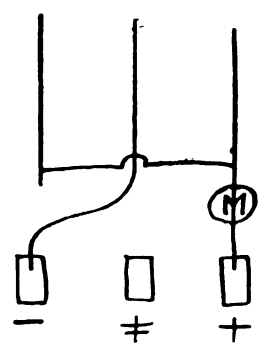

FIG. 1.

Where the system is already a three-wire one, it will be found much less costly to proceed as follows. Deal first with all three-wire installations. Change the lamps and connect up on the outers by joining the house leads together, as shown in Fig. 1. The neutral will now have to take the whole current used on the premises, but in practice this will be found of sufficient section, as the current is reduced 50 per cent. by the change of lamps. Next begin on the outlying districts, arranging the network into sections which can be conveniently changed over in a day, and work from the outside towards centre of supply area. Such sections might contain 300 or more lamps, and must be arranged to end at junction boxes, where it is possible to cross-connect the network. The fuses at these junction boxes should be removed, and the section selected thrown

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dead. Care must be taken to see that it *is* dead before connecting up again, as follows. The positive of the live network is connected to the neutral of the dead section, while the + and – of the section are joined across by a piece of cable and connected to the negative of the live network, as shown in Fig. 2. At the same time any three-wire installations in the section must have the wire going into the + box changed into the neutral, and all ampere-hour meters on + side will require leads reversing. This is only the work of a minute or two for each installation. When the day appointed for changing Section 2 arrives, it is first entirely disconnected, and the connections between Sections 1 and 2 put back as usual, and Section 2 (and with it Section 1 of course) then made alive from the main network as shown in Fig. 2. The process is now repeated until the whole area to be changed is supplied on the two-wire system at 230 volts between neutral and either outer. The change must be made in summer, so as not to risk overloading the neutral. Any feeders in the area are coupled in a similar manner, + to the neutral of network, the neutral feeder wire being left disconnected.

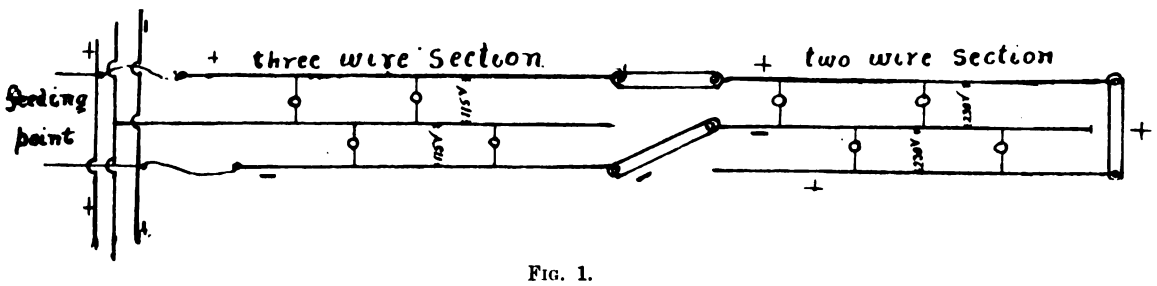

FIG. 1.

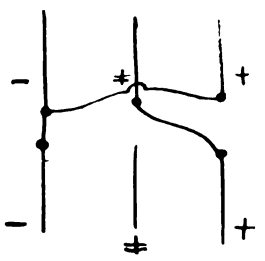

FIG. 2.

As soon as the arrangements in the engine-room are complete, portions may be connected up on a 460-volt three-wire system, by replacing the straight through connections as before the change. Before doing this, however, a man should be sent round to reverse + meter leads where quantity meters are used. In the engine-room arrangements will have to be made to get a double pressure, either by arranging machines in series or by rewinding armatures to give the required increase. If the central portion of the supply area is to remain on the lower pressure, it will be convenient to arrange the dynamos for use on either network by means of a series-parallel switch. An ordinary three-wire change-over switch may be adapted as shown in the *Electrical Engineer* for Feb. 22 last, p. 276. A 460-volt switchboard will be required.

By adopting the procedure outlined above, all necessary apparatus, etc., required for any consumer in any section can be got ready beforehand, and the minimum amount of inconvenience caused; further, if done in the order set forth there is no risk of a short-circuit on consumers' premises, and the attendant danger of fire. The writer has found the above method entirely successful in changing over a large area with about 500 consumers. With reference to alterations to fittings, etc, on consumers' premises, meters, etc., the reader is referred to a paper read by Mr. Gibbings before the Northern Society of Electrical Engineers on Feb. 8, 1897. E D. W.

Answer to No. 417 (*awarded* 5*s.*).—One of the simplest and certainly most convenient methods of changing over to double pressure on a three wire network, is as follows: First test the mains, to ascertain whether they will stand the increased pressure. Then divide the mains into sections, each section to have a sufficient number of lamps connected to keep the men that have the job in hand fully employed, starting at the farthest point from feeding source. Then (see Fig. 1) change the section to a two-wire temporarily, with the neutral wire for the negative, linking across and using the outers for the positive, changing all lamps on this section to 230 volts. Proceed in this manner until the whole network is changed, then when supply is ready at 460 volts, the links can be taken out and the mains left as they originally were. By using this method of changing to double pressure, it can be arranged so as to give the least possible inconvenience to consumers and without any augmentation of staff. Probably the quickest way to change over to double pressure is to change all lamps in one day, but the writer does not advocate this method (unless safety factor of mains is reached), because the inconvenience to consumers and trouble if breakdowns occur is so much greater. Even if safety factor of mains is reached, the distributors are generally of same section throughout, so a combination of the two methods may be used with advantage—viz., make the outer or farthest section from feeding point into a two-wire system, and when all is in readiness for increased pressure, change lamps on inner or nearest section and uncoupling the temporary links on outer sections. The above methods are equally applicable for alternating-current supply; the terms positive and negative are used for simplicity only.—W. C. FRIPP.

Answer to No. 417 (*awarded* 5*s.*).—Supposing the supply station to be owned by a company, "The pressure of supply may not be altered except by permission of the local authority, and upon such terms and conditions as the local authority may impose, and after public notice has been given during a period of one month, in such a manner as the local authority may require, of the intention of the undertakers to apply for permission to alter same. The undertakers may appeal against any decision of the local authority under this regulation to the Board of Trade, whose decision shall be final. Provided that so long as effect is given to the next following regulation, the undertakers shall not be bound, under this regulation or any regulation corresponding thereto previously made, to comply with any condition which has been or may be imposed thereunder, the effect of which is to prohibit any change in the pressure of the supply to any premises, except with the consent of the consumer." The last clause of the next regulation reads: "Provided that no change shall be made in the pressure of the supply to any premises which at the date of these regulations (1888) are supplied with energy by the undertakers, except with the consent of the consumer." As a result of a Board of Trade enquiry held in March of the present year (1901), the following provision was added: "But where the consumer withholds his consent after the undertakers have offered to comply with the general terms and conditions imposed by the Board of Trade (county council local authority), and, if not required to do so under those terms and conditions, also to pay the reasonable cost of or incidental to the charge (including compensation for any loss or damage incurred in consequence of the change), the undertakers may appeal to the Board of Trade, and that Board may, if they think fit, give their consent to the change on such terms and conditions as they impose, and the consent of the Board so given shall for the purpose of this regulation have the same effect as the consent of the consumer." From the above it will be seen that the consent of the local authority and consumer, or, failing them, the consent of the Board of Trade, must

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first be obtained. After this careful tests must be made on consumers' premises and mains (if old mains are being used), in order to know whether they are able to stand the increased pressure, the expense of alterations, if any are needed, being borne by the undertakers, also the cost of the new lamps. When these points are settled the station equipment will want attention. The switch-board will require to be divided into two sections, one for 230 volts and the other for 460 volts, each section having its own instruments, middle wire, and balancer. If new plant is not to hand, two of the old 230 volts may be connected and run, one on each side of the system, until the change over is effected, thus acting as balancers. It will be necessary to work each board separately until all lamps are transferred to high-voltage system. The feeders and distributors next require attention. The network will require splitting up into sections, each section containing not more than 80 consumers, or having a maximum load of more than 200,000 watts. The feeders and middle wire for each section must be disconnected from the low-tension board and the distributors from the low-tension network. Then, after the consumers' lamps, motors, etc., have been altered to suit increased pressure, the feeders and middle wire may be transferred to other board for 460 volts. Each section will be taken in turn, the distributors on the 460-volt system being interconnected as the work proceeds. Notice must be given to all consumers if mains are "dead" for more than one hour. Care must be taken to see that each section is thoroughly disconnected from the 230-volt before being connected to 460-volt feeders. Fuses also on consumers' premises will want reducing in section owing to decrease of current consequent on increased voltage. The middle wire must be "earthed" at "station" and provision made for testing insulation of each side of system. Given a little care and time, the change-over ought to be effected without very much inconvenience.—C. I. S.

Question No. 418.—A 700-ampere 110-volt compound-wound six-polar dynamo, fitted with carbon brushes, is continually flashing round the commutator from brush to brush. What is the cause? The commutator is freely cleaned by emery paper. Also a smaller dynamo, shunt-wound, used for battery charging, 150-volt 60-ampere, fitted with carbon brushes, frequently takes half-an-hour to generate. How can this be remedied? Different makes of carbon brushes have been tried.

Best Answer to No. 418 (*awarded* 10*s.*).—In trying to determine the cause of the sparking of the 700-ampere dynamo, considerably more information than that given would be desirable. If the flashing over did not occur when the machine was new and the commutator was in good condition, it is very probable that the cause is the rising of one or more commutator plates, causing the brushes to be momentarily thrown off the surface each time these plates pass. This results in violent sparking, which is easily carried over to some part of the next adjacent brush-holder either directly or by means of the commutator end nut. Whether this is the cause can at once be seen by passing the hand round the commutator when, if in good condition, it should be practically impossible, to feel any of the joints between mica and copper. This raising of the plates is especially liable to occur with heavy-current commutators, such as this one, which probably has an unsupported length of plate of quite 9in. or 10in. Cleaning with emery cloth is of very little use in these cases, and if the fault is found to exist, the surface of the commutator should be ground smooth either in a lathe fitted with an emery grinder, or with one of the portable emery grinders attachable to the bed-plate of the machine, and which could probably be borrowed for the purpose from the makers of the dynamo.

If, on the other hand, the trouble has always existed, it is most likely that the design of the machine is at fault, and the only complete cure then consists in having an entirely new armature arranged with considerably more commutator parts, either by reducing the number of turns per section, or, if that is not possible, by using two parallel windings in place of one. Before going to this extremity, however, it will be worth while to try one or two simpler remedies, and for this purpose it would be well to consult the makers, who from their experience of similar machines would probably be in the best position to give advice. It is possible that the free use of emery paper mentioned may itself be the cause of the trouble, especially if any oil or grease has been used on the commutator. The copper dust and grease may form a more or less continuous coating of conducting material round the commutator, bridging the mica plates, and enabling the current readily to flash over from brush to brush. To prevent this the commutator should be carefully dusted after each emery papering, and no grease should be used at any time on commutators with carbon brushes. Another possible cause of the sparking is the width of the brushes peripherally. The present brushes may be either too narrow or too wide, and the effect of different widths on the working should certainly be tried. Failing other remedies, it is always possible to avoid the dangers of an actual flashing over, without, however, curing the sparking which is its cause, by wiping out the sparks as soon as they are formed by means of a pad of asbestos paper placed in front of each brush, as suggested some years ago by Prof. S. P. Thompson (see Fig. 1).

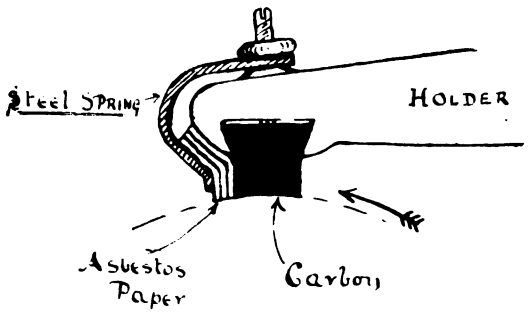

Fig. 1.

The trouble mentioned in the second part of the question is a common one, and may be due to a variety of causes. The simplest way out of the difficulty is to independently excite the machine from the battery instead of off its own terminals. This is a very usual plan in battery stations, as it not only ensures rapid excitation, but also makes the field of the machine more stable under all conditions—as for instance, when used without the battery for lighting at 110 volts. If, for any reason, this arrangement cannot be introduced, some of the following points can be considered. When starting the machine, all the regulating resistance should, of course, be cut out of the shunt

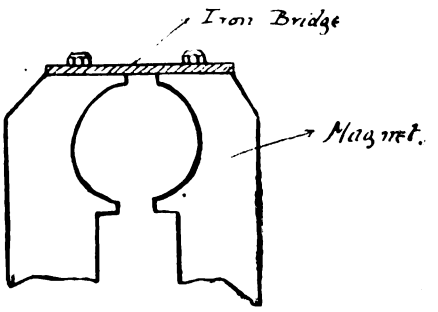

Fig. 2.

circuit, as a machine wound to give 150 volts would probably fail to excite, no matter how long it might be kept running, if the resistance for reducing the voltage to, say, 110 volts were left in the circuit. Again, the contact resistance of carbon brushes is always higher when cold than when warm, and it may be due to the warming of the commutator by the friction of the brushes during the half-hour's run that the machine is ultimately enabled to excite. This contact resistance is especially high if the commutator surface is allowed to get black through want of care. To avoid this source of trouble, the commutator should be lightly cleaned up with emery cloth each time just before stopping. The trouble may, however, be inherent in the machine, due to the fact that the iron is worked at too low an induction density, for unless worked at a point well on the bend of the magnetisation curve of the normal voltage, difficulty in excitation is sure to occur. This can be partly got over by increasing the leakage of the machine arti-

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ficially—*e.g.*, by placing a sheet of iron from pole to pole, as in Fig. 2. This remedy cannot, however, be used unless there is at present some margin in excitation, or unless the field coils are rewound, as the increased leakage will naturally increase the excitation necessary to give the 150 volts.

Another method of ensuring rapid excitation consists in connecting the two field coils temporarily in parallel (supposing there are two field coils, and that they are coupled in series at present) when starting the machine. This can be easily arranged by means of a simple switch, but is open to the objection that a dangerously high voltage may be produced unless care is taken to switch over from two parallel to two series before the machine is fully excited.—Q.

Answer to No. 418 (*awarded* 5*s.*). — If "flashing round the commutator" means simply the passage of little individual sparks travelling with the commutator, the effect is of little importance, and is probably due to the use of the emery paper which covers the brushes and commutator with copper dust. In order to prevent this sparking, the brushes should be removed before emery is used, and the commutator should be carefully wiped clean afterwards; commutator lubricant containing graphite and brushes of a soft rapid-wearing quality should be avoided. If, however, the flashing is the formation of an arc from brush to brush, it is a very serious matter, as it is caused by too high a voltage between adjacent sections of the commutator. It is possible that the flashing may be prevented to some extent by the observance of the above recommendation, but it can only be entirely cured by redesigning the armature winding. Experiments with a number of machines show that with an average of 16 volts per section no flashing over will take place, even if the commutation is very bad, while with 21 volts flashing over may take place at any time with a sudden change of load The size of commutator and thickness of mica make very little difference to the limiting voltage. A voltage of 16 per section, although safe as regards flashing over, is usually too high for good commutation. It would appear, therefore, that there are not more than six sections between the brushes in this dynamo, and assuming that each brush covers one section, the total would be not more than 42 sections.

We are not told anything about the design of the dynamo beyond the fact that it is a six-pole, but a comparison with machines of a similar size shows that the armature, to give approximately 18 volts between sections, is probably either series-wound with one turn per section or parallel-wound with about three turns. If it is the latter, the brushes must be placed at six points round the commutator at 60deg. apart, and nothing can be done to prevent the flashing but rebuilding the commutator with an increased number of parts, so as to give a smaller number of turns per section. If the armature is series-wound, it is optional whether the current be collected at two points or at six. As the current is heavy and carbon brushes are used, it is probable that all six points are made use of. In that case it would be worth while trying the experiment of collecting at two points only at opposite ends of a diameter. It may then be necessary to use copper brushes to prevent excessive heating. This arrangement would reduce the tendency to flash, but if it does not sufficiently do so, the armature must be rewound with a greater number of sections, as described above. Slow excitation of dynamos is caused by their working point being low down on the saturation curve. In this case the difficulty can easily be overcome by exciting from the accumulators. To do this connect the cells to the dynamo through two switches in series and tap off the shunt current from the mains between them. First switch in the switch near the accumulators. This will excite the fields. Then run up to the required voltage and switch in the one near the dynamo. Before shutting down open the switch near the accumulators only. This arrangement prevents opening the circuit of the shunt, which endangers the insulation.—J. W.

Answer to No. 418 (*awarded* 5*s.*).—The flashing at the brushes may be caused from a variety of reasons: (1) The armature may be carrying too much current, due possibly to an overload; or (2) the brushes, maybe, are not set at their respective angles, which should be in your case 60deg. or 180deg. The symptom of this trouble will be a sparking and cutting of the commutator, the greatness of which varies with the shifting of the brushes. (3) A poor connection between the leads and the tongue of the commutator segment will often cause flashing on account of it developing a flat hard mica between the segments, which does not wear as fast as the copper of the commutator. (4) A loose bearing will cause chattering of the brushes, with the attendant flashing and cutting of the commutator. If the bearings are loose and very much worn, they should be rerun with babbit metal or new ones put in. (5) Brush-holder screws may have worked loose to cause the brushes to tilt, so that they touch only at one point instead of the full face of the brush. (6) Vaseline and oil may have been used too frequently on the commutator, and caused it to become sticky and dirty. (7) Hard carbons that do not adjust themselves to the commutator. (8) Field troubles will cause flashing at the brushes if the circuit is in any way broken, and it will no doubt be found that the mica around the segments belonging to the broken coil will be burnt. This break will very often be found in the leads where the commutator connects with the armature wires.

When cleaning the commutator, on no account should emery paper be used. It is the worst thing that can possibly be used, on account of the emery being so sharp that it becomes lodged in the segments of copper and makes the commutator a grinding tool. If the commutator is slightly rough, it can be dressed down with a smooth file and polished with very smooth sand-paper having a drop of oil on it to gather the small particles of copper, but care should be taken to have the brushes raised before commencing to prevent them from getting clogged with filings and dust. With regard to the second part of the question, the dynamo may have field troubles; if it has, it will not come up to its full E.M.F. on account of the pole-pieces not being magnetic enough, through, possibly, a short-circuit in the field coils, which can be found by taking the resistances in each magnetic coil by a galvanometer, and any difference in resistances show that the magnet of least resistance has been short-circuited. The remedy for such is to unwind the wire on the faulty magnet till the fault is found, when the fault can be repaired and the wire wound back again. Sometimes oil which gets into the field from faulty bearings rots the insulation of the wire and causes a short-circuit.—J. A. C.

COMPANIES' MEETINGS AND REPORTS.

HAMPSTEAD ELECTRIC SUPPLY.

An extraordinary general meeting of the preference and ordinary shareholders in this Company was held on Monday at the Institution of Chartered Accountants, Moorgate-place, E.C., for the consideration of resolutions for the reconstruction of the Company. Mr. E. T. Read occupied the chair.

The **Chairman,** having explained the nature of the meeting, remarked that the ordinary meeting of the Company would have been held some three or four months ago, but the directors were engaged. and had been engaged for the last eight months, in trying, by the reorganisation of the debenture capital, to raise a further amount of working capital, which was absolutely necessary for the welfare and existence of the undertaking. He regretted to say that their efforts in that direction had proved fruitless, and, therefore, there was no other alternative than to reconstruct the Company. The facts were these: As he explained at the last general meeting, the working capital with which the Company was provided was absolutely insufficient to cope with its extended and ever-increasing business, and the profits earned—which had not been distributed, but carried to working capital—had been quite unequal to making up the deficiency. About £10,000 of the original working capital was spent on increasing the plant and the stock of one of the businesses taken over—namely, that known as Messrs. Taylor and Lown's. It had been the hope of his colleagues and himself that they might, by using the profits as working capital, have pulled the Company through without having to reconstruct. With that object in view all the directors had lent their personal financial assistance. He himself had lent the Company something between £4,000 and £5,000, and the Board had guaranteed further loans to the extent of £5,000 or £6,000. Also the Board for the last two years had not drawn one penny in the way of remuneration. He thought that fact would convince them that the directors had done their best to pull the Company through and put it on its legs. Some of the shareholders, no doubt, thought the Company had not been so well managed as it might have been, but he would like to point out that it was very difficult to manage an increasing business with practically no funds. Within the two years since he had been

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on the Board, they had practically doubled the electric lighting business; that was to say, the number of houses had increased from 500 to close upon 1,000. In his opinion that was not a bad record; and had it not been that they were hampered by the lack of working capital, their business would have been far bigger. There was a large amount of business waiting for them. The business of Taylor and Lown had also increased largely, although the profits resulting therefrom had not been quite satisfactory to the Board, and the directors had decided, with the approval of a considerable number of the large shareholders, that in the future the business of the Company should be confined solely to electric lighting. He then gave an outline of the scheme for reconstructing the Company. The capital of the new company would be £150,000, divided into 100,000 preference shares and 50,000 ordinary shares. The preference shares, it was proposed, should have a preferential interest of 5 per cent., and they also suggested, subject to the approval of the meeting, that after the ordinary shareholders had received 5 per cent., the preference shares should take one-third of the surplus profits, the other two-thirds going to the ordinary shareholders. The preference capital was double that of the ordinary; therefore, the ordinary shares still retained their speculative value, and in the event of success anticipated they would receive the lion's share of the profits. The capital of the Company would be guaranteed, and he was pleased to say that there would be no difficulty in that direction. The debenture issue of the new company would be reduced to £25,000—£12,500 "A" debentures and £12,500 "B" debentures, both bearing interest at the rate of 5 per cent.; but it was quite possible that instead of there being two classes of debentures, there might be only one. As regarded the future, the profits on their present business, carefully estimated, for the next year—assuming that the price of coal remained at its present rate—namely, between 23s. and 24s. per ton—would be from £6,500 to £7,500. That was, of course, irrespective of additional business which the Board had in view. It was always an unsatisfactory and an unthankful task to have to ask shareholders to put their hands in their pockets for the purposes of reconstruction, but in all his experience he had never known a company where such a request was more justified than in the present case. They possessed a sound business, which, with proper and careful management, he had no hesitation in saying would be as good as that of any other electric lighting company in the country. Personally he would have to pay up, in connection with the reconstruction, £2,000 or £2,500, and one of his colleagues would have the pleasure of finding £3,000 or £4,000; in fact, the Board were interested in the Company to the extent of about one-sixth of its capital. The Board of the new company would be somewhat different. Mr. A. W. Armstrong, the founder of the old Hampstead battery business, had consented to join the directorate, and he hoped to induce two other gentlemen to take a similar step. The new company would be managed properly, economically, and to the best advantage, and he recommended every shareholder to come in and take up his shares, fully believing that they would not regret doing so. He concluded by moving the resolutions for reconstruction.

Mr. A. C. B. Casson seconded the motion.

Several adverse criticisms were offered on the proposal for reconstruction, one shareholder describing it as an impudent one. Another thought that the shareholders should be represented to see that the concern was not absolutely ruined. He suggested that it would be better to dispose of the business, so that they might get a little out of the wreck, instead of running the risk of losing everything.

In reply to the questions, the **Chairman** said that the present engineer to the Company was a most capable man, but it would be for the new Board to decide who should have supreme charge of the electric lighting business in the future. It was proposed to have on the directorate of the new company certain gentlemen acquainted with electric lighting, and the shareholders might safely leave the matter in the hands of the directors. With regard to the powers of the Company, they had to compete with the local vestry in the lighting of streets and houses. There was nothing to prevent the Company lighting any house they chose, and they did not require permission from the Board of Trade or anybody else.

Attention was drawn to the fact by a **Shareholder** that although an official quotation had been granted by the Stock Exchange, the shares of the Company had rarely been quoted.

The **Chairman** explained that there were never any active dealings on the Stock Exchange on the Company's shares, and unless this took place they would not be quoted, which explanation was greeted with cries of "They are not worth it," and "You can't get rid of them." The Chairman further stated that a receiver had been appointed on his recommendation, and after some further discussion the resolutions for the reconstruction of the Company were agreed to.

Another meeting of the shareholders will be held to-morrow (Saturday) for the purpose of confirming the resolutions.

CUBA SUBMARINE TELEGRAPH.

Presiding over the half-yearly meeting of this Company on Wednesday at 58, Old Broad-street, **Mr. Charles W. Parish** said the fact that they had reduced the local rates accounted for a difference in traffic receipts; but, notwithstanding, the receipts for the first half of this year were about £1,000 more than in the preceding six months. The period, however, covered the busy time in the sugar crop and general business. He regretted that they had no definite news as to their concessions being recognised by the United States Government, and until the position of Cuba had been finally settled no definite progress was likely. The late President McKinley recognised their claim of £8,774 for damage to cables during the war, and he hoped when Congress next met they would hear that the compensation had been voted. As to the break in their cable, it was, unfortunately, in deep water, and repairs would be rather costly; but the directors had built up a reserve which could be drawn upon for this purpose. He then formally moved the adoption of the report.

Mr. G. Keith seconded the motion, and it was carried unanimously.

MONTE VIDEO TELEPHONE.

The report of the directors for the year ended July 31 last shows that there is a net profit of £10,319, after providing for all working expenses in Monte Video and London. To this must be added £1,886 brought forward, making £12,205. The directors propose to transfer £5,000 to reserve, and recommend a dividend at the rate of 2½ per cent. per annum on the ordinary shares, £1,064 being carried forward. There has been a further moderate increase in the number of subscribers, which is reflected in the improved receipts.

WESTERN TELEGRAPH.

The directors, in their report to the shareholders in this Company for the half-year ended June 30 last, state that the revenue amounted to £228,892 and the working expenses to £98,901. After providing for debenture interest and sinking fund and income tax, there remains a balance of £115,851, to which is added £7,689 brought forward, making £123,540. A quarterly interim dividend, amounting to £31,189, has been paid, £35,000 transferred to the general reserve fund, and £2,000 to the maintenance ships' reserve fund. The directors now recommend a final dividend of 3s. per share, making a total dividend of 6 per cent. for the year, and a bonus of 2s. per share, leaving £3,368 to be carried forward. The dividend and bonus will be payable on the 31st inst.

APPOINTMENTS VACANT.

Shift Engineers, Bradford Corporation, 50s. per week of 50 hours, Oct. 28. Electric Lighting and Tramway Company, Cork, 40s. to 50s. per week. Full particulars in our advertisement columns.

Traffic Superintendent, Bradford Corporation Tramways, £200 per annum, Nov. 9. Full particulars in our advertisement columns.

Car-Shed Foreman, Sheffield Corporation Tramways, 45s. per week, Oct. 30. Full particulars in our advertisement columns.

Assistant Electrical Engineers, King's Lynn Corporation, £78 per annum, 31st inst. Hanley Corporation, £80 per annum, 28th inst. Full particulars in our advertisement columns.

Chief Assistant to Superintendent Engineer, Bradford Corporation Electricity Works Department, £150 per annum, Nov. 11. Full particulars in our advertisement columns.

Consulting Engineer, Urban District Council of Garston, Oct. 25. Full particulars in our advertisement columns.

Jointer, who has served his time in a cable factory, £2 per week of 50 hours. Full particulars in our advertisement columns.

Estimators.—Two experienced men used to estimating for switchboard work. Full particulars in our advertisement columns.

Electrical Engineer (young) for small station in Spain, able to test installation, etc. Full particulars in our advertisement columns.

Various.—Fitter-Driver, 35s. per week; Stoker, 25s. per week; Switchboard Attendant, 25s. per week; and Jointer, 35s. per week, Whitby Urban District Council. Full particulars can be obtained from Mr. C. W. Kennaway, electrical engineer, Council Offices, Whitby, Yorks, Nov. 1.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

East London.—Tenders are invited for the supply of a 50-kw. alternator and engine. Tenders by Nov. 26. Details in our advertisement columns.

Hurst.—The Urban District Council invite tenders for tramway feeder cables, test wires, feeder and section boxes, and other work connected therewith. Tenders by Nov. 12. Details in our advertisement columns.

Chesham.—The Urban District Council invite tenders for the transfer of their provisional order enabling them to supply electricity within the Chesham urban district, by Nov. 16. Full particulars in our advertisement columns.

Oldham.—The Corporation invite tenders for the supply and delivery of concentric feeder cable, pilot cable, joint-boxes, etc., and motor booster, motor generator, switch gear, etc. Tenders by Nov. 5. Details in our advertisement columns.

Bournemouth.—The Town Council invite tenders for car-sheds and repairing shops. Specification, etc., may be obtained from Mr. F. W. Lacey, M.I.C.E., borough and tramway engineer, Municipal Offices, Bournemouth. Tenders by Nov. 11.

Hurst.—The Council invite tenders for the supply, delivery, and erection of steel poles, bases, section boxes, and overhead line for the equipment of electric tramways approximately 1½ miles long. Tenders by Oct. 29. Details in our advertisement columns.

Liverpool.—The Directors of the South Lancashire Electric Traction and Power Company, Limited, invite tenders for the supply and laying of high and low tension insulated electric cables, stoneware pipes, etc. Tenders by Nov. 4. Details in our advertisement columns.

Ilford.—The Urban District Council invite tenders for the supply and erection of a water-tube boiler, with fittings, pipework, etc.; one

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550-kw. steam dynamo (vertical enclosed high-speed engine); main switchboard and connections. Tenders by Oct. 29. Details in our advertisement columns.

Limerick.—The Corporation invite tenders for the supply, delivery, and erection of cables, arc lamps, Westinghouse engines, dynamos, boosters, and Dowson gas plant. Preference will be given to a contractor who tenders for the whole of the work. Tenders by Oct. 28. Details in our advertisement columns.

Liverpool.—The Directors of the South Lancashire Electric Traction Company invite tenders for the overhead electrical equipment of certain tramway lines and car depot. The route length of the tramway line is approximately 19 miles. Tenders by Nov. 25. Details in our advertisement columns.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection of 11 overhead travelling hand cranes, in 10 sub-sections. Specifications, etc., may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by Oct. 30.

Boulder City (Western Australia).—The Boulder City Council invite tenders for construction of about 3½ miles of electric tramway, with all necessary plant complete according to specifications, and the right to construct and run tramways within the municipality. Tenders by Nov. 23. Details in our advertisement columns.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station and sub-stations of two 6,000-h.p. triple-expansion engines, two 3,750-kw. three-phase alternators, 48 motor-generators for sub-stations. Tenders by Nov. 6. Details in our advertisement columns.

Swindon.—The Corporation invite tenders for the supply, delivery, and erection at their electricity works, Swindon (Wilts), of three Lancashire boilers and economiser, two jet condensers, feed pumps, pipework, and accessories, water-cooling tower, and 10-ton overhead travelling crane. Tenders by Nov. 12. Details in our advertisement columns.

Barking Town.—The Council invite tenders for the supply of an electrically-driven locomotive crane, together with the permanent way in connection therewith, at the Council's Wharf, Gascoigne-road, Barking. Specification, etc., can be obtained upon application to the Council's Surveyor, Mr. C. F. Dawson, Public Offices, Barking. Tenders by Nov. 12.

Willesden.—The Metropolitan Electric Supply Company invite tenders for supply of six multitubular dryback boilers, delivered free at the company's works at Willesden, in the following order: two in March, 1902, two in April, 1902, and two in May, 1902. Tenders are to be addressed, with full particulars, to the Chief Engineer of the Company, by 28th inst.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection of three Lancashire boilers, economiser, and mechanical stokers, and for two ejector condensers and circulating pumps, one feed pump, one grease extractor, and the extensions to the present steam, exhaust, condenser, and feed pipes. Tenders by Nov. 8. Details in our advertisement columns.

Bury.—The Tramways Committee invite tenders for the supply and delivery at Bury, Lancashire, of 14 69-passenger electric tramcars and 14 48-passenger electric tramcars. Specification, etc., may be seen at the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar, 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster, and may be obtained from the latter office. Tenders by Nov. 18.

Christiania.—Tenders are invited by the Norwegian State Railways Department, not later than 3 p.m. on 30th inst., for supply of telegraph materials. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m. Besides customs duties, the Norwegian Government give a preference of 15 per cent. to native tenders.

Ashton-under-Lyne.—The Corporation invite tenders for the supply, delivery, and erection in the borough of Ashton-under-Lyne of steel poles, bases, section boxes, and overhead line for the equipment of the first section of electric tramways, approximately 1½ miles long. Specification, etc., may be obtained from Mr. N. Appelbee, borough electrical engineer, Electricity Works, Ashton-under-Lyne. Tenders by Oct. 29.

Willesden.—The District Council invite tenders for the supply and erection of boiler-house plant, steam dynamos, transformers, motor-generators and balancing transformers and booster dynamos, switch gear (high and low pressure), overhead travelling cranes, accumulators, mains (high and low pressure), public lamps, steam pipes, and condensing plant (jet condenser and spray cooler). Tenders by Nov. 12. Details in our advertisement columns.

Amsterdam.—The Secretary of State for Foreign Affairs has received a dispatch from his Majesty's Consul at Amsterdam, stating that tenders are invited by the Town Council of Amsterdam, not later than Nov. 18, for the supply of above-ground conductors of electricity and the connections of rails for electric tramways. Particulars may be obtained at the Stadsdrukkerij of Amsterdam on payment of 3·50fl. (5s. 10d.). Information is given at the office of the Manager of the Town Tram, 164, Achtergracht, Amsterdam.

Rockhampton (Queensland).—The Municipality invite applications from companies desirous of undertaking the construction and working a system of electric tramways under the Queensland Tramways Act of 1882 and the Amendment Act of 1890, within the Municipality of Rockhampton aforesaid. Rockhampton, with a population of 15,461, is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882 and the Amendment Act of 1890, copies of which may be seen at the office of this paper. Applications to be forwarded to Mr. H. W. Johnson, mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31.

RESULTS OF TENDERS.

Abersychan.—The Council have accepted the tender of Messrs. Edwards and Armstrong for the electric lighting of Cwmavon village, at £74.

Harrogate.—The Town Council have accepted the tender of E. Bennis and Co., of Bolton, for the supply of a Westminster donkey engine at £39.

Doncaster.—The Corporation have accepted the tender of Messrs. D. Bruce Peebles and Co., Edinburgh, for the supply of one 300-e.h.p. generator, spares, etc., at £3,289.

Bury St. Edmunds.—The tender of Messrs. Hall and Hackblock, Ipswich, has been accepted for the electric wiring and fittings at the Suffolk General Hospital, at £414.

Heckmondwike.—The District Council have decided to accept the tender of J. H. Taylor and Co., of Huddersfield, for electric wiring of consumers' premises, at 15s. per light for shops and 17s. 6d. per light for dwellings.

Kirkcaldy.—The Town Council have accepted the tender of Henley's Telegraph Works, London, at £11,239, for electric lighting mains and feeders; and the tender of Crompton and Co., Chelmsford, for arc lamps, at £546.

Walsall.—The tender of Callender and Co., Limited, for laying a pair of mains solid in a wooden trough for the Highgate extension at 11s. per yard, and excavation and temporary reinstatement at 1s. 4d. per yard, has been accepted by the Town Council; also the tender of T. Parker, Limited, for supplying, delivering, and erecting a small transformer to be fixed in Freer-street sub-station, to raise the pressure to 220 volts for the Highgate extension, at £244, has been accepted.

Manchester.—The Electricity Committee of the City Council have decided to accept the tender of W. T. Glover and Co. for the supply, delivery, and laying of a number of mains. The amount of cable to be supplied under the contract is 147 miles, to be used for lighting and tramway traction purposes. It is stipulated that the cable must be laid within six months of the order being given. The amount of the contract is a little over £130,000. Messrs. Glover's tender was not absolutely the lowest, but the committee had regard to the question of delivery.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Cape Town.—The Cape Government have engaged 250 London telegraphists for the colonial service.

Monte Video Telephone Co.—The directors recommend a dividend of 2½ per cent. carrying £1,064 forward.

Buxton.—Mr Calvert's resignation has been accepted by the Urban District Council, to date from 25th inst.

Tyldesley-with-Shakerley.—The Urban District Council are applying for an electric lighting provisional order.

Gillingham.—The District Council have decided to apply for a provisional order for the purchase of the electric light works and undertaking.

Harrogate.—The question of providing an electric motor for heating and ventilating the kursaal has been left with the Building Committee, with power to act.

Bangor.—Colonel W. Langton Coke has held an enquiry into the application of the Corporation for sanction to borrow £2,032 for the purposes of electric lighting.

Llanelly.—A special meeting of the Works Committee of the Harbour Commissioners will be held on Monday next to consider the question of lighting the docks.

Peebles.—The Town Council have agreed to a proposal by which Messrs. King and Co. will erect four arc lamps in the High-street as an experiment in electric lighting.

Morecambe.—The Council have decided to apply for sanction to borrow £5,000 to complete the extension of the electric light works. The floor of the extension to the engine-room is to be concreted instead of tiled.

Beverley.—The Town Council have decided to apply for sanction to borrow £15,000 to meet the cost of providing electric light. Fifty-one promises to take current have been obtained, and 32 probable customers and 19 doubtful are reported.

New Book.—The 1902 edition of "The 'Practical Engineer' Electrical Pocket-Book and Diary" has just been published by the Technical Publishing Company, Limited, 31, Whitworth-street, Manchester. Particulars will be found in another column.

Boyle.—Messrs. Smith and Parkes, of Donegall-street, Belfast, have just successfully completed their contract for the lighting of Boyle by electricity. A number of private establishments are now using current, and we understand that the number is likely to be increased.

Hucknall Torkard.—The Urban District Council have given notice of their intention to apply for an electric lighting order empowering them to produce and supply electricity for public and private purposes within the whole of their urban district area.

Cape-Australia Cable.—A Reuter's telegram from Perth, W.A., states that the "Scotia," which has been laying the new cable connecting Australia with South Africa, has arrived at Fremantle, and the direct cable from Durban to Perth will be opened on Nov. 1.

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Aberdeen.—The Gas and Electric Lighting Committee have acceded to applications for the extensions of electric mains to Ferryhill and Craiginches districts, and also to Queen's-road West.

United States Copper.—The September production of copper in the United States was 194 tons more than that for 1900. Exports were 4,000 tons less, but some consumers are ready bidders, and the stock at present is not accumulating. No fall in price is expected.

Darlington.—The North-Eastern Railway Company is now completing at Darlington an additional erecting shop at its North-road engine works. Heavy electrical cranes for lifting the engines are being fitted up, and the machinery employed will be of the newest types.

Bath.—The supply of the current is to be extended to Weston and mains are to be extended at Bathwick-hill. Since August 2,292 additional 8-c.p. lamps have been added. An increase in salary of £20 per annum has been granted to Mr. Snewin, the engineer-in-charge.

New Branch.—The New Brotherton Tube Company, Limited, makers of "Excelsior" enamelled steel electric conduits and fittings, of Wolverhampton, have opened offices and stores at 9A, New Brown-street, Manchester, under the superintendence of Mr. Albert Moulding.

Harrow.—In consequence of a petition signed by 80 of the principal tradesmen of Harrow and Roxeth, who stated that they had no telephone at the present moment, the Council are asking the National Telephone Company if they would extend their system to Harrow.

Croydon.—Sanction has been received to loans of £30,000 for purposes of electric lighting and £550 for a house for station superintendent. Both loans are repayable within a period not exceeding 22 years. An underground sub-station is to be erected in Addiscome-grove.

Western Telegraph Co.—The directors have decided to transfer £35,000 to the general reserve fund and £2,000 to the maintenance ships' reserve fund, and to recommend a final dividend of 3s. per share, making 6 per cent. for the year ended June 30, 1901, and a bonus of 2s. per share.

Linthwaite.—The Urban District Council have been in correspondence with the Golcar, Marsden, and Slaithwaite Councils to meet them and discuss the best means of providing electric light for the districts. One of the authorities has declined to entertain the question at present.

Cheadle and Gatley.—The Urban District Council are consulting with Mr. Page, of Manchester, with regard to the proposed supply of electric light and power. They are also conferring with the authorities of the Royal Asylum to ascertain whether they would take electric light from the Council.

The Royal Tour.—During the stop at Brantford last week the Duke of Cornwall was presented with a silver casket containing the original long-distance telephone, by Prof. Melville Bell, the father of the inventor, who is a native of Brantford. The place is for this reason known as "Telephone City."

Incandescent Lamps.—The British Thomson-Houston Company's illustrated pamphlet No. 112 is a most artistically got-up print, showing the use of incandescent lamps as where ornament is the first consideration. Pretty effects are shown for the use of these lamps to outline the principal features of buildings

. **Calcutta Electric Supply Co.**—The directors have declared an interim dividend at the rate of 5 per cent. per annum for the half-year ending June 30 last on the paid-up capital of the Company, payable on Nov. 4. Letters of allotment and regret in the recent issue of 10,000 shares are being posted to-day.

Whitehaven.—The Town Council have obtained sanction to borrow £9,900 (part of the electric lighting loan). The Board have intimated that, as there was a debt outstanding on the mains to be superseded, they had decided to grant the loan only for a period of 10 years. The Council intend to apply for an extension of this term.

Shrewsbury.—The Town Council have obtained sanction to a loan of £16,526 for electric lighting, except so far as it relates to the items of £3,000 for extension of buildings, etc., and £2,626, the amount of money expended beyond the present borrowing powers for plant and extensions. With regard to these items further particulars are requested.

Liverpool-Paris Telegraph.—The French and British postal and telegraphic administrations at the end of last week established direct telegraphic communication between Paris and Liverpool. The establishment of this new service, which was opened on the 1st inst., will accelerate the exchange of correspondence between these two centres.

Bootle.—The following have been selected out of 50 applicants for recommendation to City Council for the post of electrical engineer: Mr. H. Drewett, electrical engineer to the Corporation of Morley; Mr. T. D. Clothier, Hull; Mr. John Lambert, Perth; Mr. Walter F. Long, Chorlton-cum-Hardy; Mr. William Rogerson, Nottingham; and Mr. J. M. Smyth, Keighley.

Swansea.—The resident engineer's last report states that to Sept. 30 152 applications have been made for the supply of electrical energy, equal to a lamp demand of 17,334 8-c.p. lamps, including public arcs and incandescents. The number of customers at present being supplied with energy is 122, the maximum load during the past month being 220 kw., equivalent to 6,875 8-c.p. lamps alight at one time.

Hammersmith.—The report of the Electricity and Lighting Committee states that since the last Council meeting 13 additional consumers have been connected, representing a maximum of 427 8-c.p. lamps. These, added to the number previously reported, show a total of 972 consumers taking current from the mains. New mains are to be laid at a cost of £84. 10s., and an extension at an estimated cost of £150.

Callender's Cable and Construction Co.—The directors have resolved to pay an interim dividend on the ordinary shares of 5s. per share, being at the rate of 10 per cent. per annum, on Nov. 1 next, and that 5,000 additional ordinary shares be issued and offered to the ordinary shareholders at par in proportion to the number of shares held by them.

Worthing.—Mr. Monkhouse has made a report relative to the cost of providing incandescent lights to the arc lamps on the Parade, which could be lighted when the arc lamps are turned out. Since the last report 72 applications have been received, equivalent to 3,032 8-c.p. lamps, and 39 consumers have been connected to date, equivalent to 1,665 8-c.p. lamps. The equivalent number of 8-c.p. lamps applied for as arc lamps and motors was 133.

Copper in Peru.—Copper of enormous value has been discovered near Cerro de Pasco, in the heart of the Andes. An American syndicate with a capital of 10,000,000dol. will in a short time construct a railway from Arroya to the mines, a distance of about 80 miles, after which active work will be started on the mines. Mr. Irving Dudley, U.S.A. Minister at Lima, predicts that Peru will prove to be one of the largest producers in the world.

Clitheroe Telephones.—A letter was read at the last meeting of the Town Council from the Mayor of Accrington with respect to setting up a system of telephones, in opposition to the National Telephone Company, for the Blackburn area, including Accrington, Blackburn, Darwen, Church, Rishton, Clayton-le-Moors, Chorley, and Clitheroe. Two representatives were appointed to attend any meeting convened by the Mayor of Blackburn for the discussion of the subject.

Wakefield.—A deputation representing the Wakefield Tradesmen's Association on Saturday waited upon the General Purposes Committee of the Corporation and presented a memorial urging the Corporation to establish a municipal telephone system. They complained bitterly of the cost of a connection under the existing system, and of the trouble, annoyance, and time lost in getting into communication with other towns. The committee promised to give the matter their attention.

London Gazette.—A meeting of the Okonite Company, Limited, will be held at the offices of Messrs. Ogden, Palmer, and Langton, Finsbury-pavement House, Finsbury-pavement, E.C., on Nov. 27 at 12.30 p.m. to receive the final report of the liquidator. The partnership existing between J. G. S. Cunnington and H. King Smith (trading as Laing, Wharton, and Cunnington), electrical engineers, 93, St. Martin's-lane, Charing Cross, W.C., has been dissolved by mutual consent.

Lever Switches.—Pamphlet No. 111 has just been issued by the British Thomson-Houston Company illustrating their punched clip lever switches. We understand that these switches for 125 to 500 volts and from 25 to 300 amperes are manufactured in single, double, and triple poles. They are designed particularly for use in places where a high degree of finish is unnecessary, and where an inexpensive switch will answer as well as a more costly switch. For such use they should command a ready sale.

Walsall.—The Electric Lighting Committee's last report states that the total number of consumers supplied on Sept. 30 last was 203. During the past month the total units generated at the station were £35,975. The total output from the main generators were 34,627 units. The total units from the transformers was £26,681 (estimated). The total units registered on the meters was 25,249. The machinery was run for 441 hours. Sanction has been obtained to a loan of £1,700 in respect of the Highgate extension.

Frinton.—A mast 160ft. high has been erected at Frinton-on-Sea in connection with Signor Marconi's system of wireless telegraphy. The instruments are in a house close to the pole which supports the aerial conductor. Messages have been received at Frinton over a distance of 40 miles. Mr. T. Bowden, engineer and electrician, is in charge of the station, which has been established for the purpose of giving instruction in the working of Marconi's apparatus. There are about half a dozen students living on the spot.

Private Lighting Plant.—Admiral Rowley is having complete electric lighting and water-supply plant erected at his residence Holmesland, near Botley, Southampton. Here Messrs. Merryweather are fixing a powerful oil-engine and dynamo and wiring the whole of the buildings. Accumulators are to be provided to keep the light going during the night. An electric motor is to drive a pump at a well some distance away to supply roof tanks, whence the water is to be distributed by pipes for domestic supply and fire protection.

Norwich.—At Tuesday's meeting of the Town Council the Executive Committee reported that the Postmaster-General has granted a license to the Norwich Mutual Telephone Company, Limited, for the establishment of a telegraphic exchange in the Norwich exchange area, and that the company have deposited at Messrs. Barclay and Co.'s bank the sum of £2,000 in the name of the Corporation, in accordance with the agreement entered into between the Corporation and the Norwich Mutual Telephone Company, Limited.

Personal.—We learn that Mr. Frank Forrest is leaving the Tynemouth Corporation electricity works to take up a position as assistant engineer in the stations departments of the Charing Cross and City Electric Supply Company, Limited, and Mr. J. W. Lawson, of the British Thomson-Houston Company, Newcastle-on-Tyne branch, has been appointed in his place. We understand that Mr. B. H. Jenkinson, C.E., A.M.I.E.E., has resigned his position as general manager to Messrs. Hands, Limited, and has taken up consulting practice at 18, Crouch Hall-road, Crouch End, N.

Hull Telephones.—At the sixth annual meeting of the Hull and District Chamber of Trades on Tuesday the progress made in establishing municipal telephones in Hull, which had always been supported by the Chamber, was made reference to. It was said that it was practically proved that an effective system could be provided at half

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the rates charged by the National Telephone Company, which were prohibitive except to the larger traders. The charge there will be six guineas, and it was announced that already they had as many promises as there were subscribers to the National Company's system.

Coventry.—We have received a copy of the new regulations which have been issued by Mr. J. A. Jeckell with regard to the supply of electrical energy by the Corporation. The Electric Light Committee have agreed to recommend a revision of the scale of charges as from Jan. 1 next, so as to reduce the price after the second hour of daily consumption from 3d. to 1d. per unit, leaving the price of 6d. for the first hour and 3d. for the second hour unaffected. The committee also recommended that rebates be calculated on each quarter's account instead of half-yearly as at present, and that the charge for current for purposes other than lighting be a uniform rate of 1½d. per unit.

Cardiff.—An enquiry into the application of the Corporation for sanction to borrow £107,611 for electrical purposes was held on Tuesday by Major C. E. Norton, R.E. The money will be allocated to general extensions and improvements to mains (principally in the docks district), and for new machinery, boilers, and pumps. According to the evidence given by the town clerk (Mr. J. L. Wheatley) and the borough engineer (Mr. Harpur) it appears expedient for the Corporation to undertake this work with no delay, owing to the increased demand for electrical motive power and lighting, and also to the pressing claims of the South Wales Electric Power and Distribution Company, who, granted the necessary parliamentary provision, may be able to forestall the Corporation.

Swindon.—Mr. W. O. E. Meade-King has held an enquiry into an application of the Town Council for sanction to borrow £31,000 for the purpose of electric lighting. The Town Clerk explained how the electric lighting order first obtained for the district known as Swindon New Town had been extended to both districts—Old and New Town—when the charter making Swindon one municipal borough was granted. The Corporation had already acquired a site for a generating station, loans having been sanctioned for such purpose—loans of £3,100 and £325—on July 5 last. With regard to the order, the Corporation had provisionally invited tenders for the buildings, and the price of these tenders came out practically the same as the figures estimated by the engineers. The same remark applied to the contracts for engines and dynamos.

Swansea Telephones.—Replying to the Swansea Corporation's circular regarding the establishment of a municipal telephone exchange at Swansea, Mr. Wm. E. L. Gaine, general manager of the National Telephone Company, Limited, Victoria-embankment, London, E.C., observes that "Inter-communication is dependent upon the National Telephone Company assenting to it, under the terms of the Telegraph Act, 1899. The company's system in Swansea is on the twisted twin-wire principle, and has been erected with all the latest improvements, and the Corporation cannot, without sacrificing efficiency, arrange its proposed system with greater safeguards against overhearing, etc., than are now in use in connection with the company's system." In order that misleading information might not get abroad, Mr. Gaine has sent his answer to the Press.

Presentation.—On Tuesday the employés at the Corporation's electricity works made a presentation to Mr. H. Tomlinson Lee, A.M.I.E.E., who has been four years assistant engineer, and is leaving to become deputy chief engineer at the Wimbledon Urban Council's electricity works. The electrical engineer, Mr. Blackmore, presided, and after referring to the good relations which had ever existed between himself and Mr. Lee and between Mr. Lee and the rest of the staff, and also to Mr. Lee's readiness in all times of difficulty and hard work, asked Mr. Lee to accept, as a token of the esteem and good wishes of all his colleagues on his departure, a portmanteau (Gladstone pattern) and a well-fitted dressing case, assuring him that he and all the other subscribers hoped he might have health and strength and increasing success in his profession.

Stock Exchange.—The Stock Exchange Committee has appointed Nov. 6 as a special settling day for Vickers, Sons, and Maxim, Limited, further issue of 200,000 ordinary shares of £1 each, fully paid, Nos. 2,000,001 to 2,200,000, and have also ordered Brompton and Kensington Electricity Supply Company, Limited, further issue of 8,000 7 per cent. cumulative preference shares of £5 each, fully paid, Nos. 50,001 to 58,000, to be quoted in the official list.—Applications have been made to the committee to appoint a special settling day in Willans and Robinson, Limited, 16,666 ordinary shares of £5 each (issued at £3 premium), £5 paid (of which £3 is capital and £2 premium), Nos. 125,001 to 141,666, and 16,666 6 per cent. cumulative preference shares of £5 each (issued at £1 premium), £4 paid (of which £3 is capital and £1 premium), Nos. 100,001 to 116,666.

Electricity Charges in Glasgow.—Before Sheriff Strachan, in Glasgow Small Debt Court, Alexander Grant, fruiterer, 375, Duke-street, Glasgow, was sued by Glasgow Corporation Electricity Department for £7. 19s. 8d. for electric light. There was a counterclaim against the Corporation for £12 for cutting off the current. From the evidence it appeared that defender was supplied with electricity at the end of December last on the maximum demand system. On May 31 defender was sent an account for 1,277 units at 1½d. per unit. Defender desired an abatement on the account, which he had paid at the beginning of the year at the rate of 6d. per unit. After evidence was led at length the sheriff gave the Corporation decree for the sum named, stating that defender was in the same position as all other customers. He granted absolvitor in the counterclaim.—*The Scotsman.*

Epsom.—At the last meeting of the Rural District Council a draft notice of objection against the issue of a provisional order to the Leatherhead and District Electricity Company, Limited, was approved. The objection was based upon the following grounds: (1) That in the opinion of the Council the area for which the Leatherhead and District Electricity Company, Limited, propose to supply electricity is far too great; (2) that in order to supply some parts of the rural district of Epsom with electric light it would be necessary for the said company to lay distributing mains through portions of the districts of one or more local authorities who have already obtained a provisional order; (3) that whenever the need or desire for electric light arises in certain portions of the district of the said Council, such light can be more conveniently and advantageously supplied by local authorities and companies now possessed of powers to supply areas adjoining the said rural district; (4) that in the opinion of the said Council electric lighting is not at present required in the greater portion of their district; (5) that whenever the demand for electric light arises in any portion of their district, the said Council will consider the desirability of obtaining a provisional order for the purpose of meeting such demand. The committee recommended that the draft be approved, and that copies thereof be furnished to the Board of Trade and to the company. This course was agreed to.

Water-Tube Boilers.—On Saturday Mr. G. Howard Smith, commissioner to the Board of Trade, concluded a three days' enquiry at Runcorn into the explosion of a tube in a tubular boiler at Castner-Kellner Alkali Company's works, Weston Point. The commissioner was assisted by Mr. Alex. Gray, consulting engineer for the Board of Trade. Mr. K. E. K. Gough conducted the case, and Mr. Collingwood Hope, K.C., represented the company, Messrs. Mather and Platt, Salford, Mr. P. R. Allen, general manager, and Mr. G. H. Garner, engineer to the Alkali Company. It was stated that the boiler was of the water-tube type, constructed by Messrs. Babcock and Wilcox, of Glasgow, in 1897, and that the feed water from the condensers was analysed immediately after the explosion, and only slight trace of grease was found in it. The burst tube was of Swedish drawn steel, and was tested to 1,500lb. pressure to the square inch. Mr. James H. Rosenthal, managing director for Babcock and Wilcox, said the explosion was caused by the presence of grease in the feed water, and the scale formed by the impurities of the water, which caused overheating. The commissioner, in giving judgment, said the opinion of the Court was that the overheating was caused owing to an oily deposit on the iron, and that the boiler was too heavily fired and worked beyond its capabilities, having regard to the way in which it was fed. The Alkali Company and their employés were, however, absolved from all blame, and, therefore, no order would be made as to costs.

London County Council.—At Tuesday's meeting it was agreed to lend the Hackney Borough Council £20,000 for electric light installation and £5,000 for meters; the St. Pancras Borough Council £6,380 for street-lighting purposes; the Hampstead Borough Council £7,480 for electric light installation; and the Hampstead Borough Council £2,810 for electric light meters. The following notices under Electric Lighting Acts and orders were received: from the Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Order, 1897, of intention to lay mains of high and low tension along portions of Burnt Ash-road and Eltham-road, and to construct two transformer boxes in Eltham-road. As these proposed works would be partly in the borough of Lewisham and partly in the borough of Woolwich, the Council agreed to them so far as the borough of Lewisham is concerned. The Woolwich Borough Council strongly objected to the company laying any further mains or doing any further work within the borough, and, in the circumstances, approval of so much of the works referred to in the notice as would be within the borough of Woolwich was withheld. Notices from the Metropolitan Electric Supply Company under the West London Order, 1889, of intention to lay high-tension mains along a portion of Marlborough-hill, and from the Notting Hill Electric Lighting Company, under the Notting Hill Orders, 1889 and 1895, to lay mains along a portion of Addison-gardens, were agreed to. The receipt of notices, as follows, served under orders granted to local authorities, and under which the Council has no power of approval or disapproval of works, was also reported from the Hampstead Borough Council, under the Hampstead Order, 1893, to lay mains along East Heath-road, Priory-road, Cotleigh-road, Belsize lane and road, and Upper Belsize-terrace; and from the Islington Borough Council, under the Islington Order, 1893, to lay mains along Aberdeen-park.

Liverpool.—The Electrical Power and Lighting Committee of the Corporation last Friday received a report from Mr. C. R. Bellamy, the city lighting engineer, in which he stated that under a report dated November, 1893, he recommended that the work of lighting and maintaining the public lamps should be taken over by the Corporation, and an estimate was provided showing that such a change would result in an annual saving of £7,000 per annum. The change commenced a year afterwards. The price was reduced by 10 per cent. by arbitration, resulting in a further reduction of the lighting charge of £2,500 per annum, making a total reduction of £9,500. The total number of lamps in use in the city amounts to 11,905, with an aggregate illuminating value of 2,261½ millions of candles at an annual cost for lighting and maintenance of £36,187. 11s. 8d., the illuminating power being estimated thus: 10-ampere electric arc lamps 500 candles, incandescent gas 40 candles per burner, and ordinary flat at 16 candles. The Chairman (Mr. Higginbotham) said the output of electrical energy for the year ending Dec. 31 last was: for lighting and power 4,888,653, for tramways 6,675,682, being a total of 11,564,336 units, and from the results obtained up to the present it was estimated that the output for the year 1901 would be 20,250,000. The equivalent number of 16-c.p. lamps connected with the supply mains in December, 1900, was 149,495, and in September this year the number was 167,239. The prices charged for electrical energy were: for lighting 4d. per unit, for power 2d. per unit for each unit up to 3,000 per quarter, and 1½d. per unit in excess of 3,000 units per quarter, as against 7½d. for lighting and 5d. for power when the Corporation acquired the business in 1896. The supply mains had been extended during the year to the Anfield and Breck-road districts, where a fair demand had been applied for. When the Lister-drive and the Pumpfields stations were completed, each of these stations would contain plant of 15,000 hp. The report

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just presented by the city lighting engineer indicated the successful way in which the street-lighting of the city had been dealt with. During the past three years the central portion of the city had been lighted by means of electric lamps, the actual cost of the whole of the street-lighting had been reduced by nearly £4,700. A vote of thanks was given to the chairman, to Councillor Dart, the deputy-chairman, and the proceedings closed with many complimentary remarks with regard to the work performed by Mr. Holmes, the electrical engineer, Mr. Bellamy, and the other officials.

Bolton.—At its last meeting the Finance Committee of the Bolton Corporation had before them, for the third or fourth time, the resolution of the Electricity Committee that application should be made to the Board of Trade for sanction to borrow £125,000 for the purposes of the electricity department. After further consideration the Finance Committee acceded to the application. It is proposed, roughly speaking, to expend the amount as follows: £25,000 on building extensions, reservoir, and cooling tower; £62,000 on boilers, engines, a firing floor, and work connected therewith; and the remainder on new mains, services, meters, etc. The scheme will be carried out as the growing needs of the station may demand, but it is proposed to provide for two new sets of engines, each capable of an output of 900 kw., and two of 1,200 kw. each; and it is intended, in course of time, to add about 20 boilers, for the reception of which a new boiler-house will be erected with an additional chimney 201ft. high. Between the two boiler-houses there will be a firing floor, from which coal can be taken and mechanically fed into the furnaces without hand intervention. It is also proposed to extend the lodge and cooling tower, so as to run the whole of the engines condensing, inasmuch as it has been found that since installing these two a saving of 16 per cent. in coal has accrued. With the original plant there will be an effective of 7,000 kw. at the station when the new plant is in. The present maximum load at the works is given at 1,840 kw. To accommodate the large increase of boilers and engines, it is proposed ultimately to extend the existing boiler-house, and also to construct another one to hold a dozen boilers, and to further extend the present engine-house. A considerable amount of revenue is expected in the future to accrue from the increasing demand for motors, and part of the augmented power at the station will be required for the greater motor load. It is interesting to note that when the sum already mentioned is expended the capital of the department will stand roughly at £322,000. The capital cost per kilowatt as represented by that sum is the very reasonable one of £46 or £47. Bolton, occupying the seventh position in this respect among 127 stations, it has the highest position but one (2·23d. per unit) in low selling price, is sixth in order of merit for low cost of production (1·34d.), embracing all charges except capital. It is expected that this year the committee will be able to provide the sum they have already forecast in aid of rates—viz., £2,000. Owing to the substantial sum being set apart for depreciation, it is believed that all the machinery in the station will have been paid for by the time its "life" is ended.

Hackney.—The Electric Lighting Committee last evening submitted the following four candidates to the Council, for the appointment of one of them as borough electrical engineer: F. N. Hooper, assistant electrical engineer, electricity and public lighting department, St. Pancras Borough Council, King's-road Works; H. E. M. Kensit, 2, Norfolk-street, Strand, W.C.; L. L. Robinson, 13, Rowhill-mansions, Lower Clapton, engineering superintendent clerk of the works, Hackney Borough Council electricity works; Norman Staniland, 7, St. Dunstan's-terrace, borough electrical engineer, Canterbury Corporation. A minority report on the above subject was also submitted as follows: "In response to the advertisement, 40 applications were received. Rightly or wrongly, these were voted down to eight selected, and these eight candidates were invited to meet us, with their testimonials, on Monday, 14th inst. On our proceeding to interview these candidates, Mr. Street, Halifax; Mr. Bryson, Leith; Mr. Boot, Tunbridge Wells, desired to withdraw their applications, as their plans and financial arrangements had been much improved. Mr. Boot, who was interviewed by the committee, explained that his Council had raised his salary, and that he was one of the selected candidates for another borough, at an increased salary. He, however, stated that, looking at the possibilities of Hackney, he would come if an understanding as to another £100 per annum was fixed. Your committee having decided to send up to the Council four candidates, it practically left us little choice in the matter. The minority of your committee desire to say very little as to the merits of those left, as one of them might possibly do for the appointment. Another one, although having a theoretical knowledge, has had little or no experience of running a station for any length of time, and might make a good assistant, but is not of the calibre of chief engineer for Hackney. We do not wish our sympathies to run away with our common sense. The installation is already fairly heavily capitalised at nearly £300,000, and in our judgment must be a charge on the rates for, say, at least two years. It follows in the nature of things that various difficulties will arise in starting and running a new station, and, in our opinion, these can only be coped with and overcome by one of experience of years where these difficulties have been surmounted. Three of the best of the candidates out of eight having withdrawn, it is, in our judgment, wiser to readvertise for the appointment, making it £500 as the commencing salary, and thus secure a man fit to take the appointment. On account of the various influences that have been at work, we fear this common-sense view will not be carried, but in regard to the attitude we have always taken in this electric lighting question, that it should not be a permanent expense on the rates, but after a little time the other way, we have felt it our imperative duty to offer this report. In our opinion a good man can save the situation, a second-class man cannot. Anyhow, after submitting this we are cleared, as our report will be on the Minutes No. 1, and we accordingly recommend that a fresh advertisement be issued. All of which we respectfully submit.—JOHN SHEEHAN, ERNEST H. BASSETT, JOSIAH D. DENHAM."

Heckmondwike.—The District Council's electric lighting works are to be opened in the first week of next month. From a description of the works which appeared in the *Reporter* we gather that the electric lighting station is situated in Bath-road, and is part of a building which is also being adapted for the purposes of public baths and fire station, and which extends into High-street. The original scheme provided for two water-tube boilers, made by Messrs. Stewart and Co., each capable of evaporating 4,000lb. of steam per hour, with a working pressure of 160lb. to the square inch, and also capable of working safely up to 200lb. In view of the extensions required for the purposes of the British Electric Tramway Company's scheme, the Council are also installing one of Messrs. Babcock and Wilcox's water-tube boilers, to work at the pressure above named, and with a capacity for evaporating 9,000lb. of steam per hour. This boiler has also a superheater. The Green's economiser of 96 tubes fixed in the main flue will heat water up to 230deg. before it goes into the boiler. Two boiler feed pumps have been fixed, each capable of supplying 1,500 gallons of water per hour, one being of the Blake-Knowles type, and driven by steam, and the other a three-throw pump by the same maker, driven by electric motor. Each boiler is fitted with an injector. The main steam-piping is of lap-welded steel, and is supplied by the same makers as the boilers, whilst the valves are of the Hopkinson well-known make. The two steam generators are each capable of developing 75 kw., and they will run at 460 revolutions per minute, and are both capable of developing 25 per cent. overload without injury. There is also a balancing motor-generator, for keeping the pressure of supply even on the two sides of the three-wire system, and a booster for adding the required pressure to the 'bus bar voltage, for charging the accumulators, and keeping up the pressure on the distant feeder. The engines are made by Messrs. Reavell and Co., Ipswich. The generators and the booster are by Messrs. Fowler and Co., of Leeds, and work at from 460 to 500 volts. Storage batteries are capable of discharging at the rate of 160 amperes for three hours, and are made by the Tudor Accumulator Company. The main switchboard, with the usual instruments and switches, is by Bertram Thomas, of Manchester. An overhead travelling crane has been erected in the engine-room, for use when the larger engines are put into the works at some future time. About 5,000 yards of underground mains have been laid in the principal thoroughfares of the town by Henley's Telegraph Works Company, who are also supplying existing gas lamps with the electric incandescent lights. Along the entire route of the electric cable these incandescent lamps will take the place of gas for public lighting, and 10 "M.D." arc lamps by Messrs. Foote and Milne, London, are being placed in the centre of the town. These are enclosed arc lamps, and burn 150 hours without trimming. The station is being lit up by Mr. Fred Spivey, of Heckmondwike, on a system allowing of its being thrown on either side of the network to help the balancers in keeping the pressure even. The plant is capable of supplying 6,000 8-c.p. lamps, 3,100 of which have already been applied for. Mr. W. C. Hawtayne has acted for the Council as consulting engineer, and Mr. G. H. Carter is resident electrical engineer.

TRACTION.

Paris.—Three motor postal wagons are now taking part in the daily service in Paris. This number is shortly to be increased.

Dundee.—The Tramway Committee have resolved to pay the class fees of any of their employés who may wish to learn ambulance work.

Kirkcaldy.—It is understood that operations in connection with the laying of the proposed electric tramway will be commenced very shortly.

Birmingham.—The Town Council have amended the Edgbaston and Harborne tramway scheme so as to bring the double line down Broad-street.

Burnley.—In about three weeks' time it is expected that the electric cars will be running on certain of the reconstructed sections of the tramways.

Willington Quay.—Operations in connection with the construction of the proposed electric tramways will probably be in progress by the end of the year.

Castleford.—A special meeting of the Urban District Council is to be convened to discuss the agreements entered into in connection with the tramway scheme.

Perth (W.A.).—Subject to the concession being granted, arrangements have been made to extend the Perth electric tramway system to the Osborne Park Estate.

Motor-Van Experiment.—A motorcar having a carrying capacity of two tons is being experimented with by the Caledonian Railway Company as a delivery van.

Perth.—With regard to the proposed municipalisation of the tramway system, the directors of the company have been requested to formulate their demands more specifically.

Darwen.—The new electric light railway between Darwen and the outlying districts of Hoddlesden was formally opened for public traffic last week. The new railway has cost £13,000.

Cork.—A rumour which was current in Cork this week to the effect that Mr. Pierpoint Morgan had acquired the properties of the Cork Electric Lighting and Tramways Company is denied.

Southend.—A representative meeting of owners and occupiers in the west ward has passed a resolution protesting against the introduction of trams west of High-street and south of London-road.

Bromley (Kent).—A conference of representatives of the local authorities interested has been held on the question of introducing electric tramways in the district. The matter is still under consideration.

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Northampton.—The local tramway system has been formally taken over by the Corporation, who have acquired the undertaking at a cost of £37,500. In the near future it is intended to replace the present system by electric traction.

Ipswich.—Sir Frederick Bramwell, the arbitrator between the Corporation and the local tramways company, with regard to the proposed purchase of the undertaking by the town, has given his award, fixing the price to be paid at £17,552.

New South Wales.—A Reuter's message from Sydney states that the tramway revenue for the quarter ended Sept. 30 last amounted to £136,049, as compared with £116,200 in the same period of 1900, while the expenditure was £117,168, being an increase of £20,043.

Garston.—It is reported that the Corporation of Liverpool will shortly take over the undertakings of the Garston and District Electric Supply Company and the Garston District Tramways Company, on terms to be arranged, consequent on the extension of the city boundaries.

Huddersfield.—In consequence of certain facts elicited by an investigation sub-committee, and his refusal to appear before that committee, Mr. J. Pogson, the tramways manager, has been asked to send in his resignation. Mr. Pogson has accordingly handed in his resignation.

Coatbridge.—The manager of the House-to-House Electricity Company has informed the Town Council that the question of proceeding with the construction of the proposed tramways is under the consideration of his Board, but he was unable to say when they will be commenced.

Nottingham.—On Monday the Trent Bridge section of the Corporation tramway system was opened, this being the third section completed within 12 months. The length of the new route is a mile and a quarter, and its inauguration practically dispenses with the last of the horse cars.

Keighley.—The directors of the Keighley Tramways Company in their annual report to the shareholders state that the sale of the undertaking has now been completed, and the purchase money paid to the company. The Corporation have undertaken the working of the system from Jan. 15 last.

Chiswick.—The District Council will oppose the applications of the Middlesex County Council and the London United Tramway Company for orders authorising the construction of light railways in the district when they come before the Light Railway Commissioners. It is stated that the official enquiry into the schemes will be opened on the 1st prox.

Greenock.—The Greenock and Port-Glasgow Tramways Company have applied to the Licensing Court for licenses for 20 cars. One of the magistrates said the only objection he had to make to them was the want of speed indicators. Consideration of the licenses was postponed to see what could be done with regard to lowering the entrance steps of the cars.

Motorcar Record.—News comes from Paris that to Mr. Krieger, the well-known manufacturer, belongs the credit of covering over 190 miles with an electric motorcar on one charge of the accumulators, a feat accomplished when he drove a machine of his own construction from Paris nearly to Châtellerault. The previous best record is said to be 163 miles.

South Shields.—In view of the rejection of the Sunderland and South Shields electric light railway scheme, the South Shields Corporation propose to ask for powers in the Bill of next session for extending the borough system of electric tramways to Harton village. The Property Owners' Association are opposing the proposed municipalisation of the tramways.

Croydon.—The Town Council have confirmed the table of fares on the tramway from Norbury to Purley, which is divided into three 1d. stages. Additional accommodation, consisting of an inspectors' office and mess-room for drivers and conductors, is to be provided at the Brighton road depôt at a cost of £500, and at the Thornton Heath depôt at a cost of £200.

The Price of Delay.—In view of the enquiry which will be opened next week into the question of the electrification of the "Underground" Railway, the following comparison of figures is instructive. While the Central London Railway made a gain of £859 in its traffic returns last week, the combined losses of the Metropolitan and the District Railways amounted to £970.

Temporary Supply.—We hear that the London County Council propose to obtain a temporary supply of electric energy for their tramways on the south side of the Thames, when reconstructed, from the South London Electric Supply Corporation, pending the completion of the Council's own generating station at Greenwich. The agreement is for three years from the commencement of the supply.

Appointment.—Mr. A. E. Rossignol, who for some time has filled the position of electrical engineer to the Corporation of Newcastle-on-Tyne, has now been appointed general manager for the system of electric tramways shortly to be inaugurated in the town. At a commencing salary of £750, Mr. Rossignol will be required to devote himself exclusively to the duties of business manager and electrical engineer to the tramways.

Sheffield.—The Corporation on Wednesday rejected a proposal from the Tramways Committee to apply for a provisional order for the construction of two new tramways—viz., a tramway from Fitzalan-square, along Norfolk-street and Union-street, connecting with the present tramway at the Moorhead; a tramway from Fargate, along Barker's Pool, Division-street, and Devonshire-street, connecting with the present tramway in Glossop-road.

Soothill.—At a meeting of the district authority on Monday plans of the new tramway it is proposed to construct by the British Electric Traction Company through a portion of Soothill Upper were considered. It was stated that the company intend to lay a double line from Dewsbury to Birstall if the necessary powers can be obtained, and the plans were conditionally passed upon the substitution of granite for local stone between the rails.

Portsmouth.—The heavy rains which fell last week flooded several of the main streets of the town, with the result that the tramway service was seriously interrupted. In some cases the water reached up to the car platforms, and the service was entirely suspended for a considerable time. According to the local newspaper reports, the motors on the cars also became clogged by the thick water, but in the majority of the cases no serious damage was done.

Gourock.—The Town Council have adopted a resolution that the Electricity Committee meet representatives from the adjoining burghs with a view to endeavouring to come to some arrangement in regard to the question of the Sunday running of the trams. In regard to the matter of Gourock's objection to Greenock supplying the tramways company with electrical power to run cars in Gourock, it is considered a gross violation of the Greenock provisional order.

Batley.—The Corporation have just received permission from the Board of Trade to serve a notice upon the Dewsbury, Batley, and Birstall Tramways Company requiring them to sell to the local authority such portion of their undertaking as is within the borough. An interesting state of things now exists, for only a fortnight ago the British Electric Traction Company's offer to the tramways company to purchase the whole of their undertaking was accepted by the shareholders.

Accident at Shepherd's Bush.—A collision occurred in the Goldhawk-road, Shepherd's Bush, on Wednesday evening, between a motorcar and an electric tramcar. From an account given by an eye witness, it appears that the motor, in which four gentlemen were seated, tried to pass in front of the tramcar, being forced into this extremity by the presence of a truck which was standing by the kerb. The tramcar crashed into the motor with great force, the occupants of the latter vehicle being all thrown heavily into the roadway. One of the gentlemen sustained very serious injury to his head, and was removed at once to a doctor's residence.

Manchester Carriage and Tramways Co.—At the half-yearly meeting of this Company on Tuesday it was resolved to obtain registration as a limited company, in view of the concern being taken over by the Corporation, so that they might have the option of voluntarily winding up. The arbitration to determine questions which have arisen between the Manchester Carriage and Tramways Company and the Corporation of Manchester in connection with the taking over of the tramlines has been resumed before Sir F. Bramwell at the Surveyors' Institution, London. The chief points at issue are the value of lines owned by the company in the city and outside districts, what quantity of the rolling stock, depôts, and other properties should be taken over, and the price to be paid.

Claims for Accidents.—We note that Lord Stormont Darling has closed the records and ordered issues in the three following actions against the Corporation of Glasgow for damages in respect of personal injury and death on the electric tramway system of the city. In one case the pursuer sued for payment of £5,000, as damages for the death of pursuer's husband, Andrew Noble, merchant, Torry, on June 12 last, from injuries which he received on May 17 previous in a collision between an electric car and a horse car, both belonging to the Corporation. In the second the action was brought by a sick nurse for payment of £250 damages for injury to her knee sustained while entering an electric car, which at the moment was set in motion. The defendants stated that the accident was entirely due to the pursuer's fault in attempting to board the car while in motion. The third case was also one of personal injury to a coal merchant of the name of John M'Ritchie, who sued for the payment of £500. The pursuer fell over a rope which was put up by the defendants to prevent the public crossing where they were carrying on operations in connection with the tramways. The Corporation contended that had the pursuer been exercising ordinary care he would have seen the opening for the electric cable and the rope, and could have avoided them, as there was ample room as well as plenty of light.

Speed of Tramcars.—On Monday last evidence was taken before Sheriff Fyfe in the Glasgow Sheriff Court in the case in which the Corporation of Glasgow were charged, at the instance of Mr. Thomas Simpson, of Pollokshields, with contravening the Board of Trade regulations regarding the speed of electric cars by running their cars on 24 occasions on Sept. 6 and Sept. 9 in Albert-road, Pollokshields, above the legal speed of eight miles per hour, to the danger of complainer and his family. Witnesses in support of the complaint stated that 600 cars had been carefully timed, and that not one of them was running at a less speed than 10 miles an hour. For the defence a letter was submitted from the Board of Trade in which various speeds were laid down for specific streets, and provided that for the remainder the maximum should be 10 miles per hour. The letter further showed that the Corporation's request that their cars should be permitted to run 12 miles per hour could not be acceded to until the cars were fitted with speed indicators. The Sheriff, in giving his decision, remarked that what the complainant really meant to establish was that the cars were being run at such speeds as to constitute them a public danger to himself and his family and everybody else who happened to be in the neighbourhood. He (the sheriff) could not take a general proof of the public danger, which was largely a matter of opinion, dependent upon the circumstances of the streets as qualifying the interest of a private prosecutor for a contravention of the Board of Trade rules. He did not think the prosecutor in the case, who was bound to prove his interest to prosecute, just as he was bound to prove the speed of the cars or any other fact in the case, had succeeded in leading evidence sufficient to establish his interest to bring the prosecution. The decision, therefore, would be "not proven." It was intimated that an appeal to a higher tribunal would be lodged.

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Salford.—Fares on a number of the Corporation tramway routes have been considerably reduced, and some fresh stages have been introduced. A new section between Regent Bridge, the terminus of the Manchester halfpenny cars from Deansgate, and Weaste was opened on Monday.

Union Construction Co.—We note that a new company has been registered at Somerset House, with Mr. C. T. Yerkes on the board of directors, under the above title with a capital of £200,000. The object of the company is stated to be to undertake and carry into effect the application of electric equipment and traction to railways and tramways in the United Kingdom and elsewhere.

Paignton.—A discussion took place at the last meeting of the District Council on the proposal of the Provincial Electric Supply and Traction Company, who intend to apply to the Board of Trade for a provisional order for lighting the town by electricity and to connect it with Torquay by a system of electric tramways. It was agreed to meet the engineer to the scheme for the consideration of details.

Glasgow.—Since the beginning of the present financial year on June 1 the drawings from the Corporation tramways have amounted to £242,110. 5s. 8d., as against £182,007. 9s. 6d. in the corresponding period of last year—an increase of £60,102. 16s. 2d. During the 22 complete weeks the exhibition has been open the drawings have amounted to £273,949. 14s. 5d., as compared with £208,063. 0s. 1d. in the corresponding period of last year, an increase of £65,866. 14s. 4d.

Ham (Surrey).—The District Council have decided to inform the County Council that they object to the proposed tramway scheme, principally on the grounds (*a*) that there is no necessity or demand for tramways through Ham and Petersham, which would be of little use to the inhabitants, who were opposed generally to the scheme; (*b*) that an electric tramway (especially with overhead wires) would spoil the rural character of the scenery of the village and commons, and (*c*) that, owing to the narrowness of the road in some parts, it was not suitable for tramlines.

Devonport.—Terms for leasing to the district company the new lines of the Corporation are now under consideration. The interest and sinking fund charges are to be spread over 30 years and borne by the company, and the capital expenditure will include a permanent car-shed for the St. Budeaux line. The lease is to be for 21 years, and fares are not to exceed 1d. per mile. Electrical energy is to be supplied by the Corporation, and the latter are to use the lines at any time for conveying coal to the gasworks. Rent at the rate of £30 per mile of line per annum is to be paid by the company.

Brighton.—A proposal was brought before the last meeting of the Town Council from Mr. J. Coley Bromfield that the Corporation should apply for powers to construct and work a monorail railway between London and Brighton at an estimated cost of £3,500,000, in accordance with the scheme prepared for the syndicate which he represents. The General Purposes Committee of the Council, it was stated, considered the scheme "utterly absurd," and quite outside their duties. They therefore merely acknowledged it in the simplest possible way. The committee's action was confirmed.

Dublin.—The proposal to construct a tramway from Dublin through Ashbourne to Slene was discussed at a meeting of a number of gentlemen interested in the project last week. It was stated on behalf of Mr. Fraser, C.E., that the line would be about 25 miles. To equip it with electricity would cost about £5,000 a mile; steam power would be less, and oil-motors would be the cheapest. If the County Councils of Dublin and Meath would guarantee 4 per cent. on the capital, the engineer would find the capital and construct the line. The meeting made arrangements to bring the scheme before the county councils.

Ilkeston.—Messrs. Dick, Kerr, and Co., the contractors, are hurrying on the preparations for laying down the electric tramways at this place, and it is expected that the work will be completed within six months. The length of the lines proposed is over three miles, and they extend from the northern and southern extremities of the borough. Arrangements have been made with the Derbyshire and Notts Electrical Supply Company to furnish the requisite energy for the tramways and electric lighting, the company undertaking to do so on or before Aug. 7. next. The principal streets of the town are to be lighted by arc lamps.

Mannofield.—It has now been officially announced that a syndicate has been formed to apply for a provisional order for the construction of a line of tramways from the present terminus of the Aberdeen city tramways at Woodside to Dyce, and from the present terminus at Mannofield to Culter, at an estimated cost of between £50,000 and £60,000. Plans are being prepared by Mr. George Gordon Jenkins, which will be submitted to the Council for approval at an early date. It is proposed that the tramways in question will be laid in the centre of the roads, and will be a single line. The motive power will be electricity on the overhead trolley system.

Bridge of Allan.—Referring to the proposed purchase of the Stirling and Bridge of Allan tramways at the annual meeting of the company, the Chairman said that since last year little advance had been made with the negotiations between the Corporation of Stirling and the traction company. The former had intimated their intention to take over the portion of the original undertaking in the burgh of Stirling, but so far no steps had been taken to carry this intention into effect. He might say that the most friendly relations had always existed between themselves and the Corporation of Stirling, and they hoped that the friendly relations would continue.

Bournemouth.—A deputation, representing the Anglican clergy and the ministers of the Free Churches, has waited on the Town Council in opposition to the running of omnibuses and motorcars on Sundays, and also to secure the support of the Council in preventing the running of municipal trams on Sundays when they are constructed. The Council have agreed that, inasmuch as the owners and occupiers of property in Holdenhurst-road have shown by their claims for compensation, amounting to about £50,000, that they are not favourable to the proposed street improvement, they will not proceed further with the Holdenhurst-road improvement, and the tramlines will be laid in the middle of the road.

New Zealand.—According to the *New South Wales Railway Budget*, the ceremony of the first breaking of the ground in the construction of the Auckland electric tramways was performed by the Mayor on Aug. 1. The contractors are Messrs. White, of New York. During his speech the Mayor said that the Auckland Electric Tramway Company would have to invest more than £300,000 in the scheme of electric tramways for the city, of which about £120,000 would be spent in local material and labour. The length of the various lines in the city and suburbs would amount to almost 20 miles, of which the greater portion would be double track. In single track the mileage in the city and suburbs would be about 34 miles.

Manchester-Salford Dispute.—In accordance with the resolution of the Salford Corporation on Wednesday week, the town clerk has written to the town clerk of Manchester suggesting that the tramways dispute should be referred to arbitration upon a basis which would give either Corporation the right for 21 years to run its trams over certain of the permanent ways of the other. The town clerk, however, adds the important qualification: that the right to run cars in each case is not to exclude the owning Corporation from using its own tramways to the fullest extent for all local traffic. The Manchester Tramways Committee considered Salford's proposals on Tuesday, and, as the result of a brief discussion, the matter was referred to the Negotiations Sub-Committee.

Liverpool.—A statement was made at a meeting of the Tramways Committee last week showing the enormous development of tramway traffic in the city since the introduction of electric traction. The whole tramway system, it was stated, now comprised 100 miles of track, operated by means of 350 cars carrying over 2,000,000 passengers a week. The number of passengers carried in the first nine months of the present year amounted to 75,000,000, against 29,000,000 for the corresponding period of 1897, and the traffic returns amounted to £350,000, as compared with £219,000. The gross profits for the present year to the end of September amounted to £115,000, which, after providing £75,000 for interest and sinking fund, and fully maintaining the whole system, left a net profit of £40,000 for the nine months.

Swansea.—The County Council have decided upon the construction of tramways from the existing line in Carmarthen-road, near Zoar Chapel, along Llangyfelach-road, Pentre, and Brynhyfryd to the old Swansea coalyard, near the Dillwyn Arms, with lines over the Eaton-road and Llangyfelach-road from the Commercial Inn; and from the existing tramway in High-street through Castle-street to a junction with the intended tramway adjoining the head post office. The borough surveyor is instructed to proceed with the preparation of the necessary plans, estimates, etc., for the proposed extensions, in view of application being made to Parliament in the next session for power to construct the same. It is also agreed to extend the tramways along Cwm Level-road to a junction with the existing tramways in Neath-road, Plasmarl.

Aberdeen.—The Corporation have decided to proceed with the electrical equipment of the Union-street section of their tramway system at an estimated cost of £5,000. The borough surveyor is of opinion that by using shallow-flanged wheels on the cars a few years' longer life can be obtained from the present rails. It will be necessary, however, to make the joints more rigid by fitting in sole-plates, bolted firmly to the bottom flanges. The cost of the alterations he estimates at £1,200. Mr. Bell, the electrical engineer, estimates that the cost of a span-wire system of electric equipment would amount to £3,123. Cables are also to be laid at this time to deal with the Albyn-place and Backview route between Crown-street and Holburn-street, between which points it will be necessary to open up the common ground for the Union-street and Albyn-place route. The expenditure on this work he puts at £569, making altogether a total expenditure of close upon £5,000.

Lizard Light Railway.—Colonel Boughey and Mr. Steward, Light Railway Commissioners, have held an enquiry relative to the application of the promoters of the scheme to substitute level crossings for bridges on the line. It was explained on behalf of the promoters that originally negotiations were entered into with the Great Western Railway Company for making the line. Afterwards, however, Messrs. Hiram Maxim and Co. proposed to construct and work the line by electricity, and obtained the consent of the various authorities to level crossings being substituted for bridges. Subsequently, however, the promoters found that to work the line by electricity would be impracticable, and that they could work it more economically by steam. That was the reason for making the application. The line was perfectly open, and an approaching train could be seen half a mile away. The maximum speed of the railway was only 25 miles an hour, and 10 miles an hour within 300 yards of any of these level crossings. The Commissioners eventually granted the application.

Newcastle-on-Tyne.—An arbitration court is sitting in Newcastle to consider the compensation to be paid to property owners in Osborne-road, Jesmond, for portions of their gardens that are required for the new tramways. The following appointments have been made by the New Tramways General Purposes Committee: Mr. Cowper, traffic manager at Glasgow, is appointed traffic manager of Newcastle tramways at a salary of £200 per annum; Mr. E. H. Fleming is appointed stocks superintendent at a salary of £200 per annum; and Mr. H. Richardson is appointed superintendent of the power station at a salary of £200 per annum. The draft of the new Bill to be presented to Parliament embodying special powers for extending the tramway system to Wallsend and other parts of the immediate district will be submitted to the City Council for confirmation shortly, and, if adopted,

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sent on to the committee of the House of Commons. Amongst the proposals insisted on is the clause relative to the fixing of rosettes or brackets on various buildings on the different lines of route.

Pontypridd.—The Earl of Jersey, Colonel Boughey, and Mr. Allen Steward, Light Railway Commissioners, have held an enquiry into an application by the British Electric Traction Company for power to construct a light railway through the centre of the town from the Tabernacle Chapel to the terminus of the company's existing tramway between Porth and Pontypridd, and also for powers to compulsorily purchase certain land. Considerable interest attaches to the proposal, as the District Council have already secured powers to construct a light railway from Tabernacle-square to Cilfynydd, and also to Treforest, and shortly contemplate applying for similar powers as those now sought for by the Traction Company in the town. The company have been granted an order by the Commissioners to extend the tramway from Porth to Tonypandy, but it has not yet been confirmed by the Board of Trade, and the Rhondda Urban Council will strenuously oppose it. The present application was granted by the Commissioners pending the sanction of the Board of Trade.

London County Council.—Without discussion on Tuesday the Council decided to authorise the Highways Committee to give notice to the North Metropolitan Tramways Company of the intention of the Council to put in force the provisions of the lease, granted to the company, of the Council's (northern) tramways undertaking, which relate to the adoption of electrical traction for the working of the tramways. The committee's report on the subject stated that last November, in order to expedite the adoption of such system, the Council passed a resolution asking the company to name the price at which they would surrender the lease. The company, however, declined to name any price. The Highways Committee have since been endeavouring to find some way of expediting the adoption of electric traction for the tramways, and, having regard to all the circumstances, they recommended the present course as the best one open to the Council to take. The Council have further decided to apply in the next session of Parliament for powers to acquire compulsorily certain land for the proposed enlargement of the Clapham tramway depôt.

Tunnelling under St. Paul's.—A question was put to the Lord Mayor, in his capacity as a trustee of St. Paul's Cathedral, at the meeting of the Court of Common Council as to what steps were being taken to ensure the safety of the cathedral, and also to safeguard it against tunnels in contemplation. His Lordship said Mr. Somers Clarke, the architect to the dean and chapter, informed him that the dean and chapter were taking the only steps that were open to them in defence of the cathedral. They were preparing to oppose in Parliament the Bill or Bills for railways which it was proposed should pass near the cathedral. The chapter had no desire to stand in the way of public convenience, but as guardians of so great a national monument, they had no other course open to them. The chapter had not proposed to undertake any structural works to defend the safety of the fabric. In the first place, it was not absolutely known what the nature of the attack might be; secondly, the cost of any adequate works would be very great, and, thirdly, the chapter were entirely without funds to meet such expenses—indeed, there were not, as it was, sufficient funds to keep the cathedral in thorough repair.

Vale of Rheidol Light Railway.—Colonel Boughey, C.S.I., and Mr. Henry A. Steward, Light Railway Commissioners, have held an enquiry as to the expediency of granting the application of the Vale of Rheidol Light Railway Company to authorise the Vale of Rheidol light railway order of 1901, which proposes a continuation of the light railway to the town of Aberayron, 16 miles from Aberystwyth, and which place is at present without railway communication of any kind, the nearest towns being Aberystwyth to the north, and Lampeter, on the Manchester and Milford Railway, to the south. It was explained that the application was first to have both the Devil's Bridge and the Aberayron lines put under the Act of 1868 instead of 1897, that the time for completing the extension should be extended by two years, that level crossings should be substituted for bridges, and that powers should be given to the County Council and other local bodies to lend money or make advances by taking a certain proportion of the share capital. Unless the Treasury were prepared to make a substantial free grant of money to that poor neighbourhood, there was no chance of the railway being constructed. Colonel Boughey said they would be pleased to frame an order for submission to the Treasury, in accordance with the application that day, but in respect to the application to the Treasury the Commissioners could do nothing in the matter until they were applied to by the Treasury.

The Falk Weld.—With reference to Mr. J. More's paper on "Recent Tramway Practice," which appeared in a recent issue of this journal, Messrs. Robert W. Blackwell and Co. write to us with regard to the Falk weld. This firm are the exclusive representatives in the United Kingdom for the Falk weld, and they ask us to state that they are willing to guarantee that the conductivity of the joint will be equal to the conductivity of the rail itself, and that this will be the case two years after the joints have been made. They are also willing to guarantee that the total breakages within the first two years will be under 2 per cent. As all those connected with track work are aware, the life of the track depends on the life of the joints. Where mechanical, and especially electrical traction, is adopted, up to the present no mechanical joint has been discovered which will prevent hammering after, say, two or three years' service. This hammering diminishes the life of the rail, as well as increasing the cost of maintenance, trucks, motors, and cars. By putting in Falk welding this trouble is said to be entirely done away with, as the joint becomes the strongest portion of the track. As regards the question of actual welding, it is, of course, impossible that an actual weld should take place between the cast iron and the steel of the web of the rail. In practice, however, it has been found that the assimilation between the cast iron and the steel is so great that if an attempt be made to pull these apart, the cast iron will bring away with it parts of the web of the rail. Messrs. Blackwell will at all times be glad to give information to any persons interested in Falk welding.

Tynesalde Tramways Co.—At a general meeting of the shareholders in this Company held at Newcastle-on-Tyne on Monday, Mr. W. A. Watson-Armstrong was unanimously elected chairman, and the following directors were also appointed: Messrs. J. H. Armstrong, G. E. Henderson, Summers Hunter, Dr. J. T. Merz, and Messrs. J. H. B. Noble and James Tennant. A report was read by Dr. Spence Watson on the present position of affairs, which showed that the Company were to pay the preliminary charges and expenses, amounting to about £10,000, which sum included every payment and disbursement. The Act which received the Royal assent in August last, and which conferred powers for the construction and working of tramways in the riverside district between the Walker boundary in Wallsend and Prudhoe-street in North Shields, was presented. The County Council, two corporations, five urban sanitary authorities, one rural district council, two urban councils, the River Tyne Commissioners, and the Duke of Northumberland all had to be consulted in the preliminary stages, and arrangements had to be come to with each as to special rights and desires. The Newcastle Corporation and the Walker local authority were the only opponents, and they opposed in the House of Lords as well as in the House of Commons. The directors, under the powers given them by the Act, had laid plans before the Wallsend Council for the construction of car-sheds in Neptune-road, and the local authority had communicated to the engineers and solicitors of the Company the resolution they had come to that they were prepared to consent to this line subject to the rights of owners and occupiers, and to its construction being subject to the approval of the surveyor to the Council, and to the Company further undertaking to apply for parliamentary powers in the ensuing session of Parliament for an extension of their line from Carville Station to the end of Hadrian-road, and along any new road which might at any time be made to the east of the Wallsend district, and also to carry their lines westward from Carville Station to the westernmost boundaries of Wallsend. The prospectus of the Company will be issued at an early date.

London "Tube" Schemes.—A combination of interests is reported to have been arranged between the Brompton and Piccadilly and Great Northern and Strand electric "tube" railways (the construction of both of which has been for some years authorised by Parliament), under which a through line will be made from the northern suburbs of London to South Kensington, connecting the systems of the Great Northern and the Metropolitan District Railway Companies. The scheme is contingent upon parliamentary powers being obtained for a link line to run under Shaftesbury-avenue from Piccadilly-circus to High Holborn; but no difficulty as to this is anticipated, as the Joint Parliamentary Committee of last session recommended the extension of the Brompton and Piccadilly line in a northern direction. The *Standard* understands that the present scheme has been arranged through the agency of Mr. C. T. Yerkes, who is also taking the lead in the construction of the Charing Cross, Euston, and Hampstead "tube." The new through line now proposed will have an exchange station with the Charing Cross line at the Oxford-street end of Tottenham Court-road. There will also be an exchange station at Piccadilly-circus with the Baker-street and Waterloo line (now under construction), and another with the Central London at Holborn. Arrangements have been made for the Brompton and Piccadilly section to be commenced forthwith, Messrs. Walker, Price, and Reeves, of Westminster, having undertaken the contract. It is premature to state the precise arrangement made with the Great Northern and Strand Railway Company, which was promoted in 1899 as an offshoot of the Great Northern, and whose line is planned to run under the Great Northern main line between Wood Green and King's Cross. It is likely, however, that a new company will be formed to control the through route. It may be remembered that the Great Northern and City Railway—a similar "tube" line from Finsbury Park to the City—is being constructed by a company quite independent of the Great Northern; but it is unlikely that the latter would give up altogether the control of a line which is to run under their own main line for a distance of six miles.

Tramway Securities as Investments.—Under this heading Mr. Emile Garcke, managing director of the British Electric Traction Company, writes to the *Financial Times* in order to give a few striking instances of how the inauguration of a new means of communication discovers many hidden and unsuspected sources of traffic, with the result that a new or reconstructed undertaking is placed upon a dividend-paying basis from the very commencement, notwithstanding the large capital outlay required for the adoption of electric traction. The letter runs: "In the middle of March the Tynemouth Electric Traction Company commenced to run on 3¾ miles. This is an old steam concern, which has been taken over by the British Electric Traction Company, converted to electric traction, and extended. Within five months the electric cars have carried nearly one million passengers, as against less than 350,000 per annum formerly, and the ratio of working expenses to receipts has fallen by some 40 per cent. At the beginning of April two entirely new electric lines were started at Merthyr Tydfil (three miles) and at Poole (3¾ miles). Neither of them is as yet working under the most favourable conditions. Nevertheless, the cars at Merthyr have carried in a little over four months nearly 900,000 passengers, and those at Poole over 800,000, the earnings per car mile and the working expenses being in both instances better than was anticipated. In May last the Gateshead tramways, an old steam line, commenced running electrically on about eight miles. This reconstructed and extended system has carried over 2,000,000 passengers in the first three months, as against 1¼ millions per annum under the old *régime*. I could mention many other similar results and some very much better, and, of course, these figures are nothing compared with the traffics on metropolitan tramways like those in the West of London,

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but I quote these particular instances as showing what can be done even in comparatively sparsely-populated districts. In 1900 the entire British Electric Company's systems carried some 75,000,000 passengers. For 1901 the total will be about 100,000,000. Quite apart from increase of population and extensions of line, this total will rapidly mount up as the habit of using the electric car becomes more and more pronounced, and traffic managers emancipate themselves more thoroughly from the traditions of the horse car. A comparison of these figures with the traffic of our steam railways, regard being had to the miles open, will give your readers some idea of how vast and how different is the traffic carried by electric cars."

PROVISIONAL PATENTS, 1901.

Oct. 14.

20491. Improvements in and appertaining to starting devices for electromotors. George Nevil Thomas, 8, Lombard-chambers, Bixteth-street, Liverpool.

20497. Improvements in cable terminal boxes for electricity supply purposes. George Wilkinson, Kirkside, Bilton, Harrogate.

20501. Electromagnetic sliding brake, with hand-power attachment. Jesse Greenhalgh, 6, Furnace-street, Flowery Field, Hyde, Manchester.

20504. Improvements in arc lamps. John Owden O'Brien, 6, Bank-street, Manchester. (Charles Jacquiot-Constant and H. Lavollay, France.)

20515. A leather or other material insulator cap or hand protector for electric car brake handles or other handles. Edward Nock, 124, Upper Essex-street, Liverpool.

20561. An improved feeder or junction box for electric mains. Hugh McGillivray and George Carr, 18, Buckingham-street, Strand, London.

Oct. 15.

20596. Improvements in wireless electric signalling appliances. William Miller Walters, 4, Clayton-square, Liverpool.

20602. A device for safely gripping and securely holding an electrical conductor while at dangerously high potential. George Thompson and Paul Sommerville Thompson, 23, Massey-park, Liscard, Cheshire.

20609. Improvements in arc lamps. John Tourtel, 146A, Queen Victoria-street, London.

20612. Improved electric switch and circuit breaker. Veritys, Limited, and Edwin John Selby, 165, Queen Victoria-street, London.

20619. Improvements in electric telegraphy. Alfred René Upward and Alice Marie Rivett-Carnac Le Mesurier, 19, Perrymead-street, Fulham, London.

20628. An insulating coating replacing indiarubber and gutta-percha and intended to insulate the wires having the property of conducting electricity. Eugène Louis Joseph Sénéchal de la Grange, 56, Rue de Londres, Paris. (Complete specification.)

20651. Improvements relating to electric arc lamps. Hermann Otto Schmidt, 45, Southampton-buildings, Chancery-lane London. (Complete specification.)

20661. Improvements in electrically-driven apparatus for raising and lowering loads, especially applicable to the lifting tables of rolling mills. August Schwarze, 70, Chancery-lane, London. (Complete specification.)

20664. Improvements in signal telegraphs. Erwin Lavens and Edward Joseph Lavens, 18, Buckingham-street, Strand, London. (Complete specification.)

Oct. 16.

20722. Improvements in the renewal and repair of incandescent electric lamps. Thomas Archer Rose, 7, Elsenham-gardens, Southfields, London.

20732. Improvements in means for regulating electric currents applicable to the lighting, heating, and ventilating of railway trains and other structures. Edwin Mumford Preston, of the firm of J. Stone and Co., 77, Chancery-lane, London.

20752. A new or improved means of adjusting the height of suspended articles, such as electric lamps and the like. Henry Wilkinson, 99, Cannon-street, London.

Oct. 17.

20788. Improved apparatus for trueing up commutators of dynamos. Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster, London.

20818. Improvements in and relating to means for the avoidance of hunting of synchronous alternate-current machinery running in parallel. Henry Cook Leake, 322, High Holborn, London.

Oct. 18.

20845. Improvements in electrical storage cells or accumulators. Robert Barclay Sangster, 115, St. Vincent-street, Glasgow.

20852. Improvements in the method of producing fabrics or aprons for conveying rubber or the like to be used in the manufacture of electric cables or for other purposes. Frank Reddaway, 5, John Dalton-street, Manchester.

20931. Improvements relating to electric telegraphy. Donald Murray, 323, High Holborn, London.

Oct. 19.

20945. Improvements in means to be employed in the electro-deposition of metals. The Cowper-Coles Galvanising Syndicate, Limited, and Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

20950. Electrical calculating machine. Henock Froman, 3, Berny-buildings, Grove-street, Commercial-road, London.

20952. Improvements in and relating to overhead electrically-driven vehicles. Thomas Slack and Thomas Whitaker, Wellington Machine Works, Stockport.

20959. Automatic electric point shifter. William Gibson Primrose, 172, Mottram-road, Hyde, near Manchester.

20967. Improvements in the manufacture of electric incandescent lamps. T. W. Lowden, 39, Victoria-street, Westminster, London.

21001. Improved means of displaying advertisements by wireless telegraphy. Andrew Gilligan Macculloch and Herbert Dickinson, 2, Camden-gardens, Shepherd's Bush, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 9.

1900.

18534. Electrically-operated clocks. Andersson.

18613. Rectifiers for periodic electric currents. British Thomson-Houston Company, Limited. (Lunt.)

18614. End-play devices for rotary electrical machines. British Thomson-Houston Company, Limited. (Geisenhoner.)

18618. Electrical indicating and measuring instrument. British Thomson-Houston Company, Limited. (Robinson.)

18738. Lifeguards or fenders for electric cars and other vehicles. Horsfall, Heathcote, and Bridge.

18789. Electricity meters. Ostenhusen.

18820. Electric arc lamps. Bremer.

19072. Electric accumulators. Gibbs.

19183. Electrical pushes and switches. Harcourt.

20135. Control of electrically-propelled vehicles or trains. Tyler and Hansard.

20662. Cap or cover for the handles of brakes on electric and other cars, and of machinery, such as presses and engines, where hand power is applied. Symes.

21025. Electric railways on a sectional conductor or like system. British Thomson-Houston Company, Limited. (Hild.)

21450. Methods of transforming alternating electric currents. British Thomson-Houston Company, Limited. (Woodbridge.)

21880. Electrical governing or controlling apparatus. Moy and Bastie.

22196. Electric arc lamps. British Thomson-Houston Company, Limited. (Thomson.)

22197. Electric arc lamps. British Thomson-Houston Company, Limited. (Thomson.)

22281. Means for suspending electroliers, electric lamps, and the like. Fletcher.

22819. High-tension electric fuses. Eckstein and Krause.

23104. Systems of electric motor control. British Thomson-Houston Company, Limited. (Armstrong.)

23163. Portable apparatus for wireless telegraphy for military and other purposes. Fleming and Marconi's Wireless Telegraph Company, Limited.

23366. Electric motors. Whiteley.

1901.

1267. Prepayment electricity meters. Schattner.

5791. Electric incandescent lamps. Fessenden.

6242. Electric demand indicators. Cowderoy.

9276. Electric heating body. Timar.

10053. Trolley wheel for overhead wire systems of electric traction. Munro, Brecknell, and Rogers.

10215. Casings or coverings for electric conductors in buildings. Golding and James.

11529. Manufacture of electric lighting, heating, and resistance bodies. Boehm.

13478. Electric railways with overhead collectors. Bach and Richard.

15130. Electric stoves or heaters. Greville.

17025. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Lunt.)

17144. Supporting devices for brush-holders for dynamo-electric machines. Fox.

17187. Cells of primary batteries. Lessing.

17193. Electric switches or circuit breakers. British Thomson-Houston Company, Limited. (Hewlett.)

17561. Electromagnetic spark extinguishing or arc-preventing device for electric switches. Bertram.

18329. Electric circuit breakers. British Thomson-Houston Company, Limited. (Hewlett.)

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TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	—	—	—	—	—	—
Birmingham Tramways	Oct. 19	4,834	4,432	+ 402	189,874	— b
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 18	555	414	+ 141	21,219	18,909b
Blackpool Corporation	,, 17	489	333	+ 156	34,771	25,947
Blackpool-Fleetwood Tramways	,, 19	300	259	+ 41	19,170	18,664b
Bolton Corporation	—	—	—	—	—	— b
Bradford Corporation	,, 18	1,187	515	+ 672	37,472	18,527
Bristol Tramways Company	,, 18	4,040	2,994	+ 1,046	—	—
British Electric Traction—						
Croydon	,, 18	689	—	+ 435	12,788b	— a
Devonport	,, 18	261	—	—	6,874c	—
Dudley-Stourbridge	,, 18	719	—	+ 383	27,741b	—
Gateshead	,, 18	602	—	—	13,768i	—
Greenock-Port Glasgow	,, 18	209	—	—	442e	—
Hartlepool	,, 18	232	—	+ 41	9,627b	—
Kidderminster	,, 18	119	—	+ 29	5,256b	—
Merthyr	,, 18	243	—	—	7,386f	—
Oldham-Ashton	,, 18	514	—	+ 500	21,108b	—
Poole	,, 18	240	—	—	8,484f	—
Potteries	,, 18	1,428	—	+ 260	58,752b	—
Southport	,, 18	157	—	- 8	7,086b	— a
South Staffordshire	,, 18	846	—	+ 107	32,693b	—
Swansea	,, 18	456	—	+ 67	18,638b	—
Taunton	,, 18	75	—	—	870g	—
Tynemouth	,, 18	188	—	—	9,001h	—
Wolverhampton District	,, 18	89	—	+ 37	2,684b	—
Carlisle Tramways Company	—	—	—	—	—	—
Central London Railway	,, 19	6,325	5,466	+ 859	—	—
City and South London Railway	,, 20	2,071	1,708	+ 363	30,371	24,592
Cork E. T. and L. Company	,, 17	454	410	+ 44	19,725	17,463b
Darwen Corporation	,, 18	213	159	+ 54	7,892	6,417
Dover Corporation	,, 19	218	198	+ 20	9,354	8,875b
Dublin & Lucan Electric Railway	,, 20	103	85	+ 18	2,100	1,808
Dublin U. T., electric cars	,, 18	3,544	3,468	+ 76	—	—
Dublin S. District, Electric	,, 18	781	749	+ 32	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 19	13,657	9,251	+ 4,406	—	—
Halifax Corporation*	,, 13	2,114	1,526	+ 588	—	—
Huddersfield Corporation	,, 12	921	700	+ 221	27,115	20,174
Hull Corporation, E. S.	,, 19	2,210	1,574	+ 636	28,615	22,237
Liverpool Corporation	,, 12	9,260	8,625	+ 635	368,934	323,479b
Liverpool Overhead Railway	,, 20	1,461	1,594	- 133	26,446	27,376
Portsmouth Corporation	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 20	3,727	—	—	—	—
Southampton Corporation	,, 17	892	687	+ 205	—	—

a Part. *b* From Jan. 1. *c* From June 21. *d* From April 1 *e* From Oct. 3. *f* From April 5. *g* From Aug. 21. *h* From March 22. *i* From May 8.
* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £95 increase.
Barcelona Ensanche y Gracia, £29 decrease. Barcelona, £150 increase.
Brisbane, £11 decrease.
Buenos Ayres and Belgrano Electric, £824 increase.
Calcutta, £134 increase.
Cape Town (month of Sept.), receipts, £12,467; expenditure, £6,373.
La Capital Traction and Electric, Buenos Ayres (month of Sept.), £5,880 ncrease.
Mexico Electric (month of Sept.), receipts, £17,700.
Perth Electric, £127 increase.
Port Elizabeth (month of Sept.), receipts, £2,934; expenditure, £1,746.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅜-¼
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	9.16-11/16
—— Ordinary, 1-125,000	1 ..	¼-⅜
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-6¾
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4¾-5¼
Brush Electrical Engineering, Ordinary	2 ..	1¼-1¾
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	16-17
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	1-1¼
—— 5 per cent. Debentures	5 ..	1¼-2¼
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	97-100
W. T. Henley's Telegraph Works, Ordinary	5 ..	16¼-17½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	22-23
—— 4 per cent. Debentures	100 ..	100-103
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10¼-11½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6¼
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11 xd
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6¾ xd
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10¼
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	7⅞-8¼
—— 7 per cent. Preference	5 ..	8¼-8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7¼-7¾
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10½ xd
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	4¾-5¼
—— 40,501-50,936	5 ..	4¾-5¼
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	11¼-12½
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	104-107
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¾-6¼
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8 xd
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1¾
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	113-116
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6¾
Notting Hill Electric Lighting	10 ..	15½-16½
Oriental, 1879	1 ..	1¼-1¾
—— £5 Shares	5 ..	7¾-8¼
—— £4½ Shares, New	4½ ..	7-7½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2½-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11¼-12¼
Electric Railways.—		
Central London, Ordinary	100 ..	103-106
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	51-54
—— Ordinary	10 ..	5-5¼
—— 4 per cent. Debenture Stock	100 ..	113-118
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	3¾-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-128
Blackpool and Fleetwood Tramroad	10 ..	12-13
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¼-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6-6¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	101-103 p.c. xd
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14-15
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11¾-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	121-124
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¼-2¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5¾
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
—— Prov. Cert., all paid	100 ..	100-103
Cape Electric Tramways, Nos. 1-400,000	1 ..	1¼-2¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼ xd
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104 xd
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22¼
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	105-107
New General Traction, Ordinary	5 ..	2¼-3¼
—— 6 per cent. Cum. Pref.	10 ..	3¼-4¼
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-10¼
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8s. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Wolverhampton Tramways Company	— ..	—
Telephones.—		
National Telephone, Ordinary	5 ..	4¼-4¾
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¾-5
—— 4 per cent. Deb. Stock, Red.	100 ..	96-99
—— 3½ per cent. Deb. Stock, Red.	100 ..	96-99
Oriental Telephone and Electric Company	1 ..	15/16 1 1/16 xd

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NOTES.

Indian Telegraphs.—The year 1900-01 was the "jubilee" of the Indian telegraph service, and, curiously enough, it was also the record year as regards the earnings of the department. The annual administration report for 1900-1 shows that the earnings have exceeded those of any previous year by over £50,000, while the excess over the earnings of 1899-1900 was about £110,000.

Royal Institution.—The Christmas course of six lectures to young people, at the Royal Institution, will this year be delivered by Prof. J. A. Fleming, F.R.S., professor of electrical engineering in University College, London. His subject is "Waves and Ripples in Water, Air, and Æther," and the first lecture will be delivered on Saturday afternoon, Dec. 28, at three o'clock. The remaining lectures are fixed for Dec. 31 and Jan. 2, 4, 7, and 9, 1902.

French Electrical Workmen.—It is somewhat amusing to see the difference in treatment between workmen in France and in England. We learn, for instance, that L'Association Amicale des Ingénieurs Electriciens is organising a yearly prize to be given to a workman in an electrical firm who has served for at least 15 years in the same firm without interruption. The conditions of the prize are that he shall not have been absent from work except through illness or in consequence of military service. The whole idea reminds us of the girls' friendly societies in this country.

Personal.—We hear that the professorship of physics in the Royal College of Science, rendered vacant by the resignation of Prof. A. W. Rücker, who has accepted the post of principal of London University, is to be filled by Prof. H. L. Callendar, M.A., F.R.S., Quain Professor of Physics in University College, London. Prof. Callendar's standing as an authority on the construction and standardisation of delicate thermometers, and on the measurement of temperature by electrical means, is widely known; and, in addition to this, his accomplishments as a teacher of physics eminently qualifies him for his new post.

Proposed Technology School for Pittsburg.—We learn from our contemporaries in New York that the plans for the erection of one of the largest schools of technology in the world have been adopted by the trustees of the Carnegie Institute in Pittsburg, Pa., in accordance with an offer of Mr. Carnegie to endow and maintain the school in that city. For the latter purpose he will be asked to give at least one million sterling, while the cost of the building itself is put at a far higher figure. A site of about 60 acres will be required for the school, and it is expected that this will be the gift of the city authorities.

The Monorail in Central Africa.—From the latest reports from Nyaasaland it appears that British Central Africa is in a fair way to become an industrial colony soon. The most recent move in the development of the country is a concession which has been granted by the Imperial Government for the construction of a line of railway from Chiromo to Blantyre, connecting the centre of the coffee plantations with the coast by way of the Shire and Zambesi Rivers. Operations are expected to begin towards the end of the year, and will probably last for two years or so. Meanwhile, it is stated, experiments are being conducted with a line on the monorail principle, and it is also intended to establish a system of motor trolleys and traction engines for transport work in the protectorate.

Exhibition of Scientific Instruments.—Under the auspices of the London School Board an exhibition of scientific apparatus was opened yesterday at the Examination Hall, Victoria-embankment. The exhibits, which have been constructed by pupils and teachers of the London School Board, number close upon 200 pieces of apparatus, and include induction coils, telegraph instruments, motors, voltameters, galvanometers, etc., used in the teaching of magnetism and electricity; Boyle's tubes, balances, etc., for chemistry; lantern and microscopic slides for botany and physiology; and many other ingenious specimens for use in the teaching of mechanics, sound, light and heat, mensuration, and mechanical drawing. The exhibition, which is free, will remain open until Monday evening next.

Submarine Electric Lights.—A report is current in the States to the effect that the Italian Government have commissioned Messrs. E. A. Burdick and Francis G. Hall, jun, the inventors of a submarine electric light, to construct an apparatus after their device for use on the submarine boat "Delfino" of the Italian navy. It is said that this vessel has been carrying on a series of experiments with various lighting devices with a view to adopting a light which will allow of the persons on board seeing what is going on above the surface of the water while the vessel is submerged. Although the experiments are stated to have been conducted with "great secrecy," our New York contemporary, *Electricity*, learns that the success they have attained is expected to give the Italian navy a tremendous impetus in the matter of the equipment of submarine boats.

Dundee Institute.—At the first meeting of the Institute of Architecture, Science, and Art at Dundee, to-morrow evening, Prof. Patrick Geddes will deliver a lecture on "The Glasgow Exhibition: Its Results and Lessons." In the course of his oration the professor is expected to give a retrospect of the leading exhibitions, from that held in London, in 1851, to the Paris Exhibition of 1900, outlining the main results and significance of each. Glasgow, and its importance among world cities, will also come in for a due proportion of attention; also its qualities (and defects), as illustrated by its exhibition. The immediate and remote possible results of the exhibition in Glasgow, the influence on other cities, and the value or otherwise of this are points which the lecturer may be relied upon to give considerable emphasis to.

Cape-Australian Cable.—It is officially announced that the Eastern and Eastern Extension Companies' new cable from the Cape to Australia, *viâ* Mauritius, Rodrigues, and Cocos, is now complete as far as Perth, W.A., and traffic over the line will be formally commenced to-day (Friday). One advantage accompanying the opening of this cable will be a substantial reduction in tariff for local telegrams exchanged between South Africa and the Australasian Colonies. By the new route telegrams will be transmitted throughout by the companies' own employés, and considerable improvement in speed and accuracy is anticipated. The remaining section of the line between Perth and Adelaide is expected to be opened for traffic about the middle of February next. The new cable involved the laying of nearly 15,000 nautical miles of line at an expenditure of over three millions sterling.

Newcastle Local Section.—We understand that the following papers will be read before this section of the Institution of Electrical Engineers during the coming session on the dates as given: Dec. 2, "A Combined Integrating and Maximum Demand Meter," by Mr. J. H. Barker, M.I.E.E.; Dec. 16, "Electric Car Equipment and their Maintenance," by Mr. Arthur Wigham, A.I.E.E.; Jan. 13, "Starting Resistances," by Mr. A. E. Gott, A.I.E.E.; Jan. 27, "Sub-Station Polyphase Machinery," by Mr. A. Stewart, M.I.E.E.; Feb. 10, "Electrical Legislation

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and Finance," by Mr. H. W. Handcock, M.I.E.E.; Feb. 17, "Equipment of a Modern Telephone Exchange," by Mr. F. A. S. Wormall, M.I.E.E.; March 10, "Electrical Power Supply on the North-East Coast," by Mr. C. S. Vesey-Brown; and March 31, "Mains Department of a Direct Current Supply Station," by Mr. J. F. Moore. There will also be a meeting of the section on March 24, when Mr. W. M. Thornton, M.I.E.E., will read a paper on a subject yet to be arranged.

Electric Canal Towage.—We gather from a note in the *Electrical World* that the Miami and Erie Canal will present a number of new departures in electrical engineering when completed, not the least of which is that the locomotives will be equipped with alternating-current motors. In all there will be six motorcars or electric locomotives for towing the canal boats. Each will be equipped with two 125-h.p. alternating-current motors. In the cities the current will be delivered at 380 volts, and in the country at 1,100 volts. Along the first section of the line there will be four transformer stations, and current will be delivered from lighting plants in the various towns at 33,000 volts. When towing boats the locomotives will have a speed of three miles an hour, but by cutting out one of the motors this can be increased to six miles an hour, when the locomotive is not towing boats. We understand that the first division of the canal, that from Cincinnati to Dayton, will probably be in operation by Jan. 1 next, while the entire line to Toledo is expected to be completed by January, 1903.

Electric Railways in Italy.—We understand that the electric railway of ordinary gauge between Milan and Varese has now been opened to the public. This line, which is about 46 miles in length, is being worked on the third-rail system. The third rail, acting as the conductor, is placed in between the two sets of running lines. The collectors on the car are always in duplicate, so that an ordinary crossing can be bridged by the collector connected to the front of the car, making contact before the rear collector leaves the raised rail at such crossings; also, to enable the cars to be run on either the up or down lines the collectors are attached to both sides of the cars—front and rear—so that a car on the up line will make connection, say, from the right, and *vice versâ*. The current for the system is obtained from water power from the River Ticino, but in order to guard against interference with the supply, steam plant of the equal capacity has been installed. The total capacity of the plant in the generating station is 11,000 h.p. Overhead cables are used for conveying the current to the line, and the rails are used as return. Individual cars holding 73 passengers each are run, and not trains in the ordinary way. Owing to the length of the line, it appears to us that there must be some considerable fall of potential in the return conductors, and we are anxiously awaiting further technical details on this point.

Electric Power for Making Water Gas.—The Zürich section of the German Electro-Chemical Society recently discussed an instructive paper by a Mr. Schmidt, in which the author pointed out the advantages gained from the use of electrical power for making water gas. In the present method usually adopted in Switzerland, water steam is conducted over glowing coal, with the result that CO and hydrogen are formed. Much heat is, however, absorbed in the process, as in the combustion of C to CO only about half the number of calories which are required for the decomposition of the water are set free. It, therefore, requires that the furnace shall be supplied from time to time with fresh heat, which is a costly operation. If 42 cubic metres of water gas be produced from 12 kg. of pure carbon—about 13·5 kg. of coke—there are missing 28,970 calories, for which about 8·8 more kilogrammes of coke are required. If, instead of the latter, electric heating be used—an efficiency of 80 per cent. being assumed—about 42·5 kilowatt-hours are required. Assuming the price of coke to be one cent per kilogramme the process of electric heating is economical, if the electric power cost not more than 0·21 cent per kilowatt-hour. The author considers that electric power can be furnished at this price at many places in Switzerland, especially at certain hours of small load. Although Switzerland must import all its coal, the country is rich in water power.

Import Duty in New Zealand.—There appears to be an organised agitation on the part of some of the larger municipalities of New Zealand against the present law which places a duty on all electrical machinery, etc., imported into the colony. We understand from the *New Zealand Mining and Engineering Journal* that a petition signed by the mayors and town clerks of the cities of Wellington, Auckland, and Christchurch was recently presented to Parliament urging that the custom duties on electrical machinery, plant, and apparatus, and on tramway plant and materials, should be abolished or reduced, and that, if necessary, the House should pass a law for the purpose of attaining this object. It is pointed out that under existing conditions the customs duties upon electrical plant and machinery imported into New Zealand are 10 per cent. *ad valorem*, and upon tramway plant and material 20 per cent. No part of the electrical plant and apparatus required for the electrical tramways now in course of construction at Auckland, and for those to be constructed at Wellington, can be manufactured in the colony, and only an insignificant part of the tramway plant and materials required can be so manufactured. It is therefore necessary to import practically everything from the United Kingdom or the United States. All the tramway and electric lighting installations in course of construction or proposed to be constructed are undertakings of a public nature, and if the prayer of the petitioners be granted, it is urged the public will derive the benefit.

Photographing the Electric Arc.—Prof. A. C. Scott contributes a short article to the *Scientific American*, with the main object of showing the important part photography can be made to play in indicating the operation of arc light carbons. As regards the electric arc itself, though progress in its development was slowly going on during the first half of the century, the last three decades have witnessed by far the most phenomenal results, such results being made possible only after Gramme had, in 1870, opened the way by the invention of the dynamo-electric machine. It is interesting to-day, when the manufacture of carbons has reached such a state of perfection that the carbons are homogeneous in texture and almost entirely free from impurities, to consider the vast difference in their appearance when in operation in comparison with the earlier forms, and this comparison is facilitated by the science of photography, which has reached its present development during practically the same period as electricity. Photography makes it possible for the arc to now tell its own story, and the author considers that the electric arc should not be pictured by such an antiquated illustration as is commonly used. It is not to be objected to so much, of course, on the ground of ancient history considerations, as upon that of incompleteness and incorrectness. It seems of much importance that new books should exhibit, so far as possible, new and original illustrations, and in the course of the article Prof. Scott shows how clearly the operation of the carbons may be indicated by direct photographs of the arc itself.

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Duke of Devonshire on Technical Education.—In opening the new Central Technical School at Liverpool on Saturday, the Duke of Devonshire made some note worthy remarks on the attitude of the Government towards technical education in this country. Already the field was partly occupied by many educational authorities, tenacious of their rights, with organised bodies of teachers, with private schools, and with vested interests, while ratepayers were apprehensive of new rates. The only source of strength by which the Government could hope to surmount these difficulties would be the conviction of public opinion of the importance of education itself and the necessity for its extension and organisation. At present his Grace did not see sufficient indication of the existence of that convictions, either among employers, workmen, or parents. The public did not appreciate the extent of the opportunities they had for technical and secondary education, but the apathy was partly due to the mistake of experts, who, when speaking on the subject, ought to explain the matter in simple and popular terms. He fully recognised, however, the responsibility of the Government in making its new proposals. Whether they launched a small craft or a large one, it was they who were responsible for the lines upon which it was built and for the setting of the sails and the directing of its course, but no vessel, however built, or however navigated, could sail its course unless it had a breeze behind it. Without a breeze the vessel would probably drift on the rocks and reefs and shoals. He wanted the people to provide them with that breeze, which was the one and indispensable necessity to the success of any measure which might be introduced in the future.

Electroplated Doors.—A process of electroplating wooden doors with copper, brass, and other metals is the discovery of an American inventor, who claims considerable success for it in practice. We gather from a description of the process in the *Scientific American* that the door has first to be subjected to a treatment consisting of being immersed in a tank of heated linseed oil and resinous gum in order to protect the wood thoroughly and prevent warping. Following this, the door is rubbed smooth and coated with a varnish, such as shellac, and is then dried. The edges of the door are then trimmed with sheet metal strips corresponding to its width. The advantage claimed for this is that the high conducting power of the metal strip makes a complete circuit around the door, and the width of the strip ensures an even and unbroken surface between the two sides. The material used for the strips is preferably copper, bronze, or brass. The face of the strip on the edge of the door is covered with a metallic insulating varnish, after which the entire door is coated with a metal surface, such as thin metallic leaf, metallic brass powder, or common varnishing wax with plumbago. When the coatings applied have become dry, the door is rinsed, and is ready to receive the electric deposit. The door is supported in a vertical position in the plating bath. One wire goes to the anode, and the second is preferably attached to the metal strip on one side of the door. The current is then switched on, and the electrolytic action is continued until the surface is covered to any desired thickness. By the above process it is claimed to be able to turn out a wooden door which is thoroughly enclosed in metal without any visible seams, so as to give it the appearance of a solid metal door, but which will be cheaper, lighter, and generally more desirable than if made of solid metal or covered with metal sheets, as is now sometimes done.

Dielectrics.—Mr. Van Hoor recently contributed a series of articles on this subject to the *Elektrotechnische Zeitschrift*, giving his results obtained from very extended experimental researches made with impregnated vegetable fibre dielectrics, paraffin, guttapercha, glass, and micanite condensers. A short abstract of the articles is given in the "Digest" of the *Electrical World* for Oct. 19, from which we take the following: "The author calls attention to the many sources of error due to small air bubbles, imperfect impregnation due to sticky impregnating material or too low a temperature, traces of acid, or impurities. Traces of chlorine have a bad influence, and the author believes that the reason why cable manufacturers prefer manila fibre to the more useful linen fibre, is that they fear bad effects due to the chlorine which has been used in bleaching the linen fibre. Line fibre, jute fibre, or manila fibre, if perfectly pure and free of air and impregnated with easily fusible and chemically pure paraffin, have qualitatively entirely the same properties. The author gives the results of his tests in tables and diagrams. Many of his experiments dealt with the residuum phenomena in dielectrics. The specific resistance is of great influence; in dielectrics with low specific resistance the residuum phenomena are strong and slow. The thickness of the dielectric layers is also of great influence. He found that results of tests concerning the dielectric properties, and more especially residuum phenomena, can be directly compared only if the thickness of the layers in the tests is the same. He concludes that the processes in a volume element of a dielectric and the equilibrium in the same are influenced not only by the particles in the immediate neighbourhood, but also by those farther away. There is a close analogy between the molecular mechanisms of the magnetic and of the dielectric polarisation. The author also refers to similar well-known facts; for instance, that the breaking-down voltage does not increase proportionally to the thickness of the dielectrics."

Tunnel Lighting.—Of the many systems of tunnel lighting at present in use in Europe and in America, it is hard to find one which can be voted a complete success. It is, however, a question of considerable importance to electrical engineers, especially in view of the various "tube" schemes now being promoted in London and the approaching conversion of the "Underground" railways to electric traction. In the States the problem is being attacked more particularly in connection with the New York Underground Railway, the lighting of which is at present being made the subject of experiment. The rows of incandescent lights, breast high, which run along the sides of many steam railway tunnels in America would in this case, it is held, be inadequate. Supplemented by the glare of a locomotive headlight, however, they show up the track well enough, but not without it. Referring to the subject, the *Electrical World* points out that arc lights only will give sufficient illumination if located at short intervals along the track; but here, again, there is the difficulty that the brilliant and concentrated light of an unprotected arc light would affect the sight of the motormen, who have to look straight at it. To diffuse the light without losing it is the problem therefore, seeing that most of the ordinary kinds of shades absorb a large share of the light rays. Our contemporary, however, points out that there are systems of reflectors which have merits in this direction, and globes are also made of glass cut inside and outside into facets that deflect the light upward, downward, or sideways, making the illumination as soft as from ground glass, and with a loss of only a very small fraction of the light. Experiments have been made on the New York Underground with a glass covering, but the results were not conclusive, and it is announced that it has now been decided that the walls of the tunnels shall be painted with some sort of "cold-water wash" tinted in blue or grey sufficient to modify it from a dead white. It is con-

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sidered that if this be done the motormen will not be so liable to suffer from the effects of the illumination, the tinted walls tending to lessen the dazzling brilliancy of the light.

Municipal Electric Tramways.—While a number of corporations now look upon the running of electric tramways as part of their duty, they have not always considered the matter in the way they should do. We know, for instance, of one large corporation in the middle of England which converted their tramlines for electrical working under the idea that the same change would accordingly alter the financial standing of the undertaking. The result up to the present has not been what was expected, and the lines are being worked at a loss. In the first place the capital charges on the undertakings were exceedingly high, and there has not been the regular writing down of the capital value which was required to bring the undertaking into a healthy state. When then there is added to the already heavy loans the increased expenditure for new track, new cars, and a complete electric generating station, it is not to be wondered at that the costs per car mile are exceedingly high. We believe that at the present time they are some 25 per cent. higher than the receipts per car mile. Unfortunately the financial side of the question is not the only one that is wrong, as the electric service is little or no better than was given before. Large steam tramcars were replaced by large electric cars running at the same intervals, and it is hardly to be expected if this is done that there will be such an increase in the traffic returns as is the case where the frequency of the service is increased by keeping the size of the units smaller. We know of another instance in another town where the financial results have not been all that was to be expected. In this instance the fault has been that the fares have been unduly reduced without the requisites for the increased service being found. It is quite time that our English corporations learnt the value of expert advice in such undertakings. It is not enough to employ good consulting engineers to equip the system, if the committee refuse to accept any advice on the commercial management of the undertaking afterwards. It is hardly to be expected that a consulting engineer's predictions will hold good if the fares on which they are based are reduced by one-half, and this has, we know, been done in some cases without listening to the advice of the towns' technical advisers.

Cultivation of the Guttapercha Tree.—There seems to be considerable fear in some quarters that the supply of guttapercha, which is practically indispensable to the construction of submarine cables, is becoming limited. It is not, however, so much in the scarcity of the guttapercha-producing tree itself that the danger lies, as in the fact that the cultivation of the plant is neglected. No other product known at present replaces the guttapercha found in the forests of the Malay Peninsula and in Malacca, and, according to a United States consular report, the plantations in these districts have been so ruinously exploited by the natives, who uproot full-grown trees and cut young plants before they come to maturity, that it is feared there will be a shortage in the supply of this quality of the gum in course of a few years unless means are taken to protect the forests or to propagate the plants elsewhere. The following figures will serve to show the rapid increase in the export of guttapercha: in 1845 Europe imported only 19,841lb. of guttapercha; in 1857, when the Singapore supply was exhausted, the Malay Archipelago exported more than 529,104lb.; in 1879 Sumatran exportations exceeded 299,621lb. and Borneo exported 2,863,900lb. In order to attain these figures it is estimated that the natives must have sacrificed more than 5,000,000 trees. Expeditions sent out by France, England, and Holland to discover the botanical origin of the precious gum, and to increase its production, have reached the same conclusion. As it is almost impossible to find a full-grown guttapercha-producing tree, the situation will be extremely grave if urgent measures are not taken. The British Government has posted placards for the protection of the trees, with little or no effect. Holland has planted trees, but in insufficient number and of inferior species. Productive species have, however, been found in the Malay forests, extending between the rivers of Pahang, Patani, and Perat. They have been transplanted into Reunion and Madagascar, and if they thrive there will be less danger of a dearth in the supply of gum required for submarine cables. The latest move in the matter, however, has been taken by the scientists in France, who, we hear, are now engaged upon the problem of acclimatising the tree in that country.

Street Railways in New York.—The October number of the *Street Railway Journal* takes the form of a handsome souvenir issue of the twentieth annual convention of the American Street Railway Association, and it is not unnatural to find that much space is devoted to the street railway situation in Greater New York. In modern methods of transportation America admittedly takes the lead, and what particularly enhances the value of the articles appearing in this souvenir number is the fact that they are all written either by the leading officials of the principal street railway companies or by engineers who have expert knowledge on the matters on which they write. New York is the scene of perhaps the greatest activity in electric tramway and railway construction in the world, and the compilation of a number of articles dealing with the various systems at present at work in that city, attacked both from the engineering and commercial standpoints, is especially acceptable. To refer briefly to the most striking features of this souvenir number, the first article is by Mr. Frank R. Ford, in which he reviews at length the general urban transportation problem, showing how, with a population second only to London, the physical configuration of New York City is such as to confine the travel into certain definite congested lines, making the traffic on them the heaviest of any in the world. The tables and diagrams presented with this article comprise a complete set of data of the transportation system of the city. A series of five articles by officials of the Metropolitan Street Railway Company follow, two of which deal with the operation of the road. The articles by Mr. M. G. Starrett, chief engineer, and by Mr. Walter A. Pearson, electrical engineer to the company, on the power-house and distribution system are, however, of more interest to electrical engineers, as they give the actual results obtained in the operation of one of the largest electric tramway power-houses in the world, as well as of the largest generating units and the largest polyphase system of power distribution in use for electric railways. The information contained in these two articles throws great light on the engineering questions in connection with electric tramways and railways. As a souvenir, the October number of the *Street Railway Journal*, comprising no less than 327 pages, is a striking production apart from its literary merits, which are exceptionally brilliant.

Institution of Junior Engineers.—Mr. Percival Marshall presided over the annual general meeting of this institution at the Westminster Palace Hotel last Friday, when the council's report on the work of the past year was considered and adopted. The report opened with the gratifying statement that there had been no fewer than 103 elections, bringing up the total membership to 652. The

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names of Prof. G. F. FitzGerald, F.R.S., hon. member, of Dublin, Mr. Louis F. Awde, of London, and Mr. E. H. S. Cooper, of Rugby, members, had been removed by death. In addition to the seven monthly meetings, an additional meeting had been held under the title of "Engineering Question Night," when a number of different engineering questions were dealt with, this new feature in the programme proving very successful. The institution premium had been awarded to Mr. Samuel Cutler, jun., for his paper on "Carburetted Water Gas." The council had accepted the offer of the sum of five guineas made by Mr. W. H. Northcott, hon. member, to be competed for by the members in the preparation of a paper on the mutual relations of employers and employed, and the three adjudicators (consisting of Mr. Northcott himself, Mr. J. A. F. Aspinall, and Mr. Archibald Denny) had awarded the prize to Mr. William Powrie. Reference was also made in the report to the opening last June of the institution offices at 39, Victoria-street, the rooms having been suitably furnished as library, reading and writing rooms, etc. There had been 11 visits to engineering works in London and the vicinity, and during the summer meeting at Plymouth the Government establishments at Devonport and a number of engineering and other works had been inspected. Touching upon the engineering congress at Glasgow, the council reported that a number of members availed themselves of the invitation extended to the institution to take part in it. To the provincial technical societies an invitation had been addressed enabling any of the members who might be temporarily resident in London, to attend the meetings of the institution. The council were co-operating with the German Society of Engineers in the compilation of a German-English-French technical dictionary. It was announced that the premier position in the Whitworth scholarship examinations for 1901 had been obtained by a member of the institution—Mr. C. E. Hardy, of Plymouth. Allusion having been made to the appointment register, the utility of which was being much improved; to the library, which now that the institution had offices would be considerably developed; and to the accounts, which showed that the finances were in a satisfactory condition, the report concluded with some observations as to future arrangements, including the delivery to-night (Friday) of a presidential address by Sir John Jackson, F.R.S.E., to inaugurate the new session. The election of officers was announced as follows: chairman, Mr. P. Marshall; vice-chairman, Mr. Kenneth Gray; hon. librarian, Mr. L. H. Rugg; members of council, Messrs. S. Cutler, jun., Adam Hunter, C. J. McNaught, and H. C. Reid, in addition to those remaining in office; secretary, Mr. W. T. Dunn.

Visible Radiation from Carbon.—Mr. Edward L. Nichols communicates to the current number of the *Physical Review* the results of some spectro-photometric observations he has made with regard to this subject. He explains at the outset that it was his expectation in planning the research that whatever might prove true as to the character of the radiation from grey carbon, the distribution of energy in the spectrum black carbon would change in such a manner with increasing incandescence as to become nearly or quite identical with that of the various luminous gas flames at temperatures corresponding to the temperature of the glowing carbon in those flames. He had also hoped to be able to bring about a degree of incandescence approaching that of the acetylene flame itself, and at the same time to be able to determine the temperature of any given luminous flame in which the incandescent material consists of carbon particles by ascertaining the temperature of the carbon rod for which its surface had a spectrum corresponding in distribution of energy to that of the flame. An inspection of he curves of the results obtained by the author shows, nowever, that these expectations were far from being realised, and that the distribution of energy in the spectrum of the carbon rod instead of approaching that of the acetylene flame as the temperature of the rod increased, took on an entirely unexpected character. Even at low temperatures—that is to say, up to about 1,100deg.—the change in the spectrum was not of the comparatively simple character which had been anticipated, and shortly after passing the temperature of 1,100deg. a very surprising complication in the results arose. The energy in the yellow part of the spectrum, which from the beginning had been increasing at a relatively more rapid rate than either in the red or at the blue end, became so great as to give to the distribution curve a form entirely contrary to what was expected. The experimenter was very slow to believe in the integrity of these results, but finally he was forced to the conclusion that the radiation from the carbon rods showed a much more complicated law of distribution than has been anticipated, rendering the establishment of any simple relationship between the curve of distribution and temperature out of the question. Again, the hope of being able to make direct temperature measurements up to the melting point of platinum was also disappointed. While the carbon rods at comparatively low temperatures showed a fair degree of stability under the action of the current, they appeared to undergo a decided change of behaviour at about 1,500deg., and before that temperature a rather rapid disintegration, showing itself by a change of resistance, was experienced. Further, the carbon tended to combine with the metals of the thermo-element in it, affecting the E.M.F. very much as the vapours in a furnace have been found to do, and the thermo-elements inserted in the rod began, in consequence of this action, to fail their purpose. The author was consequently compelled to abandon the attempt to measure directly temperatures much above 1,400deg. With a view to obtaining at least an approximate estimate of these high temperatures, however, he made use of the fall of potential between the terminals of the rod and also of the current of the heating circuit, and by extending these curves—which throughout the range of measured temperatures were found to be nearly straight—to the higher temperatures which he wished to estimate, he hoped to obtain some idea of the latter. By means of curves, which the author plotted and designated isochroms, it was possible to compare the rise in intensity of various wave-lengths of the spectrum with increasing temperature. Each of these curves is, of course, independent of the nature of the light of which it forms a part, but the whole of the curves from any one source have to be considered in order to get the distribution of energy. The other set of curves plotted by the author and called isotherms gives in terms of the corresponding wave-lengths of acetylene flame the relative distribution of energy in the visible radiation of carbon rods. These curves are plotted by the author for both the black carbon rods and for the rods which have been treated for flashing in a hydro-carbon. He points out that had the law of increasing intensities throughout the spectrum with rising temperature been what was expected at the beginning of the researches, the isochrom curves would have tended towards a common point corresponding to the temperature of the acetylene flames. Instead of that, the curves corresponding to the middle parts of the spectrum increased much more rapidly than the others. At the conclusion of the article the author goes into the theoretical deductions to be drawn from his experiments, which are worthy of close study by all interested in this important subject.

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HEYWOOD ELECTRICITY WORKS.

The town of Heywood is situated in Lancashire, some 12 miles from Manchester, and is a manufacturing town of considerable size, having close upon 30,000 inhabitants. In 1898 an electric lighting provisional order was obtained, and in the autumn of 1899 the committee appointed Mr. Walter P. Adams, M.I.E.E., of London, to report upon the question. In his report Mr. Adams recommended the adoption of a scheme combined with a dust destructor which the Corporation had decided to build. Owing, however, to the objections raised by some of the townsfolk to having a dust destructor situated in the centre of the town, this part of the scheme was abandoned. The works are situated on a piece of spare land belonging to the Corporation adjoining the Corporation storage depôt, stables, etc. The original site selected—about 100 yards from the present—was found to be unsuitable owing to a very deep bed of peat underlining the surface soil.

THE MAYOR OF HEYWOOD,
COUNCILLOR THOS. POPPLE, J.P.

ALDERMAN MADEN,
CHAIRMAN OF ELECTRIC LIGHTING COMMITTEE.

MR. W. P. ADAMS, M.I.E.E.,
CONSULTING ENGINEER FOR THE ELECTRIC LIGHTING OF HEYWOOD.

MR. J. A. SETTLE,
BOROUGH SURVEYOR OF HEYWOOD.

The buildings (Fig. 1) now stand upon a substantial subsoil of clay, and form a substantial structure in red brick and stone. The engine-house is 30ft. by 30ft. by 32ft. high, the walls under the stone cornice being of white glazed brick. At the far end is the switchboard gallery, and the stone cornice carries the rails for the traveller crane. The boiler-house is 49ft. 6in. by 38ft., and stands at 6ft. lower level than the engine-house. Coal bunkers are provided opposite the boilers, and the pump-room occupies the corner of the boiler-house adjoining the stokehole. The battery-room measures 21ft. 6ft. by 30ft., and accommodates 230 cells, all on one level. An exactly similar room is built above the battery-room, which for the present will be used as a store, but will later be occupied with additional batteries. Both engine and boiler houses have open glazed roofs, and are well lighted. The offices are one-storey high, and are placed in front of the building. No fireplaces are provided in these offices, the heating being done with electric radiators. Figs. 2 and 3 show the general arrangements of these buildings, and Fig. 4 is a section of the same.

The elevation to Egerton-street (Fig. 1) is in best plastic Accrington bricks with Yorkshire stone dressings. Local bricks manufactured by the Millbank Brick and Terra-Cotta Company have been used for the other portions of the buildings and chimney shaft. The contractors for the buildings were Messrs. Blakeley and Wild, of Heywood. The chimney shaft is 120ft. in height above the ground-line, and rests on a bed of concrete 7ft. thick and 26ft. square. The inside diameter of the shaft at the base is 7ft. 6in., and at the top 6ft. The firebrick lining is carried to a height of 40ft., being 9in. thick at the base and 4½in. thick at the top, and having a diameter of 6ft. The

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contractor for the chimney shaft was Mr. Cammack Dennis, of Bury. There is abundant space on the site for extensions.

The buildings were designed and the erection supervised by Mr. J. A. Settle, A.M.I.C.E., the borough surveyor. The contracts for the buildings and equipment were let in June, and the buildings were ready for the plant at the end of last year, but partially owing to the extremely busy state of the engineering trades the equipment, which was to have

The Municipal Technical School at Heywood.

been completed at the end of last year, has only just been brought into a sufficiently forward state to admit of the supply being started. Messrs. Crompton and Co. were the successful tenderers for the complete station equipment. Their sub-contractors for the boilers were Messrs. Tetlow Bros.; for engines, Messrs. Reavell Bros., of Ipswich; for batteries, the Marquand Accumulator Company, of Cardiff; and overhead traveller, the Chatteris Engineering Company, for economiser, Messrs. E. Green and Son; and for the feeders and distributing network, the St Helens Cable Company, Limited.

The engine-room plant (Fig. 7) consists at present of two steam generating sets capable of giving an output of 500 volts at 120 amperes. The machines are shunt-wound, but provision has been made for increasing the voltage by compounding up to enable the generators to be used for traction purposes. The speed of the sets is 500 revolutions. The engines are made by Messrs. Reavell Bros., of Ipswich, and are two-crank compound enclosed type. The following description of this type of high-speed engine will be of interest to our readers. Referring to the sectional drawing (Figs. 8 and 9) it will be seen that the steam inlet flange is on the body of the cylinder itself, there being a steam jacket of considerable size between the working barrel and the outside of the cylinder, and between the inner and the outer cover. The valves of the engine reciprocate in a central valve liner secured in the bottom of the cylinder, as shown, and the piston reciprocates in the annular space between this liner and the cylinder walls. The steam, entering through the stop-valve, passes up between the inner and outer cylinder walls and covers, and passes into the valve liner through ports, A, near the top. From the inside of the liner the steam passes into the cylinder through spiral ports, C, up to the point of cut-off, the clearance space shown above the piston being already filled with steam up to initial pressure, as afterwards shown, and the cut-off being effected by the valve, D, driven by the slide rod. After an early cut-off, the precise point of which is controlled directly by the governor, the steam expands during the remainder of the down stroke, and while the crank is turning the bottom centre, the ports, E, in the centre of the liner, about half-way in the stroke of the engine are opened by the valve, F, called the transfer and exhaust valve. This valve, F, at the same time opens the ports, G, at the bottom of the cylinder, so that while the piston is making its up stroke a communication is made between the top and bottom of the cylinder, transferring steam at equal pressure and temperature from the top to the bottom of the piston. This transfer continues for about half the stroke. In other words, about half of the steam which was above the piston is transferred to the other side. The transfer is closed first by the piston over-running the ports E in its upward stroke, and immediately afterwards by the valve, F, closing the ports E and G. The steam transferred to the underside then completes its second stage of expansion, and at the end of the upward stroke the exhaust valve opens, and allows this steam to escape to the atmosphere or the condenser. In the meantime, the steam which remained in the cylinder above the piston when the transfer closed is compressed during the latter half of the upward stroke, and the clearance space in the cylinder is so proportioned that this steam shall be compressed to initial pressure when the termination of the stroke is reached, and the valve, D, opens for the next admission of steam. By this means the reciprocating parts are brought to rest, and the inertia is taken up by means of the working fluid itself, while at the same time the parts which will be first touched by the entering steam are already heated up

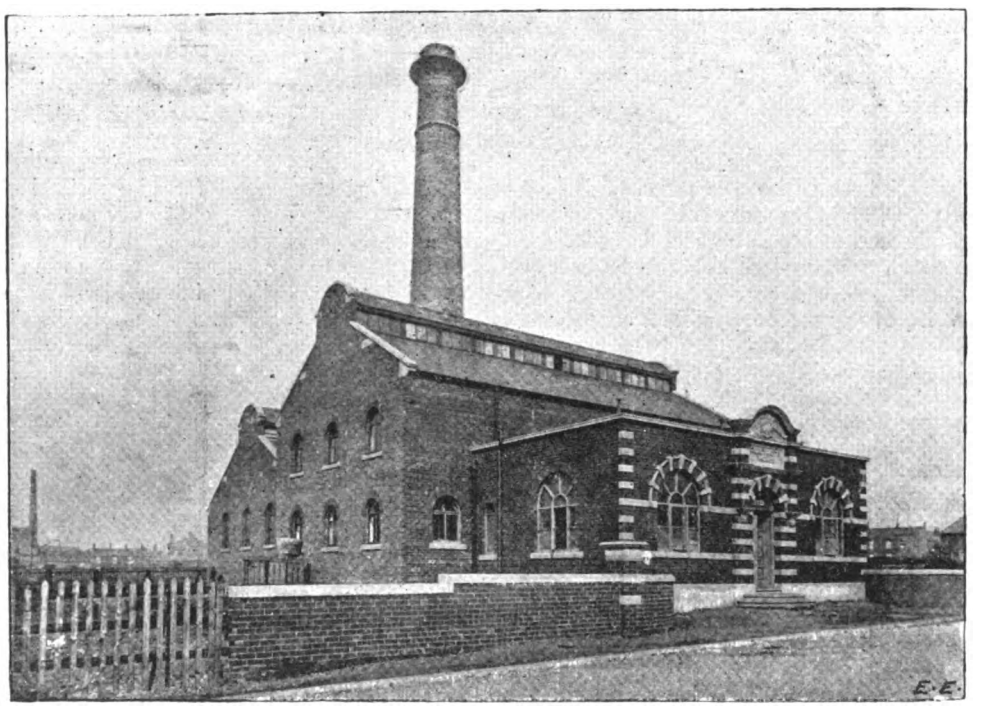

Fig. 1.—Exterior View of the Heywood Electricity Works.

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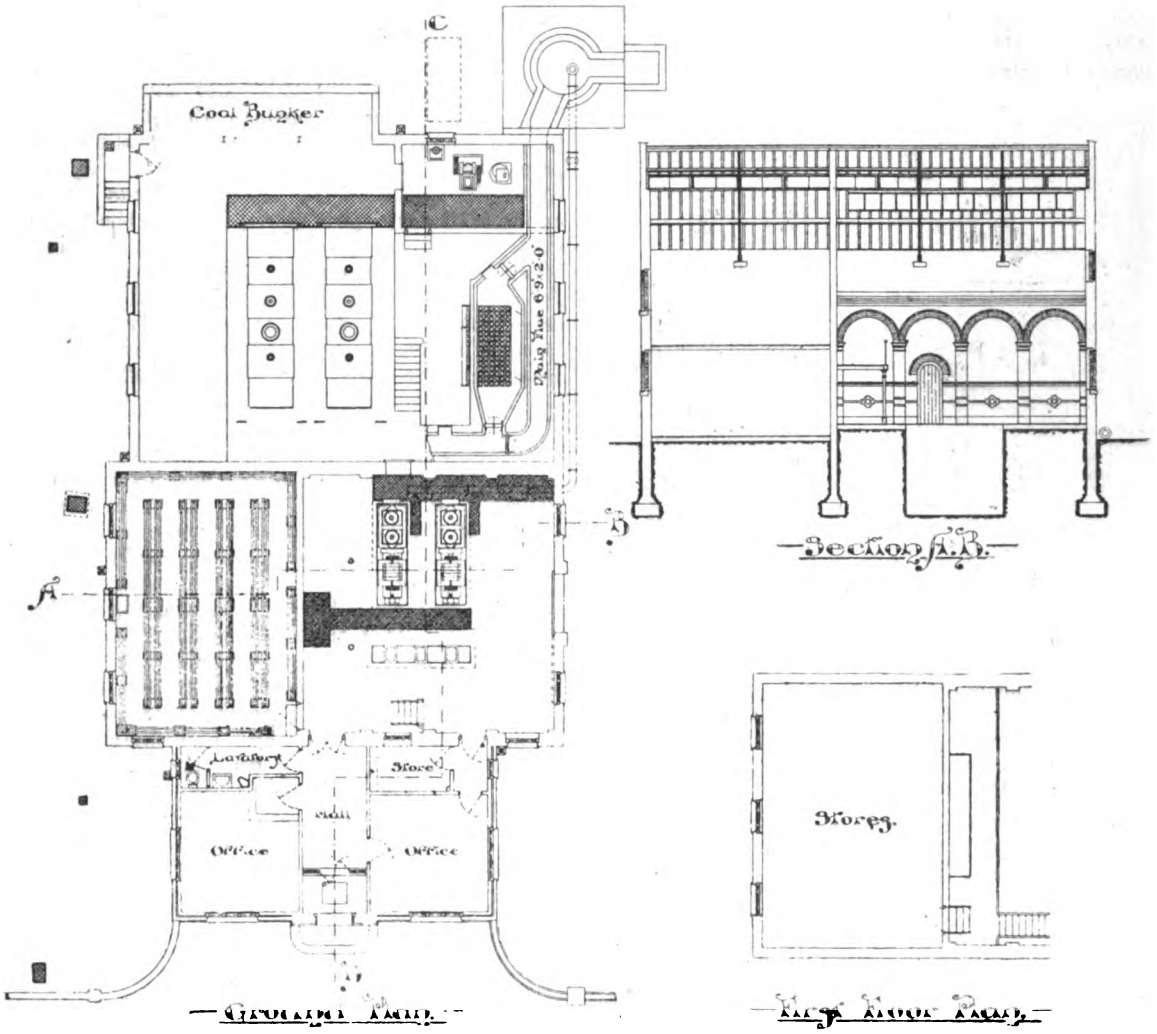
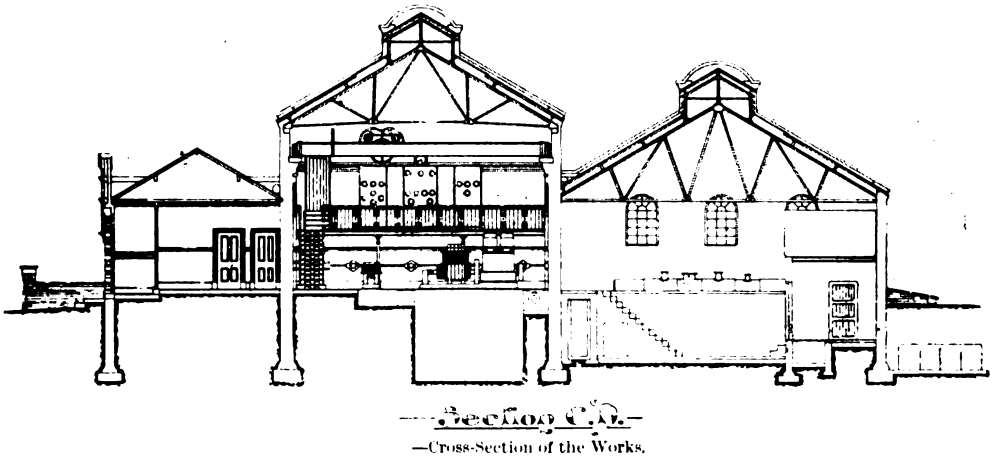
to initial temperature, and thus cylinder condensation is reduced. The steam distribution is a development of the old "Cornish" cycle, inasmuch as the steam is expanded again after transfer has taken place. Accurate and regular governing of the speed of the engine is obtained by a crank-shaft governor, which both varies the point of cut-off of the admission valve, D, and also reduces the area by means of a central spindle and bridge, B, which has two guide studs fixed to it, which pass through holes in the admission valve. The governor has a large source of energy available for doing work, owing to the combination of inertia with centrifugal force, which forms a special feature of the design. The valve, D, though reciprocated by the slide rod, and having a constant stroke, is free to be rotated by the guide studs on the bridge, B, and the ports in this admission valve, D, are so arranged in connection with the ports in the valve liner itself that a slight axial movement will cause an alteration in the point of cut-off. The valves are driven by a radial form of valve gear, operating from a point in the connecting rod, and the positions of the valve gear centres are so chosen as to enable a considerable variation in the point of cut-off to be obtained, with an exceedingly slight change in the amount of lead.



FIGS. 2 AND 3.—Plans and Elevation of the Heywood Electricity Works.

A special system of forced lubrication is used, which has a very satisfactory effect upon the economy. The combined set gives an all-round efficiency of 85 per cent. at full load. The steam consumption per kilowatt is 34·8lb. and 21·9lb. per indicated horse-power, satisfactory results for non-condensing sets of this size. One set was tested before the forced lubrication was fitted and showed a consumption of 38·6lb. of steam per kilowatt, as against 34·8lb. with the forced lubrication. The arrangement of the ducts for conveying the oil through the various moving parts to the underside of the bearings is extremely ingenious. Provision has been made in the engine room for additional sets. A balancer booster is provided; the



—Cross-Section of the Works.

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balancing machines each give 35 amperes at from 200 to 230 volts, and the normal current of the booster is 60 amperes at from 0 to 120 volts. The speed of the

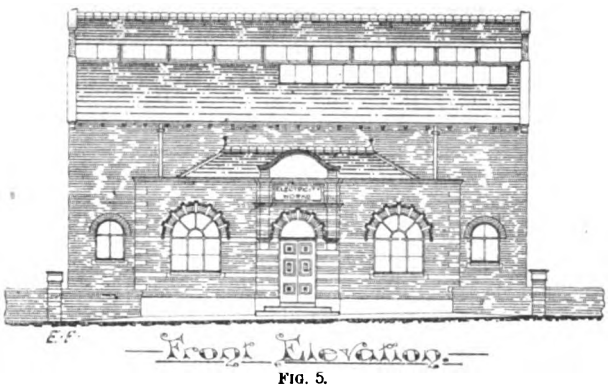

FIG. 5.

combination is 1,000 revolutions. All the dynamos were made by Messrs. Crompton and Co. An overhead traveller, made by the Chatteris Engineering Company,

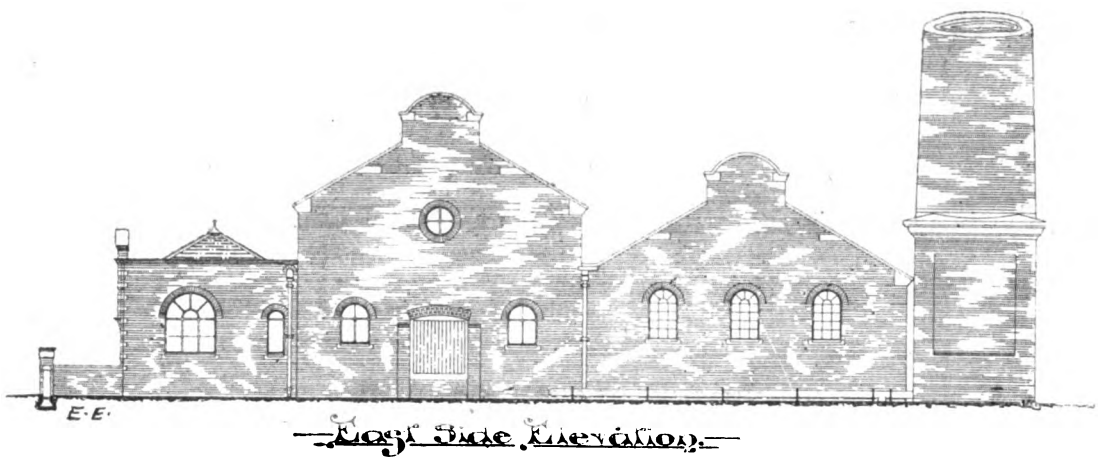

FIG. 6.

has been provided, with a span of 30ft. This is capable of lifting eight tons, and is operated from the floor of the engine-room.

The switchboard (Fig. 12) is carried on a gallery at the far end of the engine-house, and consists of five enamelled slate panels mounted in strong wrought-iron frames. The centre panel contains the feeder and battery voltmeters, balancer starting switch, booster switches and cut-outs, Crawley automatic battery switch, recording voltmeters for the batteries by Messrs. Nalder Bros. and Thompson, with centre zero, so as to record the charge and discharge, and an earth-wire recording ammeter, and Crawley automatic short-circuiting switch to cut the recording instrument out of circuit in the event of a serious earth. The panels on either side of the middle panel contain the battery switches, with Messrs. Crompton and Co.'s special racking gear. The two outer panels contain the positive and negative dynamo and feeder switches and instruments. On the negative panel, in addition to the dynamo and feeder ammeters and voltmeters, are the maximum and minimum dynamo cut-outs. On the positive panel two recording voltmeters are fitted, and these can be attached by means of multiple-contact switches to dynamo, feeder points, or elsewhere as required. For paralleling the dynamos, a centre zero voltmeter is provided, having two windings and two scales, one reading up to 450 volts and the second reading up to 15 volts. A key is provided for bringing the lower scale into use when required. The whole of the ammeters and voltmeters are of the permanent-magnet, moving-coil type, and the feeder voltmeters have illuminated scales. In addition to the instruments on the switchboard, two Aron battery meters are fitted beneath the switchboard gallery for recording the battery charge and discharge. Ordinary meters of British Thomson-Houston Company's make are also fitted under the switchboard for recording the output of the dynamos, the current used in the station meters, the current used for the station lighting, and each feeder is also provided with a meter. The

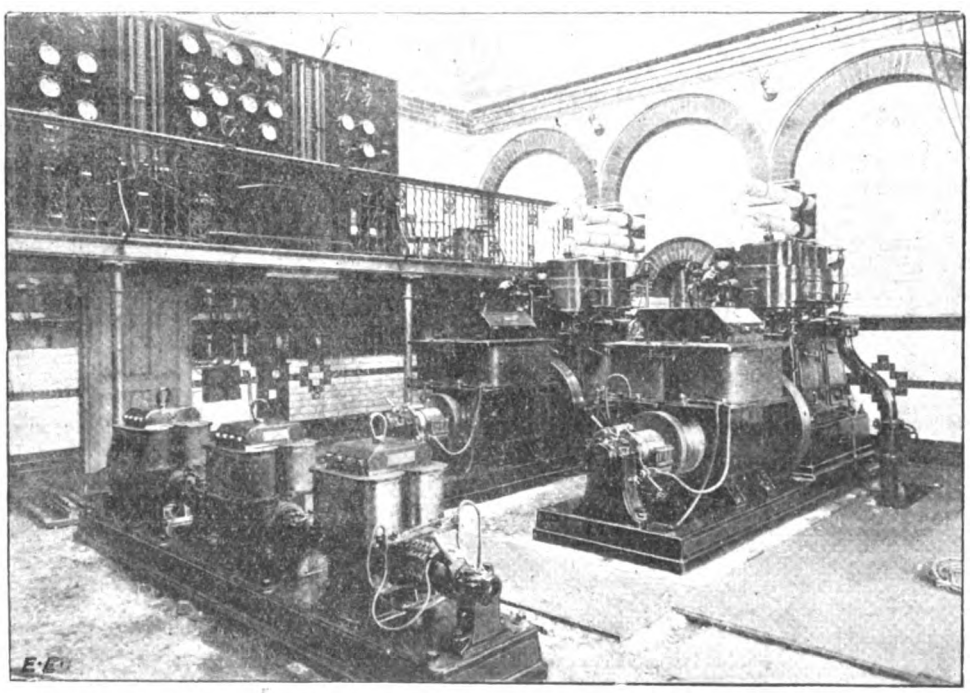

FIG. 7.—View of the Engine-Room Plant at Heywood.

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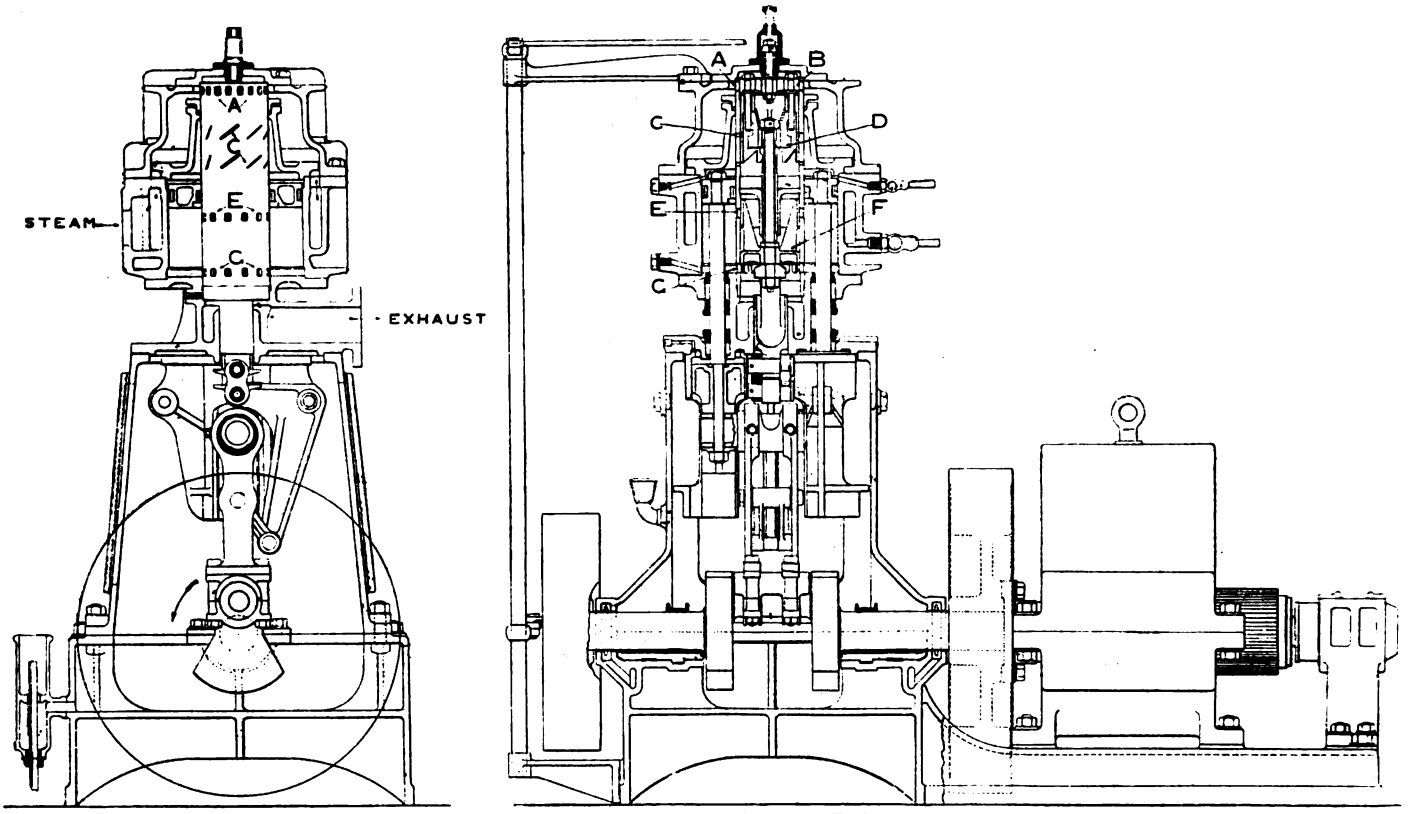
arrangement of meters and instruments is so made that an accurate record can be kept of all losses between the dynamos and the consumers' lamps. The various shunt resistances for the machines are placed under the switch-board gallery, and the shunt resistance regulating switches

steel throughout and a complete duplicate set has been provided in preference to a steam-ring. The lagging of the boilers and steam-pipes is of the Mica Boiler Covering Company's make. This lagging consists of mica flakes built up into tube form and sewn on to canvas, the whole

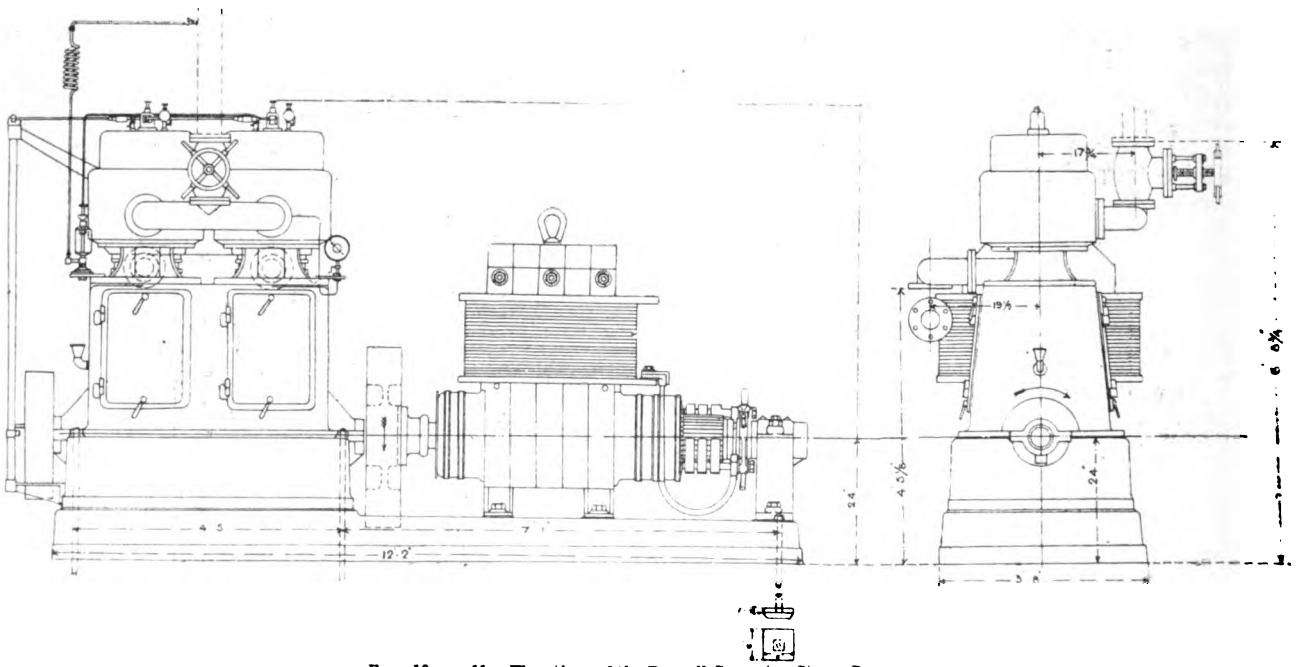


FIGS. 8 AND 9.—Cross-Sections of the Reavell Engine.

are fitted on the gallery railing immediately opposite the centre panel. The connections behind the switchboard are as far as possible made without rubber insulation, so that the risk of fire is exceedingly small. Fig. 13 gives the connections used on the above switchboard.

In the boiler-house two Tetlow Bros'. Lancashire boilers have been installed, each capable of evaporating 3,000lb.

being secured to the pipes by means of brass bands. This lagging, which is not much known in this country, has been largely used in America, and has a higher efficiency than any other known lagging. A Green's economiser has been installed in the boiler flues having 96 tubes. The scrapers are driven by means of an electric motor fixed to the roof of the pump room. The motor is of Messrs. Crompton and



FIGS. 10 AND 11.—Elevations of the Reavell-Crompton Steam Dynamo.

of steam per hour. All the boiler fittings are of Messrs. Hopkinson's make. The high-steam and low-water safety valves are provided with waste-steam pipes passing up through the roof of the boiler-house, and small sentinel pipes are fitted to these so as to give a visible indication when the valves are blowing off. The steam-pipes are of

Co.'s enclosed type, and takes a current of about one ampere at 200 volts.

The pump-room contains steam and electric pumps, and it is intended to use the electric pump as a general rule and to keep the steam-pump in reserve. The steam-pump is of Messrs. J. P. Hall and Sons' make, and is compound

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direct-acting, having a capacity at full speed of 10,000lb. of water per hour against a boiler pressure of 140lb. The tests which have been made show greatly superior results to those obtained with the Worthington type of feed pump, and the larger sizes will deliver 100lb. of water per pound of steam. It is capable of working at a very slow speed, and may be relied upon to pump as little as 200lb. of water per hour under ordinary conditions. The electric pump is of the ordinary three-throw type, with electric motor geared to it through spur-wheel gearing. Water can be taken direct from the town supply or from a large cast-iron tank which forms the roof of the pump-room. Either pump can be used at will. The whole of the water supply to the boilers has to pass through a Kennedy water-meter. A by-pass is provided to this meter, but a detachable key is arranged on the valve to prevent the meter records being tampered with. Beyond the water-meter a duplicate system of feed pipes passes to the economiser, and from thence to the boilers. All hot-water pipes are lagged with the Mica Company' lagging. The valves on the feed pipes enable the water to be fed through the economise or direct through either system. In Fig. 14 is given a view of the pump-room, and shows the electric pump, water-meter, feed-pipe valves, and economiser motor. The steam-pump is on the immediate left of the picture, but not visible. In addition to the steam and electric pumps, injectors have been fitted for use in case of emergency. Outside the pump-room is a large cast-iron blow-off tank, into which all the drains and boiler blow-off pipes are conveyed.

The battery-room (Fig. 15) contains 230 Marquand Accumulator Company's 11-plate cells of 350 ampere-hours capacity.

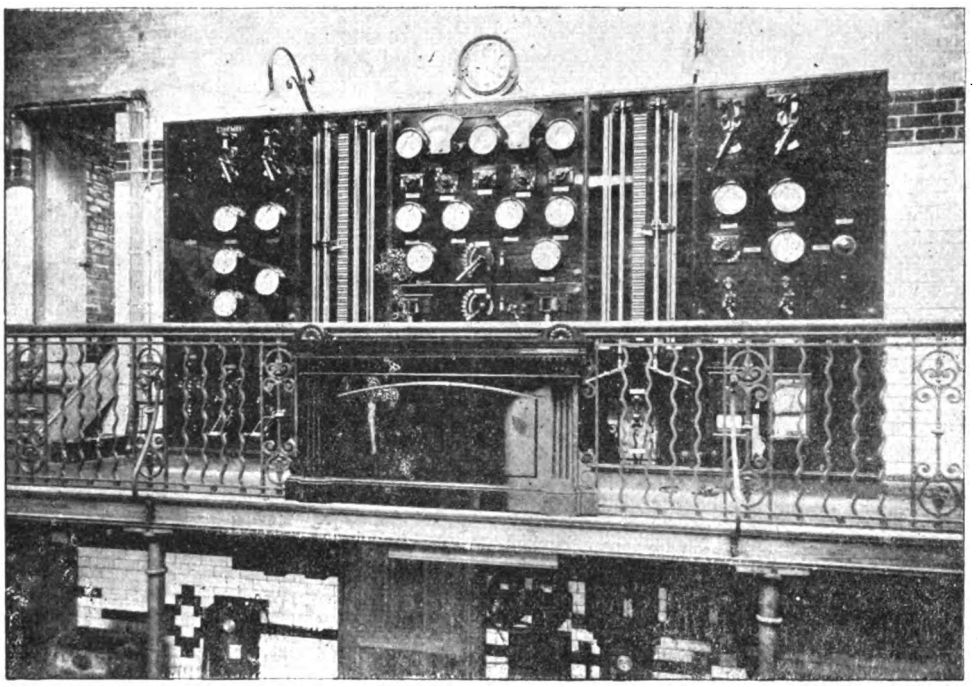

FIG. 12.—The Heywood Switchboard.

The mechanical construction of these is excellent, and any buckling of positive plates which might take place is prevented by the rigidity of the connecting lugs and the general arrangement of the plates and separators. As there are several novel features in the construction of the Marquand accumulators, the following notes on the same are not out of place. The "Marquand" plate is formed on totally different principles to those usually employed.

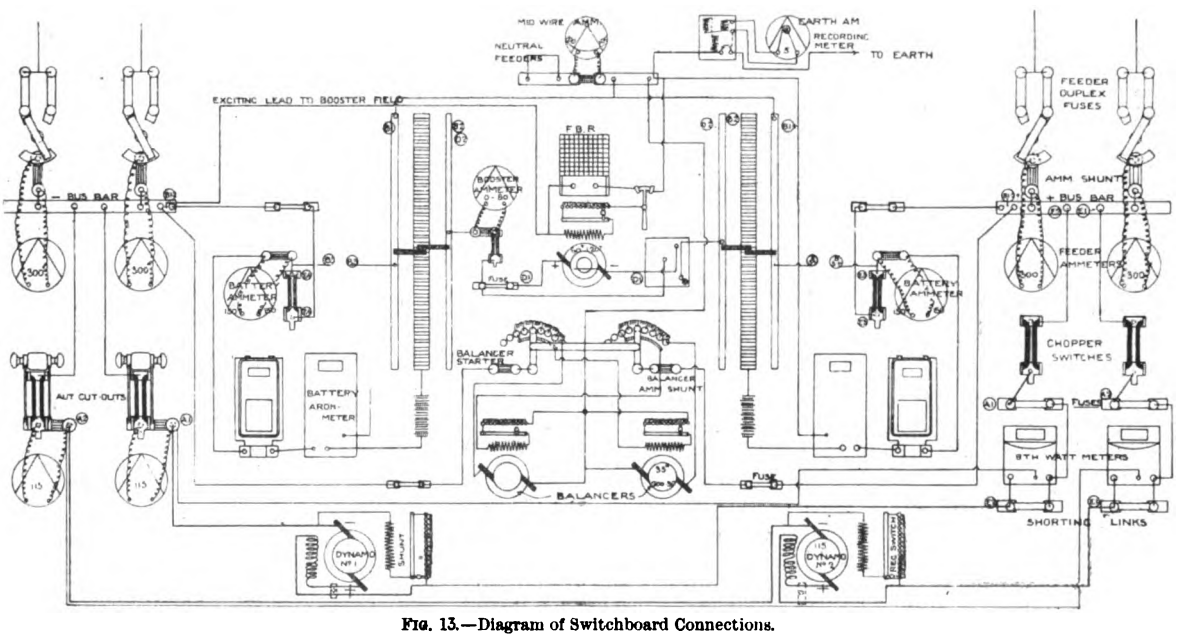

FIG. 13.—Diagram of Switchboard Connections.

Thus, a cast plate of large surface is placed in an iron frame or box, and a certain quantity of sulphur is spread uniformly over the two opposite surfaces of the lead plate; these boxes are then screwed up and placed in batches in large gas ovens of special design and raised to a certain temperature, at which the sulphur combines chemically with the lead of the plate, forming lead sulphide and sub-sulphide. The plates are then taken out of these boxes, and are ready to become converted into positive or negative

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plates by receiving a short charge as anode or cathode in pure dilute sulphuric acid; the whole plate being formed from the "pig" in 24 hours. There are two special features about this lead sulphide—one is the enormous surface roduced in this way, some idea of which can be obtained

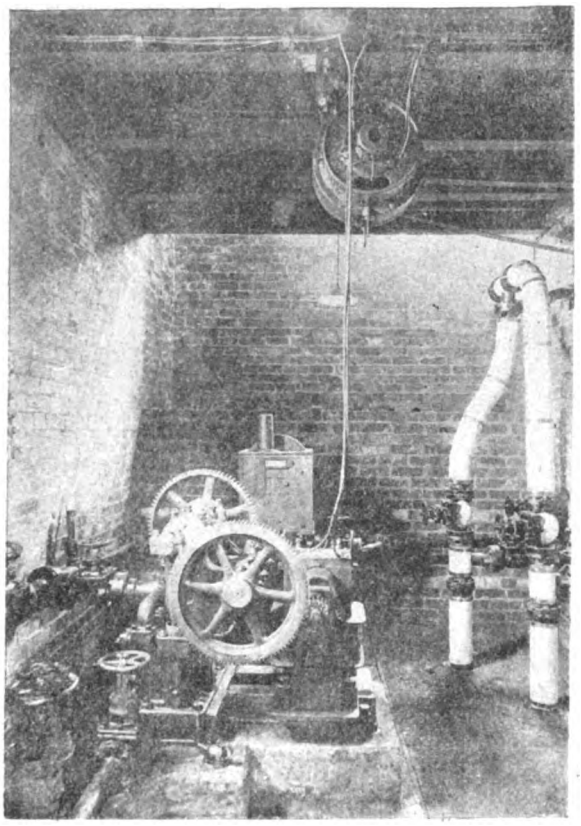

FIG. 14.—The Pump-Room at Heywood, showing the Electric Pump.

from the illustration (Fig. 16), which represents a small portion of the "Marquand" plate magnified to four diameters; and another, that each little granule of the sulphide if cut or scraped with a knife shows the bright metallic lead untouched—that is to say, in the Marquand plate there is perfect chemical continuity between the active materials and the lead of the plate, consequently there is "no disintegration whatsoever," and cells that have been at work for three or four years are said by the makers to be as clean now as when first erected. With their capacity unimpaired, in short, no disintegration spells long life and sustained capacity Again, owing to this very greatly extended surface the plates are peculiarly suitable for high charge and discharge rates, as the curves which form part of the recent tests of the batteries installed for the Heywood Corporation tend to show. A very fair idea of the general arrangement of the Marquand central-station type of cell can be gathered from the illustration. The plates are swung in tension from suitable thick glass suspension slabs carried on paraffined teak bearers. The plates are spaced ½in. apart from one another, and the four rows of glass tube separators rest upon the bottom of the cell, and are held in position by special porcelain retainers. The lugs are designed to be of ample section for the maximum discharge rate, and are burnt autogenously to trapezoidal lead bars, the whole, with the curved glass

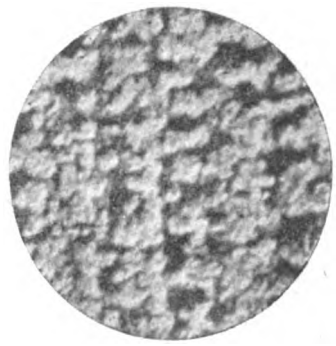

FIG. 16.—Enlarged Photograph of the Surface of a Marquand Accumulator Plate.

spray arresters, presenting a thoroughly neat and workmanlike appearance. The cells are arranged all on one level, and the wood supporting beams are carried on brick piers with glazed porcelain tops. The regulator cell connections are of quite a novel description. The cells are arranged round the sides of the room and flat copper strip is carried up from each regulator nearly to the roof and then round the sides of the room to the switchboard. The strips are separated from each other by vulcanised fibre and then clamped together and supported at intervals on porcelain insulators. The arrangement can be seen well in Fig. 15, which gives a general view of the battery-room; the arched connections in the centre are copper rods joining the ends of the different rows. Two special milking boards are provided in the battery-room for treating defective cells.

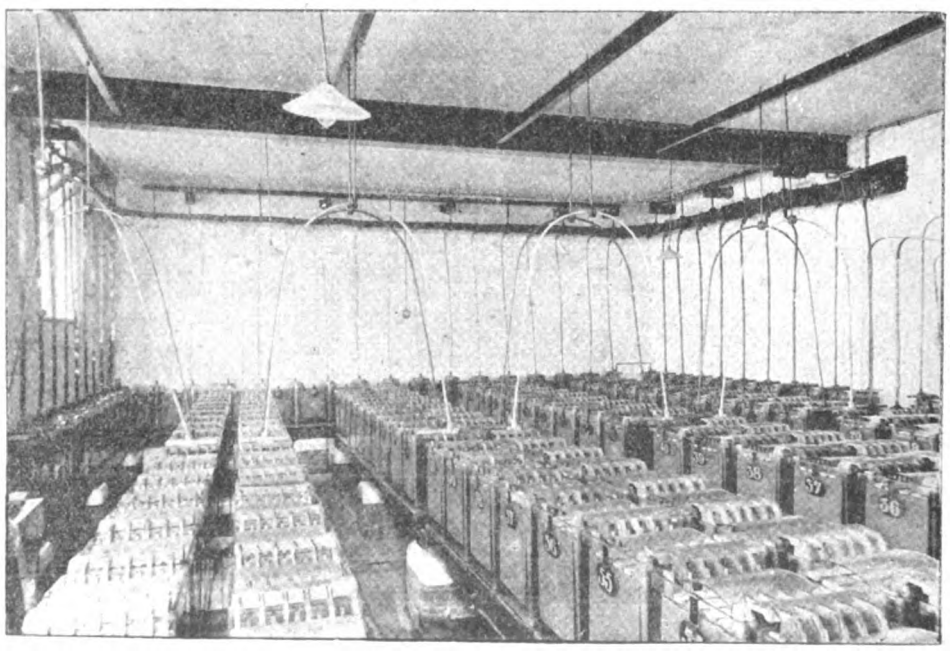

FIG. 15.—View of the Marquand Accumulators at the Heywood Electricity Works.

These have change-over switches for cutting the two milking cells from the battery and connecting them to the cell to be treated. Adjustable resistances are also provided for regulating the current, and ammeters. This arrangement is necessary, as the cells are all burnt up solid to the lugs. The arrangement of the regulating cell connections

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in bare copper strip gives a very neat appearance behind the switchboard, and takes up very little space.

The laying of the mains and feeders throughout the town has been carried out by the St. Helens Cable Company. Two feeders are at present laid—one to the junction of Market-street with Hill-street, and the second to a point on Manchester-street near the railway station. The distributing mains are laid wherever a demand for current is anticipated. Several extensions have already been carried outside the compulsory area. From the feeder points pilot wires are run back to the switchboard and connected to a special pilot wire board. The cables throughout are lead-covered, some vulcanised bitumen and others impregnated paper, laid on the solid system in wood troughing filled with bitumen compound. After the bitumen has been poured into the troughing, blue tiles about 2in. thick are laid on the top to protect the cables from mechanical injury.

At the time of writing this account the equivalent of 2,000 8-c.p. lamps have been connected to the mains, and 18½ h.p. of motors have been applied for. A regular supply was started on Sept. 30. The first building to be lighted was the technical school, built by the Corporation in 1896. The technical schools, illustrated at the beginning of this article, are a very fine block of red brick and terra-cotta, and extremely well fitted out and equipped. The formal ceremony of opening took place on Oct. 26, 1901.

We have to thank the consulting engineer, Mr. W. P Adams, for the drawings and photographs from which the illustrations above were prepared.

SOME UP-TO-DATE TRANSFORMERS.

BY W. E. WARRILOW.

(*Continued from page 587.*)

Figs. 12 and 13 are illustrations of an alternating-current static "booster" for raising the pressure on feeders which are of exceptional length, supplying outlying districts. The booster consists of a transformer whose primary is connected across the station 'bus bars, while the secondary is placed in series with the circuit to be boosted. By means of a multiple-contact switch the length of secondary

FIG. 12.—A Static Booster, made by John Fowler and Co.

windings can be increased or decreased, thus raising or lowering the E.M.F. The switch contacts, protected by heavy glass, are fitted with self-adjusting resistances and carbon breaks, to reduce sparking, while a small incandescent lamp lights up when the contacts are bridged, going out again after the switch has been left in the correct position—*i.e.*, on one stop only. The use of these boosters is considered more economical than the cost of the extra sectional area of copper in a long feeder, whose demand does not reach a maximum but for a few hours in the evening, as with a "boosting" transformer the area can be reduced, and the drop in volts due to the increased load on the feeder can be made good for the short time that it is required. The feeder will therefore be run on more economical lines by this method, than by laying a feeder whose sectional area shall provide for the drop in volts due to the maximum demand upon it.

The present type of transformer manufactured by the Electrical Construction Company is shown in Fig. 14, where both transformer and case may be distinguished.

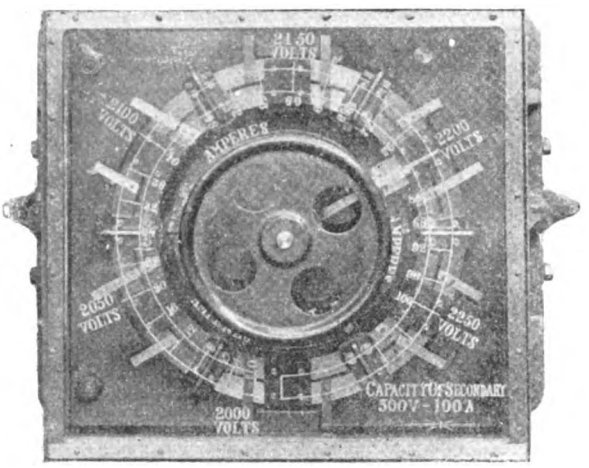

FIG. 13.—Regulator of Booster.

The latter is well ribbed to afford greater cooling surface, and the lid bolts down on to a continuous rubber ring for the exclusion of moisture. The converter represented is of 30 kw. output, the primary being wound for 2,000 volts and the secondary for either 100 or 200 volts. The change of pressure is effected by placing the secondary windings in series or parallel, as the case may require, by altering the connections. The transformer is of the shell type, with the primary made up in three separate sections, and the

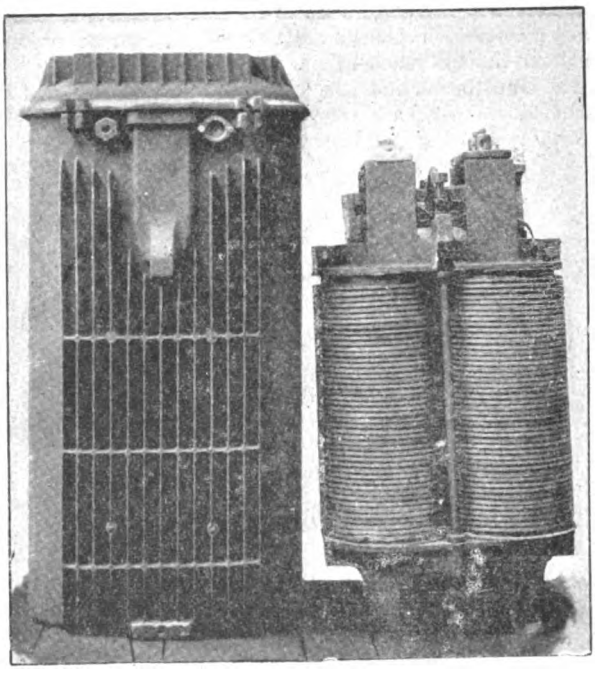

FIG. 14. An E.C.C. Transformer.

secondary formed of copper bars riveted and soldered, to make two continuous coils, the connections of which are arranged for series or parallel running. The different sections are carefully insulated from one another and the core by considerable thicknesses of mica. The core is built up of circular stampings of charcoal iron, having but one joint, and as these are made to overlap, the magnetic reluctance, and, therefore, the magnetic leakage, are reduced to a minimum.

Fig. 15 represents a transformer road-box and its switch gear. The complete arrangement is contained in a cast-

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iron tank sunk beneath the road or causeway. An inner cover well jointed to keep out damp from the terminals and transformer is provided, and an outer lid encloses the whole of the tank. The secondary switch, which occupies one side of the tank, is operated from the road by raising a circular auxiliary lid in the road cover, through which a key is passed to a spindle moving in a gland fitted to the inner cover, this spindle engaging with the switch shaft. A rectangular lid in the road frame admits of access to the

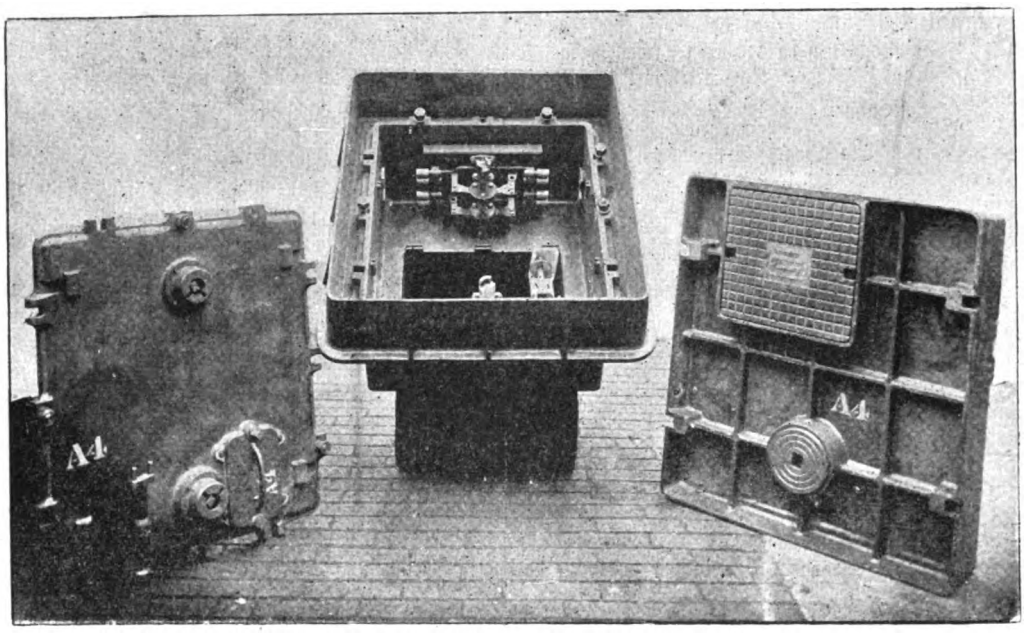

FIG. 15.—Parts of an E.C.C. Street Transformer and Box.

primary switch and fuse, the latter being examined through a small door on the inner cover. A portion of the switch and fuse can be seen in the photograph. The tank will accommodate converters up to 20 kw. capacity, it being a small matter to replace a smaller by a larger transformer until the limit is reached.

The transformer manufactures of Messrs. Cowan and Still and Co., Salford, are interesting, in that they include a patent regulating transformer, by means of which the

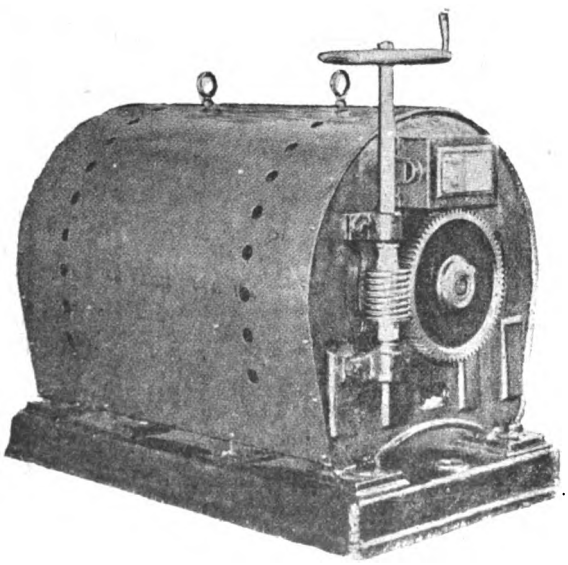

FIG. 16.—Cowan and Still's Patent Regulating Transformer.

pressure on a feeder can be raised and lowered. The arrangement may be termed a booster, as it can be worked in this capacity, though by reason of its construction it can be put to other practical uses. The principal feature is that the pressure can be raised from 0 to a maximum without the use of multiple-contact switches and without any jumps. This desirable result is obtained by placing half the secondary and the whole of the primary windings on a revolvable shuttle, made up of charcoal iron stampings to form the core. This shuttle is swung on bearings inside a cylinder, through which the other half of the secondary is wound. By means of suitable gearing the shuttle can be placed in such a position that the two windings nullify one another, and the secondary pressure will be zero. Turning of the handle will then revolve the primary and half of the secondary, so that the voltage will gradually rise until the desired maximum is reached. The external appearance of the converter can be gathered from Fig. 16, in which the handle and gear wheels are easily seen. A section through the arrangement is shown by Fig. 17, in which P P are the primary coils, S S the secondary on the shuttle, and *s' s'* the secondary on the outer ring. M are known as "damping" coils, which tend to keep the magnetism in the desired direction. For raising the volts on a distant feeder the arrangement is very convenient, more especially as a very fine adjustment is possible on account of the absence of switches. Another use the converter finds is

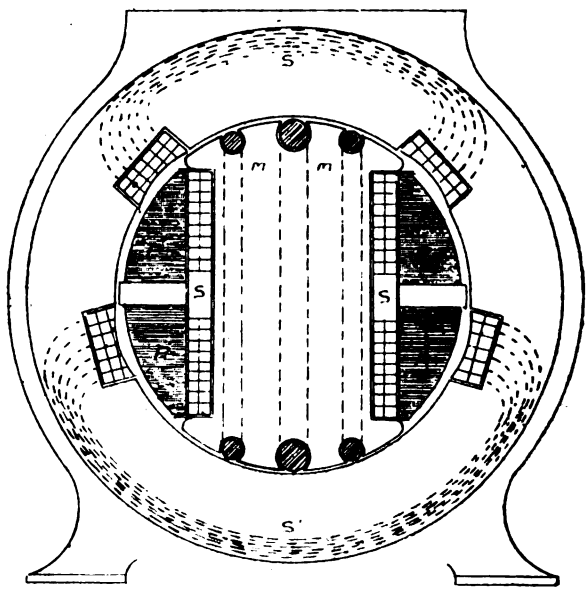

FIG. 17. Section of the Cowan and Still Regulating Transformer.

for raising the volts gradually on a feeder under test, which has been disconnected for some time. The strain on the insulation is very great when the full voltage is applied suddenly, so that for charging a main the arrangement is of great service, and for a similar reason it may be used for discharging a cable, the capacity of which may be very considerable. Fig. 18 illustrates a pit transformer tank with terminal and fuse box attached. High-pressure fuses are fitted in the box and to one side of the transformer tank. The fuses are inserted between spring clips, and they may

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be removed while under current with perfect safety. Their arrangement in a porcelain trough also confines the arc which may occur on the blowing of the fuse, a rather unlikely circumstance, as the wire is well enclosed in the fuse holder. The cables enter the junction box by water-

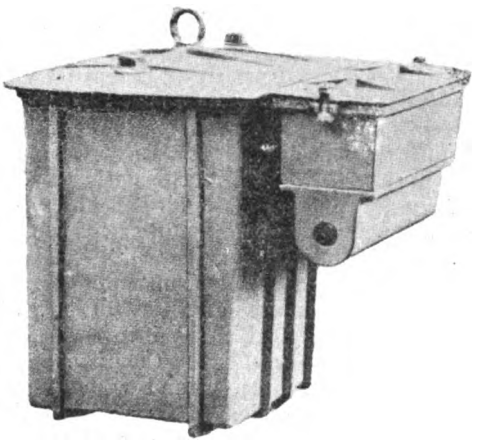

FIG. 18.—Transformer in Watertight Case, with High-Tension Fuse Box and Sealing Chamber.

tight glands, where the ends are sealed to prevent any creeping of moisture.

(To be continued.)

THE BALANCING AND FEEDING OF A MULTIPLE-WIRE NETWORK.

BY O. DEWEY.

Judging by the number of towns in this country which have adopted, or are about to adopt, an electrical supply of continuous current using the three-wire system for distributing the supply from the generating station to the consumer's premises, there appears to be little doubt that for a general system of supply, such as is required in the majority of our towns, where we find not only are we called upon to supply lighting but also motive power, this system is considered to be the most suitable. With the introduction of the high-voltage incandescent lamp the three-wire system, as applied to the distribution of electrical energy upon anything like a large scale, received a new lease of life. Almost immediately after the lamp had been put upon the market the engineers in charge of undertakings which were already using the three-wire system, but with a pressure of only 200 volts or thereabouts across the outer conductors, commenced to think about doubling the pressure on the consumer's installation, and after one or two of our leading engineers had actually started to change over, the fever caught on, and in a very short space of time most of the undertakings followed suit so as to reap the various advantages which the alteration affords—to the central-station engineer at all events. If the high-voltage lamp had not made its appearance until three or four years later, there is every probability that we should have heard considerably more of the five-wire system, such as was installed in Manchester about eight or nine years ago, and which is still in operation throughout the central portions of the city. This system enabled the energy to be sent from the station at about double the pressure which was possible with the three-wire system. The extensions into the outlying districts are carried out upon the three-wire system with 200 volts on the lamps by simply extending the two outers and middle wire of the original network, so that Manchester is about the only town which has been so long in operation which was able to make use of the high-voltage lamp without the slightest alteration having to be made to the plant in the generating station. In spite of all the arguments which were brought forward against the practical value of the five-wire system, and of all the bogies which were raised as to the great difficulty that would be experienced in keeping the voltage equal between all of the five conductors, they did not prove to be anything like so terrible as the opponents of the system prophesied, and the difference in pressure between any two wires and any other two rarely exceeded about 2 per cent. Of course, it was very necessary to be careful about the proper arranging of consumers' installations between the five distributors, so that as far as possible the installations themselves would balance one another. In the case of a large consumer whose consuming devices aggregated more than, say, 10 kw., the contractor who was wiring the installation was required to split the lights up on to four approximately equal circuits. The service for this consumer would be a five-wire one, and the house circuits would be connected to all five, a separate meter being provided for each circuit, or, if there was no special reason for registering the amount consumed by a particular circuit of lamps, a five-wire meter, Thomson or Aron, was fixed for the whole installation. However great the care might be in the arranging of the installations, it was impossible to avoid a certain amount of out-of-balance current, and this was dealt with automatically by means of motor-generators. When designing any multiple-wire system of distribution, not the least of the many points which have to be considered is the method by which the balancing is to be carried out. This point, like many others in the electrical world, is one upon which exists a considerably difference of opinion. In a large number of stations, especially the smaller ones, multiple-wire feeders are employed, in which case the pressure on either side of the middle-wire feeder, and consequently on either side of the middle wire of the distributors, can be regulated from the station, this being usually done by altering the number of effective cells on either side of the battery. If the battery is the only means by which this regulation can be carried out, and all the feeders are in parallel, it will be impossible to keep the voltage equal between the middle wire of the distributors and the outers at all points of the network, as any alteration at the station will affect the whole of the feeders, and it might easily happen that one portion of the network is very well balanced and, at the same time, another portion might be very much out. It is therefore advisable in the case of three-wire feeders, and where it is necessary to do all the regulation from the station, to have the smaller units wound for a pressure suitable for connecting to one side of the system only, and then the feeders can be split up into groups, each group being regulated independently of the others. Some engineers in this country do not consider it is necessary to use multiple-wire feeders, and only use two wires feeding on to the outers of the distributors. When a multiple-wire system is fed by this method, it will be at once seen that the main switchboard in the generating station is very much simplified; in fact, the station resolves itself into a two-wire one so far as generation is concerned. If the network is a large one, it will not be sufficient to have a set of balancers at the generating station only, for, as before explained, the balancing of the network, and consequently the voltage, might be very different in one district from what it is in another. It is, however, advisable that one set at least should be installed in the station, as it will probably be found that the one set will be quite able to deal with all the out-of-balance current after the night load has gone off, say after midnight. Of course, if the station has a battery this will be used for balancing purposes, but it would be extremely unwise, in the author's opinion, to rely wholly upon this. This balancing device, whatever it may be, will be connected to a set of distributors forming part of the network, if the network passes through the station. If the distributors do not actually run through the station, special mains should be run from the nearest point of the distributors to the works. In addition to the balancing machines at the station, sub-stations will have to be erected at different points on the circuit in which balancers can be installed. The number of these stations and the distances apart at which they should be fixed will, of course, depend upon the character and magnitude of the demand, and no special rule can be made for determining these points. It is very necessary, however, that the engineer should give serious attention to the proper location—perhaps we might call it electrical location—of these sub-stations, as it is quite certain that if the distance between them is too great, an unequal pressure on consumers' installations will be the result. This was the system which was adopted in

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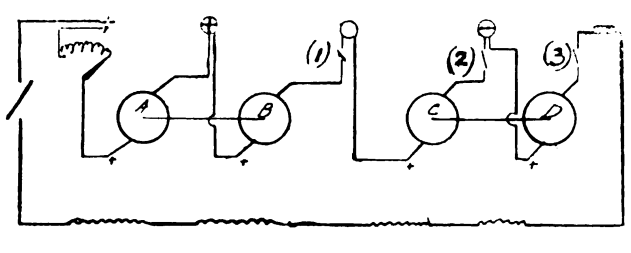
Manchester in connection with the five-wire network, and as this undertaking, according to some people, was going to present such great difficulties as regards balancing, it would perhaps be of interest to some of your readers to give a description of the arrangements used for equalising the pressure between the five conductors forming the network. The sub-stations which are used exclusively for balancing purposes are three in number. They are constructed underground, and were originally lighted by means of deck lights, which, however, proved unsatisfactory, owing to the difficulty experienced in keeping them watertight; these were removed, and only artificial illumination was employed. Each station was sufficiently large to contain two complete sets of balancing machines and all switch gear in connection therewith. The sets each consisted of two separate machines, each machine having two similar windings upon the same shaft, which revolved in a field common to both windings. The two machines were mechanically coupled together by means of a flexible coupling. In the first set of balancers that were put down, the two sets of field magnets were excited off one pair of the 100-volt mains, the two being connected in parallel. This method of exciting is all right so long as the network is in normal condition; but it will be at once seen that if a short-circuit takes place between the pair of mains from which the exciting current is obtained, the field of the whole set instantly dies away, and there will be no tendency on the part of the balancers to burn out the fault. The balancing sets which were put down in later years were not excited in the manner just described. The four limbs forming the two sets of magnets were all connected in series, and the whole series was connected across the two outers of the five-wire network. This arrangement proved to be much more satisfactory than the method which had been employed previously. In the event of a short coming on between any of the five mains, the field was still excited as long as the plant at the station could be kept running, and, therefore, the balancers would work against the fault, and if it was not of too great a magnitude, it would be possible to burn it out without interrupting the supply altogether. The shunt winding was excited quite independently of the four armature windings, a Siemens shunt switch being used for making and breaking the circuit. The shunt switches which were employed in the first instance were of the double-pole type, and were so constructed that on opening the circuit a resistance equal to that of the shunt winding was introduced in series with the shunt; the shunt was then short-circuited, and, finally, the circuit through the non-inductive resistance was broken. This type of switch is, no doubt, suitable if employed with low voltages only, but with 400 volts it proved to be exceedingly dangerous, and the author had rather a serious accident when using one. It happened on one occasion that it was necessary to start up and shut down a particular set of machines two or three times in quick succession. When it came to starting up the third time, the current which was left in field winding started an arc across the 400-volt terminals, to which the leads for the shunt were connected, and as there were no fuses in the shunt circuit, the arc was maintained until the two $^{7}/_{14}$ cables feeding the shunt switch were fused by the enormous current taken by the arc. The author was operating the switch at the time, and was rather severely burned on the face and hands. This was the second time these shunt switches had caused serious trouble, so the use of them was discontinued, and Siemens's well-known switches were fixed to take their places.



The accompanying diagram shows the connections of a set of motor-generators for the five-wire system. To set the combination to work, the shunt switch was first closed, which at once gave the field the full excitation. The armature, A, was then switched on to one pair of the five wires through the starting resistance, which resistance was cut out of circuit as the machines came up to speed. When full speed was attained the switches marked 1, 2, and 3 were closed, thereby connecting the other three armatures to the mains. When this was done the armature connected to the pair of mains upon which there was the lightest load acted as the motor, driving the others as generators. All the switch gear was specially designed by Mr. C. H. Wordingham, city electrical engineer, and was so arranged that it was impossible for the switches 1, 2, and 3 to be closed until the whole of the starting resistance had been cut out of circuit. All these sub-stations were run from about 7 a.m. until 11 p.m., after which the set of balancers in the main generating station was sufficient to deal with the load. It was not found necessary to keep a man in attendance all the time the machines were running, and one man was able to look after all three stations, visiting them in turns during an eight hours' shift.

The following figures will show the differences in pressure between the five mains with and without the balancers running. Of course, when I say without the balancers running, I mean without one particular sub-station running; there would still be two other sets at work on the network, and also the set at the generating station.

	+	(+)	0	(−)	−
Balancing	101·4	101·5	101·5	103	
Not balancing ...	101	99·5	101	106	

Greatest difference when balancing = 1·6 volts.
Greatest difference when not balancing = 6·5 volts.

In the outlying districts, where only the three-wire system was in use, with 200 volts on the lamps, the balancing was done in the same manner, but of course it was only necessary to have a single machine with two windings on the armature, instead of the two machines, as in the case of the five-wire system.

Another arrangement which was adopted in Manchester for balancing a portion of the three-wire network was put into operation by the author a few months ago. For the purpose of feeding the outlying districts high-tension three-phase current was transmitted to sub-stations, where it was converted to low-tension continuous current, this being supplied to the outers of the network, as in the case of two-wire feeders. The static transformers in the sub-station were connected in star fashion, and by means of a connection between the middle wire and the centre point of the star, the middle wire was maintained at a potential half-way between the positive and negative conductors. This method of balancing is a very great advantage, and being able to do it in this manner is a very strong point in favour of using rotary converters instead of motor-generators for feeding a three-wire system with continuous current. Before the last-mentioned method of balancing was put into actual use on the circuit, a few experiments were carried out in order to find out the sensitiveness of the arrangement.

The high-tension mains from the generating station not having been joined up throughout the whole of their length, two complete sets of sub-station plant were used for the purpose of carrying out these experiments, one set being used for stepping up and the other for stepping down again—viz., the first rotary converter was supplied from the network, and the output on the three-phase side was transformed up to 5,000 volts, and after being transformed down again to about 250 volts was used for driving the second converter on the three-phase side. The continuous-current side of the second converter was connected to the outers of a three-wire system, which was so arranged that the number of lamps on either side of the middle wire could be altered as desired. The middle wire was connected through a switch to the centre of the star of the low-pressure winding of the transformers belonging to the converter supplying the continuous current.

First condition.—Balancing switch off, and 2 × 16's on one side of the middle wire and 3 × 16's on the other:

	+ 3 × 16's	0	2 × 16's −
Volts with balancing switch off	168	236	
" " " on	203	203·2	

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The lamps were then altered until 13 × 16's were on the one side and only 1 × 16 on the other, a condition which it would be almost impossible to obtain practice.

	+	0	−
	1 × 16	13 × 16's	
Volts with balancing switch on	203	202·5	

Of course it was impossible to take the pressure without the balancing wire being connected in this case, as if the pressure had been put on with so great a difference in the numbers of the lamps, the 1 × 16's would have burst. These currents were, of course, very small to be much of a practical test, so the experiment was tried with a much larger load, so as to produce a drop in all of the apparatus employed. This was done by having two liquid resistances in series across the continuous-current side of the converter, the wire from the star connection being tapped on between the two tubs.

Current, 55 amperes.	+	0	−
Not balancing	172 volts	220 volts	
Balancing	196 „	195 „	
Current, 70 amperes.			
Not balancing	169 volts	218 volts	
Balancing	193 „	192·5 „	
Current, 100 amperes.	+	0	−
Not balancing	184·2 volts	190 volts	
Balancing	189 „	189 „	

One of the outer plates was then lifted completely out of the tub, and 100 amperes left on the one side only, the conditions then being that the 400-volt converter was supplying current at 200 volts or thereabout.

+	0	−
No current	115 amperes	
185 volts	187 volts	

These figures will show how very well the arrangement worked, and the above experiments were well borne out by the behaviour of the machines when working on the network under normal conditions. The only disadvantage of having a large network fed exclusively by two-wire feeders is that in the event of a fault coming on to the network, it is impossible to split it up so as to let each feeder supply a distinct portion of the system, as it is necessary to have some balancing device across each portion which is isolated, and it is not likely that one would have as many balancing stations as there were feeders. In the author's opinion the best arrangement for a large cross-connected network would be to have most of the feeders two-wire ones, and have a few multiple-wire feeders, so as to enable the network to be split up into small sections for localising faults.

SIMPLEX STEEL CONDUIT.

We have received from the Simplex Steel Conduit Company, Limited, copies of their October and November supplementary sheets in connection with their current price-list. These sheets, which we

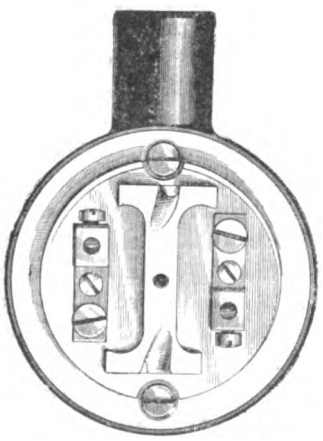

Fig. 1.

understand are now being issued to the trade, show the latest improvements in detail to the firm's well-known system of conduit wiring. Amongst other improved fittings illustrated and described in the November sheet may be mentioned a ceiling-rose box with solid terminal pieces, cut from special section brass, and recessed porcelain back, suitable for "looping in" wiring for three-ampere circuits. The box has an internal diameter of 1⅛in., and a depth of 1in., while the base of the ceiling rose is only 2¼in. diameter, as against 2⅝in.—the diameter of the large "looping in" rose illustrated on p. 53 of the firm's price-list. A plan of this ceiling rose with the cover removed is shown in Fig. 1. It is fitted with solid terminals for looped wires, and the boxes are made for ⅜in. and ½in. inlets and outlets, both terminal and through. Fig. 2 shows a side elevation of the twin switch

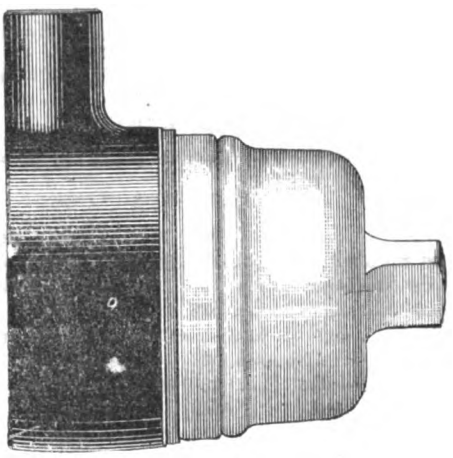

Fig. 2.

box supplied for use in conjunction with the fitting just described. This switch box has an internal diameter of 1⅛in. by 1in. depth, as in the case of the ceiling rose. The compactness of the combined fittings should recommend them. For cleaning out the slight burr after cutting the conduit, the taper reamer (shown in Fig. 3) has been introduced. This tool can be used for all sizes of conduit from ½in. to 1in. diameter.

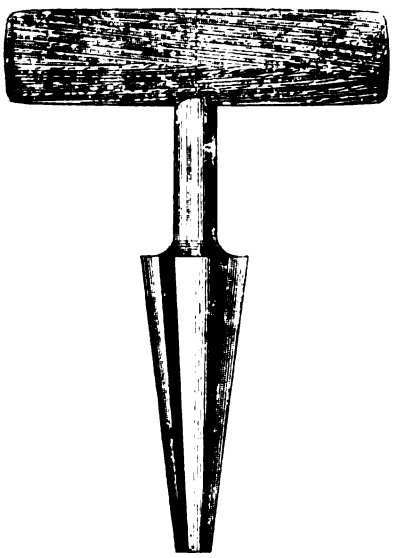

Fig. 3.

Distributing fuse boards of the new pattern Simplex D.P. type are also described and illustrated in the November sheet. The firm are certainly to be commended on their endeavour to perfect in detail a system of wiring which has already found universal favour.

FORTHCOMING EVENTS.

FRIDAY, NOV. 1.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Sir John Jackson, F.R.S.E., will deliver his presidential address.

Institution of Mechanical Engineers.—At 8 p.m., adjourned discussion on "The Second Gas-Engine Research Report," by Prof. Frederic W. Burstall.

SATURDAY, NOV. 2.

Electrical Engineers' Volunteers.—At 8 p.m., smoking concert at Headquarters.

Dundee Institute of Architecture, Science and Art.—At 7 p.m., Technical Institute, Dundee, ordinary meeting. Lecture on "The Glasgow Exhibition: Its Results and Lessons," by Prof. Patrick Geddes.

TUESDAY, NOV. 5.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting Address by Mr. Chas. Hawksley (president), and presentation of medals and prizes.

SATURDAY, NOV. 9.

Manchester Association of Engineers.—At 7 p.m., ordinary meeting. Paper: "Recent Developments in Fine Machine Grinding," by Mr. Hans Renold.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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INVENTORS AND INVENTIONS.

In a recent issue we dealt somewhat briefly with the ways of inventors and promoters. We are glad to record the success of our esteemed contemporary the *Electrical Review* in its defence of a libel action brought against it by an inventor whose invention was condemned in an article in our contemporary's columns. There was no absolute necessity for our contemporary to decry the so-called invention, but it was certainly good for the public at large, and, indeed, for the inventor himself, that the truth should be told. Inventors are but human, and many of them honestly think they have solved problems which the scientific and manufacturing world have long struggled with in vain. Given that it is not an impossibility for an outsider to have a happy inspiration, the probability of such a thing happening is almost infinity to unity. The man most likely to solve any problem connected with machinery is the man who knows in what direction progress is possible, who is thoroughly familiar with machinery and with the principles upon which it is constructed. Thousands of patents are taken out in this and other countries which are mere modifications of details in workshop practice, such as any artisan would introduce when considering the conditions for which the apparatus was to be employed. These are by courtesy called improvements, and are patented to the detriment of all good practice, inasmuch as they would be introduced as a matter of course in any shop where the apparatus was being constructed to fulfil certain conditions. The editors of technical papers are placed in a very peculiar position with regard to patents, promotions, and designs. If they speak at a time when it might be possible to save the public from loss by timely warning, they probably become involved in costly litigation, from which if they emerge successful they have no recompense for their intense mental worry, even if they obtain a return of money expended. Perhaps we may give away the whole case if we say that the general public deserve their fate and their losses in all these transactions, but there exists a deep-rooted feeling that though the public deserve all they get for being such fools, the clever men who carry out schemes which fleece the public are not to be permitted to carry out such work with impunity. In saying this we do not refer to the case just concluded, but to the general case. The particular case under review related to the claims for an engine of new design, our contemporary pointing out that the law of conservation of energy still held, but did not seem to be really understood by the designer. No doubt the writer made some maladroit references to the style of the English in which the designer's views were put forward in pamphlets. In our opinion a man is to be congratulated rather than laughed at in his attempts to express himself in a language not thoroughly understood, but to point out bad English is not libellous. The jury, we notice, took twenty minutes to consider their verdict. We are unable to see a single sentence of those put forward as indiscreet which required twenty seconds' consideration as regards its libellous character. The author of the article was in a chaffing mood; he put his case against the design somewhat bluntly, but he also translated into technical language what he considered the principles of the machine, and condemned the design as being no improvement, but rather the contrary, on what was already well known. The law is so queer that we again heartily congratulate our contemporary upon its success. A glance at the proceedings of the Law Courts will show how closely promoters sail to the wind, and as in most cases the damage is irretrievably done when a company is once floated, the only

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chance a technical paper has to save the public money is to refer to schemes in their early stages. Of course, the reply to criticism then is, grammatically or otherwise, We have done nothing to nobody. Why single us out for animadversion?

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

COMPETITION.

SIR,—We beg to hand you herewith copy of memorandum we are sending to a number of firms from whom we received some time ago quotations for arc lamps. We think that the publication of this memoranda may be the means of inducing manufacturers in this country to more readily accept conditions which are acceptable to competitors on the Continent.

We also direct your attention to the following notes: The first (A) written to a firm in London when asked to replace certain electrical fittings broken in transit, because insufficiently packed.

The second (B) is a note received from our customer abroad, and is made in reference to the replacing by a Continental firm of 100 lamps complained of.

If the treatment by Continental firms compares so favourably with that of British manufacturers, one can readily understand the preference by merchants and importers on the other side to the former.—Yours, etc.,

OSWELL AND STRACHAN.

No. I.—*Re* your quotation for arc lamps, the following is an extract from a letter received from our customer abroad: "We duly received your quotation, and after very careful comparisons regarding them we regret that they cannot see their way to meet us with regard to the conditions specified. Messrs. ——'s representative (a German firm) here, however, has offered to supply us with a lamp on the specified conditions."

(A.) From ————, London: "With regard to the complaint made by your customer, we are very much surprised to hear it. We have shipped these goods and similar ones to all parts of the world, and we have not had any complaints of broken goods owing to bad packing, and we certainly do not think that those goods were improperly packed by us, and we must decline to be held responsible for the breakage. We have not got any spare covers for these cut-outs in stock, but shall be pleased to order the quantity you name, provided you are willing to pay for them. We cannot say when we could deliver them, but would do our very best to get them off prompt for you."

(B) From ————, South Africa: "We note that the lamps have been supplied to us gratis, and we thoroughly appreciate the way in which they have treated us."

REVIEWS.

Electricity in the Service of Man. Rewritten and enlarged by R. MULLINEUX WALMSLEY, D.Sc. (Lond.), F.R.S.E. A popular and practical treatise on the application of electricity in modern life; with over 950 illustrations. To be completed in 16 monthly parts. Part I., price 6d. Cassell and Co., Limited.

The publication in part form of the above brings within the reach of the multitude a work which has already made its mark as a popular and practical treatise on the application of electricity. In the introduction to Part I. the early history of the science is dealt with. Then we have in Chapter I. a brief treatise on the principles of magnetism and the elementary fundamental phenomena connected therewith, many familiar cuts being used to illustrate the text, besides several new ones which lend a certain freshness to the book. Chapter II., of which we have the commencement, treats upon electrostatics in the most approved text-book style. It needs no prophet to foretell a renewed success for the work in its revised form. The publishers are certainly to be commended for their enterprise.

HACKNEY ELECTRIC LIGHTING.

Yesterday afternoon at 3 o'clock the Mayor of Hackney formally opened the Hackney electricity works, with which are combined a large refuse destructor. The opening of the works is somewhat premature in one respect, in that the engineering equipment is far from completed. It is, however, in a sufficiently advanced state to allow of a supply being given to the large number of consumers who have been clamouring for electric light. A continuous supply will accordingly be given from yesterday, and the opening ceremony was not, therefore, out of place. The Hackney electric lighting provisional order was obtained in 1893, and the history of the earlier attempts to trade with this order are neither edifying nor creditable to the Hackney authorities. The outcome of these attempts was a resolution that the Hackney Vestry refused to sell, lease, or in any way part with the electric lighting order. In September, 1898, Mr. Robert Hammond was appointed consulting engineer, and his report on the electric lighting and dust destructor question was accepted early in 1899. Messrs. Gordon and Gunton were appointed at the same time architects to the buildings. After a considerable amount of negotiations a freehold site was obtained on the banks of the River Lea Navigation, which will be used for transporting the coal.

As regards the plant at Hackney, we propose to leave a full description of this until the works are more completed, and photographs and drawings are available. The system of supply is the three-wire low-pressure, with 240 volts at consumers' terminals. A 12-cell destructor of the Stirling type has been erected, capable of burning 160 tons of refuse per day of 24 hours. The three boilers, which are fired by these destructor cells, are arranged for a pressure of 250lb. per square inch. The coal-fired boilers, on the other hand, are designed to supply the engines with steam at 190lb. In between the two ranges a reduction valve is placed so as to reduce the steam from the destructor boilers to 190lb. In this way the fluctuation of steam pressure, which is so objectionable in destructor-fired boilers, would be obviated. The engine-house plant consists of two 500-h.p. Willans engines and two 1,000-h.p. Belliss engines. The dynamos were all supplied by Messrs. J. H. Holmes and Co. Those of 600 kw. capacity for the large engines are designed for the full voltage across the outers of the three-wire network. The two smaller engines each drive three dynamos in tandem, which, supplying between the centre wire and the outers, can be used as balancing machines. A large battery of accumulators of 2,800 ampere-hour capacity has been installed by the Tudor Accumulator Company. The switchboard, which is worthy of most careful inspection, is of the Ferranti type. The mains were supplied and laid by the British Insulated Wire Company. Distributing mains have already been laid in some 55 streets, and the arc light mains supply some 320 arc lamps in 14 of the principal streets. These arc lamps were supplied by Messrs. Johnson and Phillips.

OPENING CEREMONY.

The formal inauguration of a regular supply of electricity from the above-described works took place yesterday in the presence of an attendance which seriously threatened to overtax the accommodation provided. The chair was taken by the Chairman of the Electric Lighting Committee, Alderman JOSEPH RICHMOND, who, in his address to the assembly, touched upon the history of the undertaking. The scheme had been a fairly long time developing, but no time had been lost since the foundation stone of the works—which they were about to be declared open—was laid some twelve months ago. The dust destructor was not yet completed, but they hoped to be in a position to destroy refuse in the early part of next spring. They expected to obtain from the refuse collected from the Hackney dustbins, enough power to keep one of the 500-h.p. generating sets running continuously. The site which had been selected for the works was probably the best available in the whole borough of Hackney. Coal could be brought right up to the site by water, and an electric elevator and conveyor would provide

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for its conveyance from the barges to the boiler-house. Their accumulator-room was second to none in the country. The accumulators installed would be sufficient to keep the 300 public arcs going for a period of eight hours, so there was no fear of the failure of the street-lighting. Great credit was due to Mr. Robert Hammond, their consulting engineer, for the way in which the work had been carried out.

The next speaker, Mr. HAMMOND, described in his lucid manner the details and purposes of the undertaking, dwelling upon the necessity of getting rid of ashbin refuse by cremation, and explaining how it was proposed to make the destruction productive by utilising the heat generated for raising steam in specially provided boilers. No day load of any moment being immediately at hand, accumulators had been provided to store the energy obtained from the refuse during the day for use at night.

The architect for the buildings, Mr. JOSIAH GUNTON, F.R.I.B.A., of the firm of Messrs. Gordon and Gunton, then gave some details of the buildings, the chairman subsequently introducing his Worship the Mayor of Hackney (W. R. Horncastle, Esq., J.P., C.C.), who duly switched on the light, at the same time declaring the works opened, and the supply of electricity for light and power available in the borough.

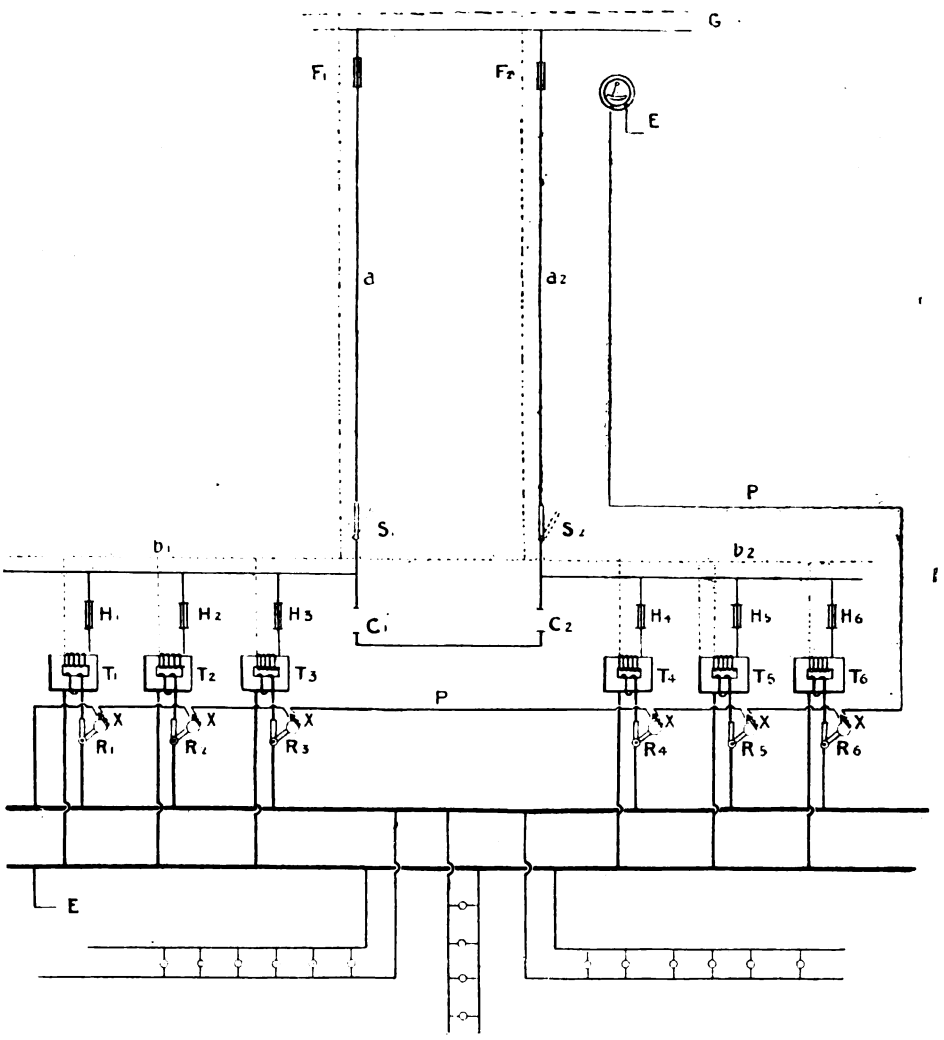
The ceremony was performed in a large marquee, in which a device bearing the words, "Success to the Hackney Electricity Works," in electric glow lamps had been erected, and a few arcs suspended to lend brilliance to the scene. After the usual votes of thanks, etc., had been passed, the guests had an opportunity of inspecting the splendidly-equipped—we might say, model works.

DUPLICATE ELECTRICITY FEEDERS.

BY LEONARD ANDREWS.

In a paper read before the Institution of Electrical Engineers in 1898, the writer described a system of duplicate mains he had devised for the purpose of preventing an interruption to the supply in the event of a short-circuit occurring on any electricity feeder. Since that time a number of experiments have been made to test the reliability of this system, but it is only within the past few months that it has been introduced into practical use. Shortly after the duplicate supply to one of the principal sub-stations at Hastings had been completed, a bad short-circuit occurred on one of the duplicate high-tension feeders supplying this sub-station. The faulty section was immediately automatically disconnected, and the supply to some thousands of lamps was maintained through the remaining feeder.

The feeders are connected up as shown in the accompanying diagram. The transformers in the sub-station, T_1, T_2, etc., are supplied from two independent high-tension 'bus bars, B_1 and B_2, half of the transformers being on one bar and half on the other. These 'bus bars are fed by means of the duplicate feeders, A_1 and A_2, with current



from a common source of supply, G, at the generating station. High-tension fuses, F_1 and F_2, are inserted in series with these feeders at the generating station end of same. These feeders are not directly connected together at the sub-station end, but are indirectly connected through the transformers, since the secondaries of each transformer is connected to a common low-tension 'bus bar. High-tension fuses, H_1, H_2, etc., are inserted in series between the primary winding of each transformer and its 'bus bar, and means are provided for directly connecting the two high-tension 'bus bars in parallel by inserting the interconnecting fuses, C_1 and C_2. High-tension switches, S_1 and S_2, are provided for disconnecting the high-tension feeders from the 'bus bars. Return-current cut-outs, R_1, R_2, etc., are inserted between the secondaries of each transformer and the low-tension 'bus bars. A pilot wire, P, is run from the sub-station to the generating station for the purpose of indicating at the latter the pressure across the low-tension 'bus bars in the sub-station. A small auxiliary switch, X, on each of the low-tension

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cut-outs is connected in series with this pilot wire, the object of this arrangement being to signal to the generating station the opening of any low-tension cut-out due to the failure of any transformer to maintain the supply.

When the short-circuit referred to above occurred a momentary roar was heard on the generators, and it was noticed that the needle of the voltmeter connected to the particular sub-station referred to had fallen to zero, thus indicating that one or more of the cut-outs in this sub-station had opened. On going to the sub-station, it was found that the cut-outs, R_4, R_5, and R_6, had opened, thus showing that a current had been flowing back from the low-tension 'bus bar into the transformers fed by the feeder, A_2. It was at once concluded that this feeder had short-circuited. The switch, S_2, was, therefore, opened and the return-current cut-outs R_4, R_5, and R_6 were closed, thus magnetising the transformers that had been cut off through the secondaries. This showed that there was no fault in these transformers. The interconnecting fuses, C_1 and C_2, were, therefore, inserted, and the whole of the transformers in the sub-station were supplied through the healthy feeder, A_1. On examining the fuse F_2, it was found that this had blown, thus confirming the conclusion that the short-circuit was in this section. The faulty feeder was tested and the fault localised. It was found that the short-circuit had started in an old rubber tape joint, which had apparently been attacked by the sea-water. The arc had evidently been a fairly destructive one, as it had burnt out a foot or two of $^{19}/_{16}$ cable before the fuse had blown.

As the fault occurred at the time of maximum load it will be obvious that if fuses had been used between the secondaries of the transformers and the low-tension 'bus bar, as is usually done, the supply to this 'bus bar would most certainly have been interrupted, because the three transformers on the healthy side of the sub-station would have had to maintain the whole of the load taken over from the transformers on the faulty side, in addition to supplying the current necessary to blow the fuses on the faulty side, and would certainly have blown their own fuses first.

ELECTRIC TRACTION ON THE "UNDERGROUND."

On Tuesday last, at 11 o'clock, the Hon. Alfred Lyttleton, K.C., M.P., opened the court of enquiry into the dispute between the Metropolitan District and the Metropolitan Railway Companies as to the system of electric traction to be adopted on the "Inner Circle." As previously noted, Mr. Lyttleton is being assisted by Mr. Horace F. Parshall, representing the District Company, and Mr. Thomas Parker, representing the Metropolitan Company. The counsel engaged in the arbitration are: Mr. Fletcher Moulton, K.C., M.P., and Mr. J. W. Gordon, for the Metropolitan District Railway Company; Mr. C. A. Cripps, K.C., M.P., Mr. Roger Wallace, K.C., and Mr. F. G. Thomas, for the Metropolitan Railway Company; and Mr. E. Moon, for the Great Western Railway Company. The enquiry is being held in the Lord Chief Justice's Court at the Law Courts.

Mr. Fletcher Moulton, K.C., M.P., opening the case for the District Company, first explained to the arbitrator the extent of the lines owned by the District Company and the proportion of the Inner Circle in which they are interested. He stated that they owned four miles of the Inner Circle, and that rather more than one mile in addition was owned jointly by the two companies concerned in the dispute. The Metropolitan Company owned the remaining seven miles. The District Company had 25 miles of line outside the Inner Circle. The density of the traffic on the Inner Circle was exceedingly great, owing partly to the way it was fed by its external lines. His clients had recognised for some time that electricity was the best means of dealing economically with this very heavy traffic, because when once installed more trains could be added at comparatively small cost. Although the conversion would seem a serious matter, it was not so, because of the vast amount of experience at hand as to the use of electricity for railway working. He might express it by saying that there was no risk electrically, but there was, of course, the usual financial risk in conversion, as one had to assume certain increases in traffic in consequence of the change. In America there were some 21,000 miles of electric line at work. While he did not suggest that these were all electric railways like the Underground, they were worked, as a rule, more like railways than like tramways, and there were railways, such as the Metropolitan of New York and the Chicago lines, which were quite comparable with the Metropolitan lines in London so far as density of traffic, etc., were concerned. In England there were only some 908 miles of electric line working, but these were quite sufficient to show what could be done. The development of electric traction had practically all taken place within the last 20 years. Many systems had been tried and had proved useless, and the present system, so largely used, was the outcome of practical experience over that time, and it had been found to meet practically all requirements. Mr. Moulton then explained to the Court the direct-current system for working tramways and railways with between 500 and 600 volts on the trolley wire. This voltage, he said, was found to be a mean result between the requirements of safety and of the electrical engineer, who looked for economy in the installation. The risk with this voltage was only moderate, as linesmen were in the habit of ascertaining if a line were alive by touching it quickly with the finger. As the districts became larger the direct-current feeders for the conductors were found insufficient, and it was now the usual practice to use three-phase currents for transmission at between 12,000 to 15,000 volts, then transforming it to a low voltage, after which it was converted by means of rotary converters into direct current for use on the line. By this means all the alternating current and the complexities connected therewith were kept on the generating side of the system, and were quite independent of the traffic arrangements. In the conversion of a line like the Metropolitan, the first consideration without doubt was the safety of the public and of the staff, but next to that came the question of the certainty of uninterrupted traffic. In large towns like London, New York, Chicago, etc., it was required that the communication should be maintained with an almost monotonous regularity. The Central London Railway was an example of what could be done with the system he had described, and it was due to the success of that line that the company he represented was compelled to go in for electric traction. In view of the evidence so acquired, the directors of his company felt justified in advising the shareholders to convert their system for electrical working. He recognised the advantage of a uniform system throughout the Inner Circle, and Parliament had made this a *sine qua non*; hence the present enquiry. Referring now to the system suggested as the best by the Metropolitan Company, it required the use of 3,000 volts in the cars themselves, and thus it did not keep the dangerous currents apart from the traffic side of the railway. This system was an experimental one, as there was not a single yard of railway working on the system, nor had there ever been. It was absolutely unknown how far it would be successful. Also, the general idea of the system had been known for years by those responsible for the conversion of lines elsewhere, and it had not been adopted. It was true that a few lines in Switzerland had been worked on the three-phase system, but the Swiss Government had restricted the voltage on the line to 750. The Zermatt-Gornergrat Railway was one case in point, but who would compare this small line of five miles with its three or four trains a day crawling up a mountain side with the Inner Circle Railway? The other lines worked on this system brought the total mileage up to about 51, but they were all working at 750 volts, and he asked if they dare trust this system, which had only been used for lines with such few trains per day, on the Inner Circle, where there were at least 1,050 trains passing a given point in the course of a day? No matter what promise the system might have, they ought not to experiment on the line in question. The experience should come slowly, and he instanced the failure of the "Great Eastern" as an example of what happened when one hurried the development of any science. As an example of the difficulties which the Ganz system would have, it required two charge conductors for the trains. At a point like the meeting of the lines at Aldgate East, where there were converging points whichever way the trains approached, he thought it would be exceedingly difficult to prevent trouble owing to the reversal of the motors. Perhaps this difficulty could be got over, but in so doing it was quite likely that greater difficulties would be found. The difficulty of the reversal of the motors was not experienced with the direct-current system. In the yards, also, the Ganz system would be most complicated. As regards the system of control, considerable evidence would be brought before the Court. He would point out that the trains could not make up lost time. This might not be thought a serious matter for Inner Circle trains, but it would disorganise entirely the interpolated trains from the extension lines. It is true they would be told there was a line in Italy, some 67 miles long, which was being equipped on the Ganz system as proposed for the Inner Circle. This line was to have been opened in the spring, but it was still incomplete. Even if it were found successful, however, it would not prove that the system was suitable for the Inner Circle, as the conditions were so different. In the energy required to produce a given acceleration the Ganz system was much worse than that used on the Central London Railway. He would bring evidence to show that the supposed saving in first cost was fictitious. He then explained to the arbitrator how idle currents existed in alternating-current work. As regards the history of the undertaking, a specification was used by Messrs. Preece and Parker on Aug. 3, 1900, in which it was required that the parties tendering should observe the Board of Trade restrictions. In reply to this nine tenders were received, of which the British Thomson-Houston Company's tender and that from Messrs. Ganz and Co. were the most favourable. In the report by the above engineers on these two tenders, comparisons were made which he would show by evidence were not correct. For instance, it was said that the Ganz Company offered more plant at a lower cost—*i.e.*, 14,000 kw. for £300,000 as against 10,000 kw. for £500,000. He wondered that these engineers had not looked into the matter more closely. It would be shown, for example, that the boilers provided in the tender of the British Thomson-Houston Company had 80,000 square feet of heating surface, whereas those in the Ganz Company's tender had only 46,000 square feet. This showed that it was utterly impossible for the Ganz Company's plant to develop the output mentioned. He put it to the Court that they were really holding an enquiry because Sir W. H. Preece had passed forward these two tenders to the Advisory Committee without sufficiently criticising their details, and exposing the audacity of the tenderer he recommended After that Messrs. Preece and Parker went to Budapest to inspect the Ganz system, and wrote a report which read more like a prospectus. In that report things were accepted as proved which could only have been demonstrated experimentally as possible. The learned counsel then proceeded to call evidence in support of his case.

Mr. R. W. Perks, M.P., the chairman of the Metropolitan

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District Railway Company, examined by Mr. Moulton, said his company owned 4 miles 4 chains of the Inner Circle, while the Metropolitan Company owned 7 miles 6½ chains. The portion of the line between Aldgate High-street and Mansion House—*i.e.*, 1 mile 7 chains—was jointly owned by the two companies. He then explained the various extensions owned by his company, having a total length of 29 miles 29 chains. The relative importance of the traffic on the Inner Circle was much less than would have been expected. Thus for the year ended 1900 the District Railway had carried some 42,200,000 passengers, of whom only 17 per cent. were Inner Circle passengers. He also explained the running rights which other railways had over the District Railway, and the veto which, in consequence of their agreements, some of these lines had on the question of the electrical system to be used. For instance, on one part of their system there were 860 trains per day apart from the Inner Circle trains. There were 220 Inner Circle trains a day, and under present working arrangements each company ran the trains on one line of rails. He then went through the history of the steps towards electrification, and showed that in 1900 both the companies had full powers to convert. In 1898 experiments were authorised on the line between Earl's Court and Kennington High-street. On April 9, July 4, and Aug. 20, 1900, reports were made to the Advisory Committee of the two companies on the success of the experiments on these lines. On Aug. 3, 1900, a circular letter and preliminary specification, drawn up by Messrs. Preece and Parker, was issued, in response to which nine tenders were received. These tenders were reported on on Dec. 19, 1900, and on Feb. 2, 1901, a further report was made after the two engineers mentioned above had inspected the Ganz system at Budapest. On Feb. 9 this report, advocating the Ganz system, was forwarded to the two Boards. On March 22, 1901, a joint letter by the secretaries of the two companies was forwarded to Messrs. Ganz and Co. which expressed the approval of the company to the Ganz tender, and suggested the drawing up by the engineers of an agreement. Mr. Perks then went on to explain the opposition which he had as a large shareholder to the Ganz Company's proposal, and stated that his objections were shared by the Board of Trade. He had for a good time advised the late chairman of the District Company (Mr. Forbes) on financial questions, and he did not believe that they would be able to raise the money for an experimental system. In his opinion an economical, practical, and safe system was required, and these points were met by the direct-current system. He had no interest in the Metropolitan District Electric Traction Company.

Mr. R. W. Perks, cross-examined by Mr. C. A. Cripps, K.C., M.P., did not agree that the three reports by Sir John Wolfe Barry and Sir W. H. Preece only were concerned with continuous-current systems. He thought that the reference to overhead wires in one of these reports had reference to a system like the Ganz. Sir John Wolfe Barry had resigned his position as consulting engineer to the District Company, but he believed that he was now about to advise them again as consulting engineer.

Mr. Cripps then read through Sir W. H. Preece and Mr. Parker's report on the Ganz system, made after their visit to Budapest. This report, which was made at the request of the Boards of the two companies, referred to the advantages which the Ganz system had in starting trains, and to the fact that in braking or when descending grades energy was restored to the line. The uniform maximum speed, and the construction of the motor, by which all the weight was spring-borne, were also alluded to as advantages.

Mr. Perks said that the letter sent to Messrs. Ganz and Co., and signed by the two secretaries of the companies, had not been authorised by the Board of directors. He had objected to an experimental system like the Ganz, and early this year had secured with his English and American friends a majority of the shares of the company. These American friends had no interest in manufacturing concerns. He was not aware that Mr. Coffin, one of the new shareholders from America, was the chairman of the General Electric Company of America. He did not agree that the Metropolitan District Electric Traction Company was formed in the first instance for the purpose of entering into a contract with the District Company. They expected to have much other work to do, quite apart from the equipment of the District Railway. Mr. Cripps then cross-examined Mr. Perks as to the agreement between the above two companies for the equipment of the line. Under the fourteenth clause of this agreement which was scheduled to the Act of Parliament, the Metropolitan District Electric Traction Company were to receive for the equipment £500,000 of ordinary shares in the District Company, reckoned at £25 per £100, also £166,000 of 4 per cent. debentures at par. In addition to this, any further sums required were to be paid in cash. The various materials were to be supplied at cost price, but Mr. Perks would not agree that this cost price might be much higher than the ordinary market price, owing to manufacturers being interested in both the companies which were parties to the agreement.

The Court then adjourned.

Wednesday's Proceedings.

The examination of witnesses in support of the case for the District Company was continued.

Mr. Yerkes, examined by Mr. Fletcher Moulton, explained his connection with the District Railway. The only two manufacturers among his associates in the undertaking were Mr. Coffin, of the General Electric Company of America, and Mr. White. Mr. Coffin was not interested as a manufacturer in the undertaking, and the General Electric Company had no advantage in the supply of one system of electric traction over another. Mr. Coffin had never asked him for a contract. He (witness) approved of the direct-current system for traction work, because he had proved it to be serviceable in other undertakings. With it they were able to run trains with a three-quarter-minute headway, and, he believed, even with a half-minute headway, which he did not think could be done with a three-phase system. The system as he knew it had been improved year after year by the process of condemning that which had been proved to be unserviceable. He would not be so reckless as to recommend the expenditure of a million of money on a system which had not been tried over an extended period, even if it seemed to have every promise of success.

In reply to the Arbitrator, Mr. Yerkes said he considered the 500-volt system safe, and on all the undertakings he had been connected with there had not been a single death from electric shock. Of course, a severe shock could be received.

The cross-examination of Mr. Yerkes was postponed.

Mr. E. W. Rice, the third vice-president of the General Electric Company of America, was examined by Mr. Fletcher Moulton. He explained that the executive work of that large company was divided up into four departments under four vice-presidents. He was responsible for the engineering and manufacturing department. The output of the company was between six and seven millions sterling last year, and they had installed at least 65 per cent. of the whole traction apparatus used in America and 50 per cent. of that used in Great Britain. As a firm they experimented largely on new systems, and had tried to use three-phase plant for traction work on the two miles of line equipped for experimental purposes at their works. The conclusion drawn from their experiments was that the high-voltage transmission by three-phase current transformers and rotary converters, with direct current on the cars, gave the best results for a large system like the Inner Circle. This line required high acceleration, and there was a comparatively small period at which the trains were able to run at full speed. For this class of work the induction motor was most unsuitable. The series-parallel control was an example of how technical advances had to be made. This system took years of work to perfect. If he were advising on the matter, he would say that the system used on the Central London Railway was the only one he was justified in recommending, and with it he would have no fear of electrical troubles. They had been experimenting with induction motors for traction work during the last 10 years, and seven years ago he tried the cascade system now being introduced by the Ganz Company. Under working conditions they found the induction motors more costly to build for equal efficiency, and much more costly to maintain. In fact, the induction motor was only comparable with a direct-current motor when it was running at full speed, and there was no system of controlling the speed which was economical and satisfactory. He thought the water rheostats proposed to be used by the Ganz Company were unreliable, and only fit for experimental work. The use of air pressure to alter the liquid resistance was most unsatisfactory, as the acceleration would not vary in relation to the requirements at a given time. He condemned the use of a roller collector, and did not advise the use of 3,000 volts on the conductors in tunnel working. There had been no trouble whatever recently with rotary converters, and the old commutating troubles with the direct-current motors had now been overcome by the use of carbon brushes. Other manufacturing companies in America all used now the general system employed on the Central London Railway.

Cross-examined by Mr. R. W. Wallace, K.C., Mr. Rice said he had been connected with the electrical equipment of the Boston Underground Railway and with the Central London Railway. Other lines in America of the railway class were overhead. In the case of the Central London Railway the only particular in which the practice of his firm had not been followed was in the use of gearless motors and rigid trucks. As a result of experience the line was now reverting to geared locomotives. They had also supplied a multiple-unit train for that line. He did not agree that they were still experimenting as to to the best way of equipping the Central London Railway, as the new plant supplied had all been proved serviceable in other directions. In the particulars sent by him for the tender of the British Thomson-Houston Company for the District Railway, both locomotives and multiple-unit system cars were quoted for. Either could be used satisfactorily. The principal objection to three-phase motors for traction work was their inefficiency with varying speeds. He might like to use some such system on a railway 100 miles long required to be worked without stops. At any rate they had been trying to find some such railway in America, so that experiments might be made with the system. He knew that storage batteries were proposed to be used in the sub-stations on the District Railway. These had an advantage on account of the grades, and had been used on the Metropolitan Railway in New York. They had made in his firm some 500,000 h.p. of rotary converters in the last eight or ten years, and the hunting difficulties were now solved. He agreed that with the cascade connections energy could be returned to the line. They had found experimentally that this energy was from 5 to 10 per cent. of the energy stored in the moving train, but he was not sure that this return was worth the extra complication involved.

Re-examined by Mr. Moulton, Mr. Rice said that the mounting of the motors on the train had nothing whatever to do with the system used. Direct-current motors could be made wholly spring-borne equally well as induction motors. He did not know of any electrical difficulty which had arisen in the working of the Central London Railway. He then explained the multiple-unit system of control. As regards the returning of the current to the lines, this could be equally well done on the direct-current system by the use of shunt motors. Scores of inventions had been brought before him with this object, but he had found that in all the energy was returned at the expense of complication and often inefficiency in starting. The motors also required to be considerably larger.

In reply to the Arbitrator, Mr. Rice said that with the high-voltage system he thought the difficulties were increased by the Inner Circle being an underground line. Accidents in any case would be considerably more serious on this line than if it were in the open.

Mr. James Swinburne, examined by Mr. Moulton, said the direct-current series system of controlling traction plant was quite satisfactory.

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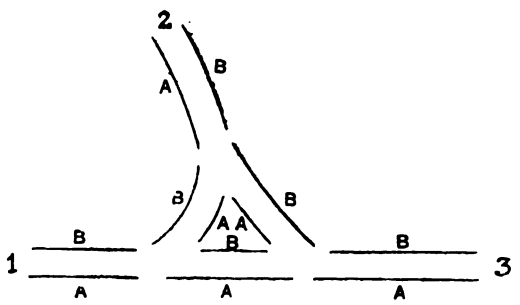
There was practically no danger in the use of that system at 500 volts. He agreed with Mr. Rice that rotary converters were economical and satisfactory machines. A 3,000-volt system was much more dangerous than a 500-volt one. It was not fair to compare the Ganz system with the single-phase alternate-current systems of electric lighting systems in London. In the latter all the wires were insulated, whereas the conductors in the Ganz system had to be bare. Danger would arise from accidental contact with the wire, or through the wire breaking. He did not think that any safety device could be relied upon to give absolute protection in the latter event. While multiphase motors could be used safely on Swiss lines where water power was abundant, they were most unsuitable for the Inner Circle. Mr. Swinburne then explained the working of the Ganz system. Eight motors were proposed to be used on the train in sets of two. Calling the motors of one set A and B respectively, the stator of the A motor would be permanently connected to the 3,000-volt circuit. The rotor of that motor was designed for generating 300 volts, and when starting up was connected to the stator of the B motor. A resistance was then placed in the rotor of the B motor. As the motor gained speed that resistance was gradually withdrawn, and the train reached practically half its maximum speed. The B motor was then cut out of circuit, and resistance inserted in the rotor of the A motor. As that resistance was reduced full speed was obtained. When it was required to stop, the B motor was again switched in, with the result that energy was returned to the line until the speed was reduced to one-half. As resistances the Ganz Company proposed to use iron plates in a carbonate of soda solution. The plates would be fixed, and the height of solution varied by means of air pressure from the brake system. The variation of resistance would thus depend on the orifice through which the air passed, and accordingly the acceleration would vary according to grade, and would not be regular. With the Ganz system there was no possibility of making up lost time, and there could be no change in the maximum speed. That maximum and economical speed would seldom be reached owing to the short distances between the stations. As regarded the returning of current to the line, that was not realised to the extent one would expect owing to the energy required to overcome the ordinary running friction. The same thing applied when accelerated—*i.e.*, owing to the frictional losses much more energy was required than was represented by the momentum of the train at a given speed. The stator of the A motor was to be left on always, which would result in considerable losses. One great trouble with the Ganz system would occur at triangular junctions. This point Mr. Swinburne illustrated to the judge by a sketch.

[We understand that the difficulty in question is represented by the accompanying illustration of a junction such as occurs in Whitechapel. The lines in the illustration represent the insulated conductors. It will be seen that a train proceeding from 1 to 3, or from



2 to 3, would not reverse its connections, but that a train proceeding from 1 to 2 would require to have the connections to the motors reversed at a given point. Failure by the driver to do this would give great trouble.—Ed. *E. E.*]

Mr. Swinburne summed up the requirements of an electrical system for the Inner Circle as follows: (1) safety to passengers and operators; (2) freedom from breakdown and interruption; (3) a maximum acceleration; (4) a margin of power in the motors for making up time; (5) a capacity of easy extension to meet the requirements of a suburban traffic at high speeds; (6) that the system should be capable of being installed without stopping the traffic. He held that the direct-current system, as explained by Mr. Moulton in his opening speech, had advantages on all the above points.

The enquiry was then adjourned for lunch, after which an argument by **Mr. Moon, K.C.**, to the effect that he should be heard on behalf of the Great Western Railway, and should be allowed to examine witnesses, was decided against that company.

The **Arbitrator** said, however, that he should be pleased to hear any witness the Great Western Company might like to have examined as to which of the systems would be the most suitable for the Great Western Railway's interpolated traffic on the Metropolitan line.

Mr. Yerkes was then cross-examined by Mr. Cripps. He gave evidence to the effect that he first met Mr. Perks in July, 1890. He had then an interest in the District Railway Company, which he had largely increased since. He was chairman of the Metropolitan District Electric Traction Company, and thus had an interest in both the parties of the contract for equipment of the District Railway. He denied that he had a controlling interest with both parties to this contract. He also denied that he had ever told Mr. Blathy that his engineers had found the Ganz system very satisfactory. He had sent Mr. Chapman, Mr. H. F. Parshall, and Mr. P. Dawson over to Budapest to test the Ganz system, and had gone there himself. His enquiry of Mr. Blathy as to how soon the firm could deliver the goods required was prompted by his own belief that the works of Messrs. Ganz and Co. could not supply the same in reasonable time.

Re-examined by Mr. Fletcher Moulton, Mr. Yerkes said that he had at first expressed his determination not to have anything to do with the Ganz system. He then thought that as a business man it was only right to know what that company had done. He accordingly sent the three engineers mentioned above to Budapest. On arrival he found that they had been rather coldly received at the works, and he told the directors that if the system was as good as it was represented, he was quite prepared to consider its use. His engineers' report on what they saw at the works in Italy and in Switzerland on lines equipped by Messrs. Brown, Boveri, and Co., decided him not to have anything to do with the Ganz system.

Mr. James Swinburne, again examined by Mr. Moulton, said that the question of the vibration caused by the Earl's Court train had nothing to do with the direct-current motors *per se*. It could be avoided equally well on either system, and, in fact, the direct-current motors were rather superior because they weighed less. In the same way the multiple-unit system could be used either with direct or multiphase currents. He was taken through the report of Messrs. Preece and Parker, dated Feb. 7, and disagreed with most of the conclusions in that report. One objection to the use of air pressure to keep up the trolley was that if the air pressure in the brakes failed with the trains going at high speed, the electric brakes would also be thrown out of action.

THURSDAY'S PROCEEDINGS.

Mr. James Swinburne, further examined by Mr. Fletcher Moulton, said he had now worked out a comparison between the Ganz system and a direct-current system working at 3,000 volts as far as the conductors were concerned. Assuming that the Ganz locomotive took 250 amperes from each of the two overhead wires, the direct-current motors would only require 300 amperes from a single wire at the same voltage. He had assumed the power factor to be 0·7. These figures showed that 500 amperes had to be collected with the Ganz system, as against 300 amperes by the direct currents. With the Ganz system one of the motors was idle at all above half speed, and on this account he did not agree with the statement in the report by Messrs. Preece and Parker that the cascade arrangement was a step in advance of the series-parallel control. The Ganz system needed heavier field magnets for the dynamos, heavier cables, and heavier motors on the locomotives. He thought that the real reason for going to the high voltage was that it would be exceedingly difficult to collect a large alternating current by means of sliding contacts. This difficulty had been avoided by using 3,000 volts on the overhead wires.

Mr. Swinburne, cross-examined by Mr. Cripps, was taken over the summary of the essentials for a satisfactory system on the Inner Circle which he had given in his evidence. After considerable argument over the drawings which represented the proposed position of the conductor rails near the running track with the 500-volt system, he would not agree that these rails were more dangerous than the overhead wire of the Ganz Company at 3,000 volts. He thought that the two conductors of the 500-volt system would be least likely to cause accidents when placed both on one side of the track with an insulated division between them. With a 500-volt shock death was never instantaneous, and the person touching the conductors, as a rule, interrupted the circuit in consequence of muscular contortion. As regards the freedom from breakdown, he thought that the Ganz system of control was likely to get out of order. The trolley wire also might break. There was no inherent difficulty in the alternate-current system, but there had not been sufficient experience with it for traction work to overcome the various objections he had alluded to. As regards the third point—*i.e.*, that of acceleration—he thought that the Ganz system would take more power than the direct-current for a given acceleration. As regards the returning of energy to the line, all power so returned caused the lag in the circuit, which was very harmful. On the question of speed, it would be a wasteful proceeding to run the alternate-current motors always below the maximum speed in order to be able to make up lost time on emergencies. A margin of speed of this kind costs too much with the Ganz system, whereas the continuous-current system worked with the greatest economy at high speeds. As regards the question of the use of either system on lines outside the Inner Circle on which higher speeds were required, this could be done more easily with the direct-current system. He would suggest the use of four motors which would work all in parallel on the lines outside, and in two parallels of two in series on the Inner Circle. It would not be feasible to use four three-phase motors in cascade. Mr. Swinburne was then examined on the question of cost, and as a scientist expressed his belief that there was no advantage on these grounds from the Ganz system. What was saved in the sub-stations by the omission of the rotaries, would be more than expended in the increased size of the plant required.

The luncheon interval was then taken.

NEW COMPANIES REGISTERED.

The following new companies have been registered since our last issue:

Bland Bros., Limited.—Capital, £20,000. Object: to acquire the business of electrical, sanitary, and general engineers as now carried on by W. E. Bland and A. H. Bland, as Bland Bros., of 147, Barrasbridge, Newcastle-on-Tyne, and at Church-street, West Hartlepool, Durham.

Petersen-Stephens Engineering Company, Limited.—Capital, £5,000. Object: to acquire the business of consulting and general engineers now carried on at Newcastle-on-Tyne as the Petersen-Stephens Engineering Company, and to carry on the business of hydraulic, electrical, mechanical, and general engineers,

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

425. Feeder cables are used to keep up the voltage at a distant point. Why are they used instead of putting in a larger conductor with less drop in volts, for they are simply in parallel with the conductor, and take a proportion of the current?—W. A. T.

426. Discuss the relative advantages and efficiencies of steam-driven and electrically-driven balancers for use on a three-wire direct-current system with batteries.—D. KELLEWAY.

ANSWERS.

Question No. 419.—State clearly the way you would start if asked to design a choking coil of the ring type and open-coil pattern. The space is limited—that for the ring 4in. by 3in., and the coil 5½in. by 3in. The choker is required to impede 30 volts with seven amperes at 50 ~. Give working example of each type.

Best Answer to No. 419 (*awarded* 10*s.*).—The commencement of the design of a choking coil of any type is largely a matter of trial and error, and the arrangement giving the greatest economy in material can only be arrived at by the comparison of several independent workings of the design in much the same way as with dynamos or transformers, with the difference that for these latter the mass of practical and experimental data collected and published greatly simplifies the process. The formulæ necessary for the design of choking coils of the usual types were collected in the answers to Question No. 341, which appeared in the *Electrical Engineer* for Feb. 1, 1901, and can be conveniently employed here.

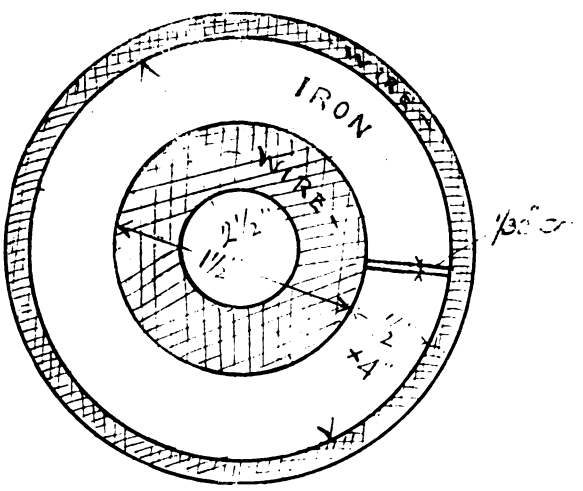

FIG. 1.

1. A ring-type choking coil to choke 30 volts at seven amperes and 50 ~, and to go into a space of 3in. by 4in. (depth not stated): We will assume a core made up of thin sheet-iron rings of 2½in. outer diameter and 1½in. inner diameter and built up to a depth of 4in. (Fig. 1). Allowing 15 per cent. for loss through insulation and gaps between the discs, the net section of iron in the ring will be 4in. × ½in. × ·85 = 1·7 square inches. At a periodicity of 50 it will be quite safe to work the iron at an induction density of from 60,000 to 90,000 C.G.S. lines per square inch. We will choose a density of 72,000. This gives a total flux of 72,000 × 1·7 = 123,000. The number of turns required in order to obtain 30 volts across the coil with this flux is given by the ordinary transformer formula:

$$\text{Turns} = \frac{\text{Volts} \times 10^8}{\text{Flux} \times \text{periods} \times 4{\cdot}44} = \frac{30 \times 10^8}{123{,}000 \times 50 \times 4{\cdot}44} = 110.$$

The total ampere-turns in the coil at seven amperes = 7 × 110 = 770, whilst the number of ampere-turns required to pass the above flux round the ring is = mean length of iron path × ampere-turns per 1in. at the given flux density = 6·28 × about 10 = 63. The difference in ampere-turns (770 − 63 = 707) must be made to expend itself on some additional reluctance introduced into the circuit, otherwise the flux will be increased above the required figure, saturating the iron and causing heating and waste. This reluctance is best produced by sawing through the iron core at one point and leaving the edges separated by a small air-gap (see Fig. 1). The width of the required gap is given by the formula

$$\text{Ampere-turns} = {\cdot}313 \times \text{width of gap} \times \text{flux density};$$

or $$707 = {\cdot}313 \times \text{width of gap} \times 72{,}000,$$

from which width of gap = ·0312in., or $\frac{1}{32}$in.

The size of wire for the coil is determined by the permissible current density, and allowing a density of 1,400 the area required is ·005 square inch, which corresponds to ·08in. diameter wire (No. 14 S.W.G.). The double cotton-covered diameter of this wire is ·097in., so that 110 turns will go into about three layers inside the ring, and two layers on the outside. The mean length of a turn of winding is about 10½in., and the resistance is

$$\frac{{\cdot}00000078 \times \text{mean length} \times \text{turns}}{\text{Area of wire}} = \frac{{\cdot}00000078 \times 10\tfrac{1}{2} \times 110}{{\cdot}005} = {\cdot}18 \text{ ohm},$$

giving a C^2R loss of seven amperes of 8·9 watts. The volume of the core iron is 1·7 × 2 × π = 10·7 cubic inches, and the loss per cubic inch of ordinary iron, in hysteresis and eddy currents at the above density, at 50 ~, is about ·6 watt, so that the total iron loss is ·6 × 10·7 = 6·4 watts. The cooling surface of the whole winding is about 66 square inches, giving 15·3/66 = ·23 watt per square inch of cooling surface, which is low enough to keep quite cool on a long run. The weight of copper is 2lb., and of iron 3lb. The coil will occupy a space about 3in. diameter × 4½in. high.

2. An open-coil type (Fig. 2) for the same duty as the above: The ground space allowed in this case is 5½in. by 3in., so that a core 4in. by 1½in. made up of 1½in. strips of sheet iron can be used, leaving room for ½in. to ¾in. depth of winding all round. In this type the difficulty consists in making the magnetic reluctance of the outside air path from pole to pole, as well as the total flux to be carried

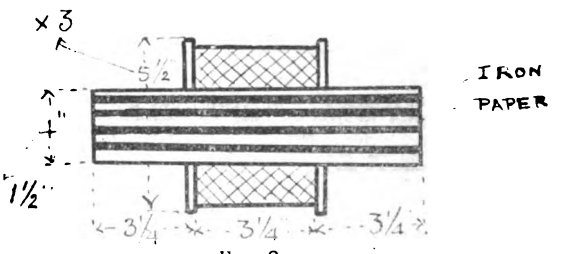

FIG. 2.

along this path, sufficiently low to keep the necessary ampere-turns within reasonable limits. This means that the ends of the core must be of large area, and must project considerably beyond the ends of the coil. At the same time, in order to satisfy these conditions, the flux density in the iron within the coil becomes unnecessarily low, and a considerable saving in weight of iron can be effected without appreciably altering the reluctance of the circuit by replacing part of the iron by sheets of paper or cardboard, uniformly distributed amongst the iron sheets. In our case it will be sufficient if one-third of the gross cross section of the coil is of iron and the remaining two-thirds is non-magnetic material. The net section of the iron will then be 4 × 1½ × ⅓ = 2 square inches, and the density in this will still have to be kept quite low, say to 35,000 C.G.S. lines per square inch. The total flux will therefore be 2 × 35,000 = 70,000, and this corresponds to a number of turns = $\frac{30 \times 10^8}{70{,}000 \times 50 \times 4{\cdot}44} = 192$.

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The ampere-turns of the coil at seven amperes are $192 \times 7 = 1{,}350$, and by the formula given for this type in the answer to Question 341, we can find the necessary amount of core projection to enable this number of ampere-turns to pass a flux of 70,000 through the coil. For

$$\text{Turns} = \frac{\text{flux}}{\text{current}} \times \frac{1{\cdot}25}{\sqrt{\text{area of core projecting beyond the coil at each end.}}}$$

$$192 = \frac{70{,}000}{7} \times \frac{1{\cdot}25}{\sqrt{\text{area}}},$$

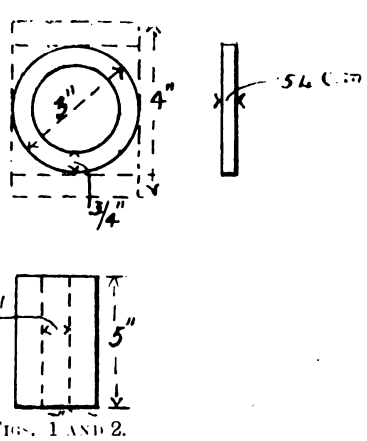
from which the area of core projecting at each end $= (6{\cdot}5)^2 = 42$ square inches. This area will be obtained if the core projects $3\frac{1}{4}$in.; for

$$(4 + 1\tfrac{1}{2})\ 2 \times 3\tfrac{1}{4} + 4 \times 1\tfrac{1}{2} = 42 \text{ square inches.}$$

Using the same size of wire as for the other type of coil we can get the required 192 turns into six layers, each $3\frac{1}{4}$in. long, as shown in Fig. 2. The whole length of coil will, therefore, be $3\frac{1}{4}$in. $\times$ 3in. $= 9\frac{3}{4}$in. The mean length of a turn of winding will be about 14in., and the resistance of the coil ·41 ohm, giving a C^2R loss at seven amperes of $20\frac{1}{2}$ watts. The core volume is $19\frac{1}{2}$ cubic inches, and at a density of 35,000 the hysteresis + eddy-current loss per cubic inch at 50 ⌒⌣ is about ·2 watt, so that the iron loss is $19\frac{1}{2} \times {\cdot}2 = 3{\cdot}9$ watts. The cooling surface of the coil is about 51 square inches, and assuming that only the C^2R watts cool from this surface (the iron losses cooling directly from the iron ends), the watts per square inch of cooling surface are $20{\cdot}5/51 = {\cdot}4$, which will not give any tendency to overheat. The weight of copper is $4\frac{3}{4}$lb. and of iron $5\frac{1}{2}$lb. The coil and core will occupy a space $5\frac{1}{2}$in. by 3in. by $9\frac{3}{4}$in.

Comparing the two types of coil, it is obvious that the advantage, whether in weight, space occupied, or efficiency, lies with the ring type as against the open-coil type, and the reason for the more common use of the open-coil type in practice is the fact that it permits of regulation by withdrawing the iron core, whilst the ring type does not admit of any such adjustment. The open-coil type dealt with above, for instance, would only choke about five or six volts with seven amperes passing at 50 periods if the iron core were entirely withdrawn.—Q.

Answer to No. 419 (*awarded* 5*s.*).—In the case of the ring type, take a ring 3in. diameter over all, and, say, $\frac{3}{4}$in. depth of iron in the ring (see Fig. 1). If the coils are wound on top and bottom portion only, they will not occupy more than space available—viz., $\frac{1}{2}$in. at top and bottom.



FIGS. 1 AND 2.

Reactive E.M.F. required is 30 volts—*i.e.*,

$$E = 2\pi n L C = 30;$$

$$= 2\pi \times 50 \times L \times 7 = 30;$$

or, $$L = {\cdot}013 \text{ henry.}$$

But we know $$L = \frac{4\pi T^2 \mu A}{10^9 l} \quad (1)$$

where A = section of iron in square centimetres;
T = number of turns on the ring;
l = length of magnetic circuit.

The mean length in this case is

$$l = \pi \times 2{\cdot}25 \times 2{\cdot}54\text{cm.};$$

$$\therefore \text{ from (1) } T^2 = \frac{L \times 10^9 \times l}{4\pi\mu A}.$$

Take B, the maximum induction, at 94,000 per square inch, or 15,700 per square centimetre, then $\mu = 730$, and substituting values,

$$T^2 = \frac{{\cdot}013 \times 10^9 \times \pi \times 2{\cdot}25 \times 2{\cdot}54 \times 1}{4\pi \times 730},$$

whence $$T = 18{\cdot}1.$$

The ring is taken as ·52cm. thick. Hence we must wind 18 turns on the ring. Taking current density at 500 amperes per square inch gives ·014 as section of wire requisite, and $^7/_{18}$ copper wire having section of ·013 will be near enough. The length of winding and C^2R loss can now be calculated if necessary.

With regard to the open-coil type: take the iron core 1in. in diameter; this leaves 2in. available for winding, and the length will be, say, 5in. Then the number of turns required will be

$$T = \frac{N}{C} \times \frac{{\cdot}175}{\sqrt{D}},$$

where N = flux corresponding to the maximum volts (30) the coil is to choke with current, C;
D = total superficial area of the iron core outside the coil.

$$D = \frac{\pi}{2} \times 6{\cdot}45 = 10{\cdot}06.$$

$$N = B\,S,$$

where S = section of core $= \frac{\pi}{4} = {\cdot}785$ square inch.

Taking $B = 15{,}700$

$$N = 15{,}700 \times {\cdot}785 \times 6{\cdot}45 = 79{,}400;$$

$$\therefore T = \frac{79{,}400}{7} \times \frac{{\cdot}175}{10{\cdot}06}$$

$$= 19{\cdot}75.$$

Hence 20 turns should give required choke.—E. M.

Question No. 420.—I wish to measure the "slip" of a 5-h.p. single-phase induction motor. What will be the best method to do this accurately? What is "slip?"

Best Answer to No. 420 (*awarded* 10*s.*).—The slip of an induction motor is the difference in speed of the revolving field of the stator and the speed of the rotor, the former depending upon the frequency of the supply and the number of poles on the stator, and the latter depending upon the design, and which varies with the load on the motor. The slip of a well-designed single-phase motor of 5 h.p. at full load would be about 5 per cent. with a wound rotor, and about $6\frac{1}{2}$ per cent. with a "squirrel" cage rotor.

There are many direct methods by which the slip of a motor may be measured; amongst them may be mentioned the following:

1. The measuring of the speed of the rotor by means of a tachometer preferably reading direct in revolutions per minute, and subtracting that speed from the speed of the revolving field of the stator in revolutions per minute, which is determined, as mentioned above, by the frequency of the supply and the number of poles, and is equal to $\frac{60 \times \text{the frequency per second}}{\text{number of pairs of poles}}$; the slip being generally termed in a percentage.

2. By a stroboscopic method, in which a disc with alternative black and white sectors is fixed on the rotor shaft; the disc is illuminated by an arc lamp fed from the same mains as the motor. The motor is then run up to speed, and the apparent slow rotation of the disc is in direct relation to the slip. The above apparent slow rotation can also be noted on a motor fitted with slip rings, and where the arc lamp running on the same mains reflects on the rings a revolving shadow can be plainly discerned in between the rings, and which is in direct relation to the slip.

3. A very simple method, which depends upon the frequency of the induced rotor currents, can be made use of in motors where the slip is not more than 7 or 8 per

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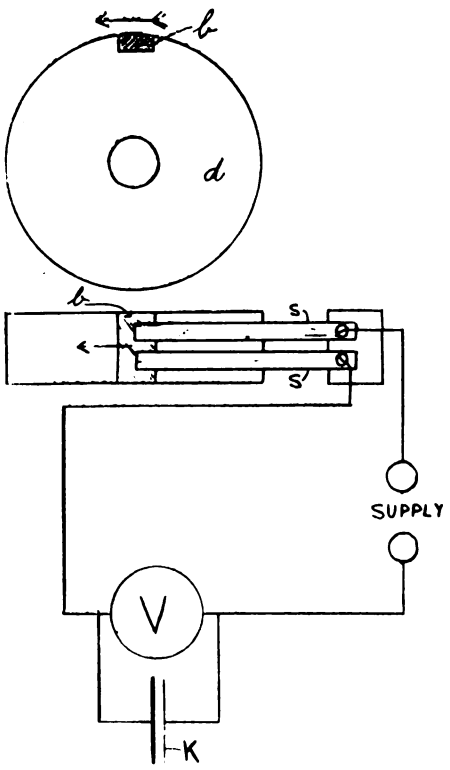
cent., is by placing a galvanoscope near the rotor and observing the number of deflections in a given time.

Another method, depending upon the frequency of the currents in the rotor, and where a wound rotor is employed, is by having a search coil about 2½in. diameter and wound with about 300 turns of ·0127 wire, and which is connected to a telephone receiver. On this search coil is wound two or three turns of one of the cables which connect the rotor slip rings to the starting resistance, and as the ear can follow higher frequencies better than the eye, it is much more preferable to use with the small motors, where the slip ranges in the order of 10 per cent. or more. When a "squirrel" cage motor is employed, use is made of the field leakage, due to the rotor currents, by means of an induction coil and telephone receiver or reflecting galvanometer.

Other methods are used in which the peculiar note given off by the motor at various loads is utilised, but this is not at all reliable and cannot be recommended.—JUNO.

Answer to No. 420 (*awarded* 5*s.*).—The "slip" of an induction motor at any load is the difference between its synchronous speed (or that of the rotating field) and that of the rotor. It is usually expressed as a percentage of the synchronous speed. Thus, if the synchronous speed of a motor be 1,000 revolutions per minute, and the rotor speed be 950, then the slip is said to be 5 per cent. The synchronous speed in revolutions per minute is equal to $\frac{N}{p} \times 120$, where N = frequency in cycles per second, and p = number of poles per phase.

The most *direct* method of measuring the slip under any given load is to measure the actual speed of the motor, and from this measurement and the known synchronous speed deduce the slip. This, however, is a very inaccurate method, consisting as it does in measuring a small difference between two large quantities by measurement of those quantities themselves. A far more accurate result is obtained by a direct measurement of the small difference itself. The following method has been found by the writer to be a reliable one for the purpose: Upon the shaft of the motor to be tested is mounted a small hardwood disc, *d* (see sketch), 2in. or 3in. in diameter, and about 1in. or so wide.



Into the periphery of this disc, and parallel to the shaft, is let a strip of brass, *b*, about ¼in. wide. Two insulated springs, *s s*, are arranged to make contact simultaneously with *b* as the disc revolves. These springs are then connected in series with a high-resistance voltmeter (preferably a Weston) whose range is at least 1½ times the effective voltage of the motor, and the circuit thus formed connected across the supply terminal. A single-phase connection is shown in the sketch, but for two or three phase the arrangements are the same, the voltmeter circuit being taken off any two terminals of the motor. If the voltage is too high for the voltmeter, a transformer may, of course, be interposed. A condenser, K, shunted across the voltmeter serves to give more readable deflections.

It is evident now that if the motor were to run at synchronous speed, the voltmeter would indicate a steady voltage, as the latter would have the same value every time contact was made. As, however, owing to the slip, contact is made a little later at every revolution, the voltmeter needle travels up and down the scale with a certain frequency depending on the amount of slip. It is easily seen that this frequency is the same percentage of the working frequency as the slip is of synchronous speed. In fact, it is the frequency of the currents in the rotor winding. Hence it is only necessary to find the time taken by the voltmeter needle to complete one cycle. Let this be *t* seconds. Then we have

$$\text{Slip} = \frac{100}{N\,t} \text{ per cent.},$$

where N = frequency of supply. It will be seen that if the value of N be 1 per cent. in error, the value of the slip will only be affected 1 per cent. thereby, whereas in the speed measurement method referred to above 1 per cent. error in N would mean probably 20 per cent. error in the slip. The following figures taken from an actual test on a motor running light shows the application of the method:

Frequency of circuit = 96; time of one cycle of voltmeter needle = 2·6 seconds. Therefore

$$\text{Slip} = \frac{100}{96 \times 2{\cdot}6} = 0{\cdot}4 \text{ per cent.}$$

—R. C. C.

Answer to No. 420 (*awarded* 5*s.*).—The answer to the former part of the question will be more easily understood if the meaning of the term "slip" is first explained. The speed of a single-phase induction motor, running without load, is a trifle below synchronous speed, owing to the fact that the motor armature lags a little behind the revolving field. This is called the slip. The amount of the slip is the difference between the actual speed of the motor and the synchronous speed.

The following is a good method of measuring the slip of an induction motor: Fix a disc to the end of the motor shaft having black and white segments painted on alternately, the number of segments being twice the number of poles of the motor. Suspend an arc lamp near this disc connected to the

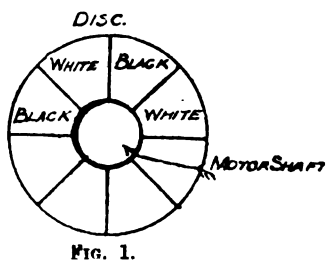


FIG. 1.

same source of supply as the motor. Incandescent lamps will do, but an arc lamp is far better. The light given by the lamp, though appearing constant to the naked eye, is not really so, but is continually flickering according to the alternations of the current. It is for this reason that, supposing the motor ran synchronously with the generator, the disc on the motor shaft would appear to be standing still. In the case of the motor in question, where the rotor has a certain amount of slip, depending on the load, the effect is to produce an apparent slow rotation of the disc. The number of revolutions that the disc appears to make can be counted, and this number is the equivalent of the difference in the angular velocity between the motor armature and the revolving field.

Another good method when the generator is not far from the motor is to fix two revolving contacts, one on the end of the generator shaft and the other on the motor shaft. These are arranged to break contact at one point

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of the revolution (Fig. 2). Connect the two revolving contacts in parallel across a circuit consisting of a battery and a single-stroke bell arranged to ring when the arm is released. The bell will thus only ring when the two contacts are broken simultaneously, which will occur at every complete revolution lost by the motor.

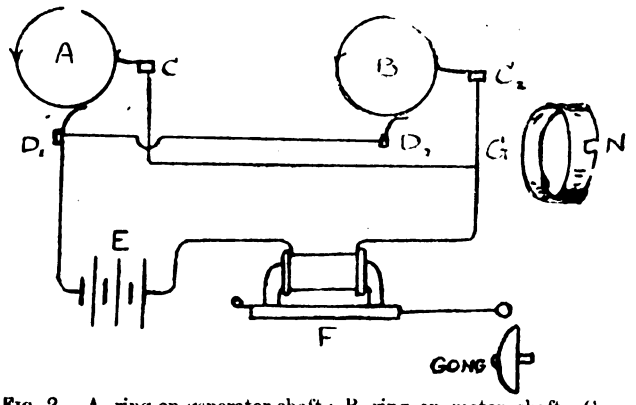

FIG. 2.—A, ring on generator shaft; B, ring on motor shaft; C_1 and C_2, contact pieces which break contact once every revolution; D_1 and D_2, contact pieces making continuous contact; E, battery; F, single-stroke bell; G, ring showing slot, N, which breaks contact with contact piece, C_1 and C_2.

When the last method is out of the question, and there is a large amount of slip, making it difficult to count the apparent number of revolutions of the disc previously mentioned, the following method may be adopted: Make a search coil about 3in. in diameter, and wound with 300 to 400 turns of ·2mm. wire. Round this coil wind one or more turns of the cable connecting the induced system with the starting resistance, and connect a telephone receiver with the search coil. The frequency of the currents in the induced system may be determined in this way, and knowing this the amount of slip can easily be found. The ear is able to follow much higher frequencies than the eye, and this method is available over the entire range, which is important in practice.

To obtain a permanent record of the slip the induced currents can be made to actuate the relay of a Morse writing telegraph instrument, and thus a rapidly varying slip up to 20 per cent. can be accurately determined at any instant. The slip at full load of this particular motor, with constant pressure on stator terminals, will probably be about 7 per cent.—W. A. T.

APPOINTMENTS VACANT.

Draughtsman for switchboard work. Full particulars in our advertisement columns.

Electrical Engineer for a large shipbuilding and engineering works. Full particulars in our advertisement columns.

Traffic Superintendent, Bradford Corporation Tramways, £200 per annum, Nov. 9. Full particulars in our advertisement columns.

Working Engineer, to carry out repairs at the Windsor Electrical Installation Company, Limited. Full particulars in our advertisement columns.

Junior Assistant Engineer, Birkenhead Corporation electric tramways, 30s. per week of 56 hours, Nov. 11. Full particulars in our advertisement columns.

Switchboard Attendant, Birkenhead Corporation electricity supply, 27s. per week of 56 hours, Nov. 11. Full particulars in our advertisement columns.

Engine-Driver, Borough of Leigh Tramway and Electricity Department, 35s. per week of 56 hours, Nov. 16. Full particulars in our advertisement columns.

Chief Assistant to Superintendent Engineer, Bradford Corporation Electricity Works Department, £150 per annum, Nov. 11. Full particulars in our advertisement columns.

Various.—Working Electrician to take charge of the whole of the works, an Assistant, two Enginemen to take charge of the engines, and two Stokers, Pemberton Electric Lighting Station, Nov. 9. Full particulars in our advertisement columns.

Boulder City (Western Australia).—The Boulder City Council invite tenders for construction of about 3½ miles of electric tramway, with all necessary plant complete according to specifications, and the right to construct and run tramways within the municipality. Tenders by Nov. 23. Details in our advertisement columns.

PHYSICAL SOCIETY.

At the ordinary meeting held on Oct. 25, 1901, Prof. S. P. Thompson, president, in the chair, a paper "**On the Variation with Temperature of the Thermo-Electromotive Force, and of the Electric Resistance of Nickel, Iron, and Copper between the Temperatures of −200deg. and +1,050deg.**" was read by **Mr. E. P. Harrison.** In this paper the changes with temperature of the thermo-electromotive force and the resistance of nickel and iron are traced over a wide range, and the singularities present in the curves representing these changes are investigated. In all experiments the same specimens of metal were used. Previous work on this subject has been performed by Tait, Fleming and Dewar, Holborn and Day, and Stansfield. In the author's experiments on E.M.F. an ordinary potentiometer method was used, the potential difference due to the thermo-couple being balanced against a portion of that due to two accumulators. Before each reading a standard cadmium cell was balanced on a definite resistance in the accumulator circuit. Readings of E.M.F. of copper-nickel couples were accurate to 1·8 microvolts, while those of copper-iron couples were accurate to less than one microvolt at moderate temperatures. The heating arrangement was designed to give a uniform temperature, which was measured by a platinum thermometer, and recorded automatically by Callendar's recorder. The cold junctions were placed in a large test tube full of water, the test tube being placed in a larger vessel, also containing water. The temperature of the cold junctions varied with that of the room, and all observations were reduced to cold junction 0deg. C. Finally, in each case observations were taken by placing the junctions in liquid air with the platinum thermometer beside them. To prevent oxidation of the metals forming the junctions at temperatures above 500deg., it was necessary to exhaust the porcelain tubes which contained them. The curves for variation of E.M.F. with temperature of copper-nickel and copper-iron couples are, roughly, a straight line and a parabola respectively. The differences between the actual curves and a selected straight line in the former case and a parabola in the latter case have been plotted against temperature. These difference curves show that the maximum variations occur in the case of copper-iron at 70deg., 230deg., and 370deg. The temperature of inversion (cold junction 0deg. C.) is 536deg. C., and the neutral point is 262deg. C. In the case of copper-nickel, maximum variations occur at 70deg. and 340deg., and there appears to be a small hysteresis effect at the latter point. The temperature of inversion does not occur within the limits of the experiments, and there is no neutral point. The E.M.F. curve for a nickel-iron couple up to 700deg. has been obtained from the two previous experimental curves by addition. Above this temperature direct observations have been taken. This curve is nearly linear up to 900deg., at which point a decrease in E.M.F. occurs. Curves of thermo-electric power have been derived from the E.M.F. curves by drawing tangents, and these show that a considerable range of the copper-iron curve can be represented by straight lines, but that the remainder is approximately parabolic. The copper-nickel power curve can be represented by bits of straight lines. The Peltier coefficient variation curve for iron copper is at first parabolic, and can then be made up of straight lines; for copper-nickel it can be made up of bits of parabolas. Considerable difficulty was experienced at high temperatures in getting concordant results, owing to chemical changes and other effects. The experiments were therefore carried out under different conditions, and the results are discussed in the paper. In the resistance experiments a potentiometer method was employed, a manganin resistance coil immersed in an oil bath being used as a standard. The resistance of nickel increases with temperature almost parabolically up to 370deg., when a change of slope occurs, and the resistance increases much less rapidly and almost linearly up to 1,050deg. In the case of iron the resistance curve does not change its parabolic form till nearly 800deg., when it becomes linear and remains so up to 1,050deg. The author concludes from his paper that the thermo-electric change in nickel-copper coincides approximately with the resistance change, but that no thermo-electric peculiarity exists for iron-copper at the temperature of the iron resistance change.

Mr. A. Campbell said that with purer iron the change in thermo-electric properties might correspond with the change in resistance. Dr. Knott had performed experiments on nickel in 1886, and got results similar to those of the author. His results with thick wires were different to those with thin, probably because he did not exclude air and prevent oxidation. Mr. Campbell said that he had himself made experiments upon two samples of nickel differing in resistivity, and although their temperature coefficients were also different the change in slope of the curve connecting resistance and temperature occurred at practically the same temperature in both specimens. Their thermo-electric powers were identical up to 300deg., but above they differed slightly.

Dr. D. K. Morris pointed out that the thermo-electric force, the resistance, and the magnetic properties should be observed at the same time. In taking a thermo-electromotive force there must be a temperature gradient, and in the interesting parts of the curves differences of magnetic properties may arise and produce discrepancies. He drew attention to the caution which must be exercised in differentiating by drawing tangents except when the curves are smooth. Dr. Morris said the connection between resistance and magnetic qualities was interesting. The temperature coefficient of resistance of a magnetic body rises with temperature so long as the body is magnetic, but reverses when the body becomes non-magnetic. He asked for information on the subject.

Prof. H. L. Callendar said he had followed the research with interest, and referred to the experimental difficulties especially at high temperatures. He should like to have said something in reply to Dr. Morris, but he was afraid the subject was a large one and might well

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be discussed at some future meeting. There were several points to clear up, and the fact that the curves described cannot be represented by straight lines or parabolas showed that the subject was beyond the range of a simple theory.

The **Chairman** suggested that it might be well to re-examine more carefully some of the curves which are accepted as straight lines, and on which there is no complication due to magnetic properties. He hoped the author and others would continue working at this subject.

Mr. E. P. Harrison, in reply to Dr. Morris, said he thought the number and accuracy of his observations justified him in drawing tangents to form his power and Peltier effect curves.

A paper on "**Asymmetry of the Zeeman Effect,**" by **Mr. G. W. Walker,** was read by Mr. W. Watson (secretary). Prof. Voigt predicted an asymmetry of the normal triplet which has been verified by Zeeman. The author has considered the subject mathematically, and finds that asymmetry may arise as a second order term due to the magnetic field. The asymmetry would be more distinct the greater the field, which is opposed to the theory of Voigt. By giving numerical values to the symbols, it is shown that the effect is extremely small. The author points out that his theory can provide an explanation of why a line may not be resolvable.

The society then adjourned until Nov. 8, 1901.

COMPANIES' MEETINGS AND REPORTS.

HAMPSTEAD ELECTRIC SUPPLY.

At the Institution of Chartered Accountants on Saturday last, an extraordinary general meeting of this Company was held to consider resolutions passed at a meeting held on the previous Monday for the reconstruction of the Company.

Mr. E. T. Read (the chairman) formally moved that the resolutions be confirmed, and

Mr. Soares seconded.

Mr. Preston (shareholder) moved an amendment for the adjournment of the meeting until audited accounts were produced, and in doing so stated that it was the feeling of many shareholders that they had not been given the information to which they were entitled. What reason, he asked, was there for reconstruction? He did not know whether the Company were solvent or insolvent, and he thought that accounts should be presented so as to enable the shareholders to form their own opinion on that point. He did not say that the directors had not done their best for the Company, but, on the other hand, he was not able to say that they had, because he was in the dark as to what had happened. If there were nothing to hide, he could not understand why the Board should object to proper accounts being submitted. The shareholders knew nothing beyond what the chairman had chosen to tell them, and he for one would not assent to the passing of the resolutions until more information was forthcoming.

Mr. Wheelock (shareholder) seconded the amendment, remarking that in the event of reconstruction being agreed to, the shareholders had to ask themselves whether a continuance of the old management was advisable. He denied that the Board had consulted the *bonâ fide* large shareholders before bringing forward the present scheme. He also made a number of statements with regard to the action of the directors.

The **Chairman** denied the allegations, adding that Mr. Wheelock was himself one of the original underwriters, and introduced certain other underwriters who got their commission but did not pay the money due from them, thereby depriving the Company of a portion of the working capital.

Mr. Wheelock, in some further remarks, criticised the meagre business results as compared with the statements in the prospectus.

Answering another shareholder, the **Chairman** said his object in applying for the appointment of a receiver was to prevent any hostile creditor taking steps prejudicial to the interests of the Company. His action was supported by four-fifths of the shareholders.

Ultimately the amendment was defeated, and the resolutions were then put and declared by the chairman to be carried.

This ruling was disputed, and the numbers voting on either side not being announced, a poll was asked for.

The **Chairman,** however, stated that the signatories did not hold the requisite number of shares to make the demand valid.

The proceedings then closed.

With reference to the above meeting Messrs. Westbury, Preston, and Stanridi, solicitors, write to the *Financial Times* to the following effect: "We are instructed by a committee of shareholders in the above Company to represent them in supporting a petition which has been presented for the compulsory winding-up of the Company. At an extraordinary general meeting of the Company held this day (the 26th ult.) a preliminary resolution for the voluntary winding-up and reconstruction of the Company was declared to have been passed by the chairman, who had refused to agree to an amendment, which was very largely supported by those present, requesting the Board to deliver audited accounts and balance-sheet before the resolution for winding-up was passed. The last accounts rendered by the Board of the Company only relate to business done down to December, 1899, and it is felt by independent shareholders who have paid for their shares that it is essential in the interests of all such shareholders to have a thorough investigation of the affairs of the Company by the Court. In the interests of such we have been asked to communicate with you, in order that in the short time intervening between now and the hearing of the petition, which has been fixed for the 30th inst., as many shareholders as possible may have the opportunity of joining their fellow-shareholders and pressing for the information that is being denied them. We shall therefore be much obliged if you will give publicity to this fact."

WESTERN TELEGRAPH.

At the half-yearly meeting of the Company, which took place on Wednesday at Winchester House, E.C., **Mr. W. S. Andrews** presided, and in moving the adoption of the report reminded the shareholders that the six months under review included the first complete year, counting from June to June, of the amalgamated Company's working. The results of that measure of consolidation continued to be wholly satisfactory. The reduction in certain of the tariffs of the Company took place in the half-year under consideration. It was to be expected that these reductions would make themselves distinctly perceptible in the revenue. There was, it was true, an increase in the number of words transmitted, but quite insufficient to recoup the loss. The diminution of revenue would have been considerable but for the rise in the value of exchange, which, fortunately, came in to help them and minimised the loss of the Company occasioned by the reduced rates. As a consequence, in the gross, for the comparatively insignificant loss of £2,886 in the receipts, the Company had been enabled to confer the boon of reduced rates upon the mercantile and telegraphing public. The current receipts, compared with the corresponding period of 1897, 1898, and 1899, had increased in a very satisfactory manner, and they were going on augmenting.

Sir John Wolfe-Barry seconded the motion, which was carried.

A vote of thanks to the chairman closed the proceedings.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Midland Railway Company.—The Directors invite tenders for the supply of various stores by Nov. 12. Details in our advertisement columns.

East London.—Tenders are invited for the supply of a 50-kw. alternator and engine. Tenders by Nov. 26. Details in our advertisement columns.

St. Annes-on-the-Sea.—The Urban District Council invite tenders for the supply and instalment of certain street mains. Tenders by Nov. 15. Details in our advertisement columns.

Hurst.—The Urban District Council invite tenders for tramway feeder cables, test wires, feeder and section boxes, and other work connected therewith. Tenders by Nov. 12. Details in our advertisement columns.

Chesham.—The Urban District Council invite tenders for the transfer of their provisional order enabling them to supply electricity within the Chesham urban district, by Nov. 16. Full particulars in our advertisement columns.

Oldham.—The Corporation invite tenders for the supply and delivery of concentric feeder cable, pilot cable, joint-boxes, etc., and motor booster, motor generator, switch gear, etc. Tenders by Nov. 5. Details in our advertisement columns.

Kingston-upon-Hull.—The Electric Lighting Committee invite tenders for six rotatory transformers for continuous-current transformation, 2,000 volts to 220 volts, 90 kw. each. Tenders by Nov. 28. Details in our advertisement columns.

Bournemouth.—The Town Council invite tenders for car-sheds and repairing shops. Specification, etc., may be obtained from Mr. F. W. Lacey, M.I.C.E., borough and tramway engineer, Municipal Offices, Bournemouth. Tenders by Nov. 11.

Liverpool.—The Directors of the South Lancashire Electric Traction and Power Company, Limited, invite tenders for the supply and laying of high and low tension insulated electric cables, stoneware pipes, etc. Tenders by Nov. 4. Details in our advertisement columns.

Liverpool.—The Directors of the South Lancashire Electric Traction Company invite tenders for the overhead electrical equipment of certain tramway lines and car depot. The route length of the tramway line is approximately 19 miles. Tenders by Nov. 25. Details in our advertisement columns.

Rotherham.—The Weekly Board invite tenders for the wiring of the Rotherham Hospital, preparatory to a supply of electricity from the Corporation mains. Specifications, etc., may be obtained on application to the borough electrical engineer, Mr. Edward Cross, Rawmarsh-road, Rotherham. Tenders by Nov. 12.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station and sub-stations of two 6,000-h.p. triple-expansion engines, two 3,750-kw. three-phase alternators, 48 motor-generators for sub-stations. Tenders by Nov. 6. Details in our advertisement columns.

Swindon.—The Corporation invite tenders for the supply, delivery, and erection at their electricity works, Swindon (Wilts), of three Lancashire boilers and economiser, two jet condensers, feed pumps, pipework, and accessories, water-cooling tower, and 10-ton overhead travelling crane. Tenders by Nov. 12. Details in our advertisement columns.

Barking Town.—The Council invite tenders for the supply of an electrically-driven locomotive crane, together with the permanent way in connection therewith, at the Council's Wharf, Gascoigne-road, Barking. Specification, etc., can be obtained upon application to the Council's Surveyor, Mr. C. F. Dawson, Public Offices, Barking. Tenders by Nov. 12.

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Rochdale.—The Corporation invite tenders for the supply, delivery, and erection of three Lancashire boilers, economiser, and mechanical stokers, and for two ejector condensers and circulating pumps, one feed pump, one grease extractor, and the extensions to the present steam, exhaust, condenser, and feed pipes. Tenders by Nov. 8. Details in our advertisement columns.

Bury.—The Tramways Committee invite tenders for the supply and delivery at Bury, Lancashire, of 14 69-passenger electric tramcars and 14 48-passenger electric tramcars. Specification, etc., may be seen at the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar, 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster, and may be obtained from the latter office. Tenders by Nov. 18.

Willesden.—The District Council invite tenders for the supply and erection of boiler-house plant, steam dynamos, transformers, motor-generators and balancing transformers and booster dynamos, switch gear (high and low pressure), overhead travelling cranes, accumulators, mains (high and low pressure), public lamps, steam pipes, and condensing plant (jet condenser and spray cooler). Tenders by Nov. 12. Details in our advertisement columns.

Amsterdam.—The Secretary of State for Foreign Affairs has received a dispatch from his Majesty's Consul at Amsterdam, stating that tenders are invited by the Town Council of Amsterdam, not later than Nov. 18, for the supply of above-ground conductors of electricity and the connections of rails for electric tramways. Particulars may be obtained at the Stadsdrukkerij of Amsterdam on payment of 3·50fl (5s. 10d.). Information is given at the office of the Manager of the Town Tram, 164, Achtergracht, Amsterdam.

Rockhampton (Queensland).—The Municipality invite applications from companies desirous of undertaking the construction and working a system of electric tramways under the Queensland Tramways Act of 1882 and the Amendment Act of 1890, within the Municipality of Rockhampton aforesaid. Rockhampton, with a population of 15,461, is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882 and the Amendment Act of 1890, copies of which may be seen at the office of this paper. Applications to be forwarded to Mr. H. W. Johnson, mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31.

RESULTS OF TENDERS.

Bristol.—The Town Council have accepted the following tenders: Babcock and Wilcox, coal-conveying plant, £2,756; Babcock and Wilcox, pipework, £2,911; S. Z. de Ferranti, Limited. switchboard, £2,295; Mereweather and Sons, altering pipe and sump at the Avonbank Estate, £79; Buchanan and Curwen, electric light installation, £325; and C. A. Hayes, sub-station in the roadway in Baldwin-street, near St. Nicholas's Church. £151.

Swindon.—The Corporation have received the following tenders for erection of buildings and chimney shaft for the Corporation electricity works in Corporation-street, including all excavations and foundations and the supply and delivery of all materials necessary for the construction of the works:

A. J. Colborne, Newport-street, Swindon (accepted) ...	£5,174	1	0
T. and J. Binns, Croydon ...	9,500	0	0
H. and C. Spackman, Clifton-street, Swindon ...	5,902	19	0
F. G. Minter, London ...	5.860	0	0
C. Williams, Swindon ...	5,692	14	3
C. Wilkins, Swindon ...	5,621	8	5

Erith.—The Urban District Council have accepted the following tenders:

Spurr, Inman, and Co., Limited, Wakefield (Section A)	£1,870	0	0
Babcock and Wilcox, Limited, 30. Farringdon-street, E.C. (Section B) ...	921	3	0
Wheeler Condensing and Engineering Company, Limited, 179, Queen Victoria-street, E.C. (Section C)	607	0	0
International Electrical Engineering Company, Clun House, Surrey-street, Strand (Section D) ...	3,070	0	0
International Electrical Engineering Company, Clun House, Surrey-street, Strand (Section E) ...	980	0	0
Carrick and Ritchie, Waverley Engineering Works, Edinburgh (Section F) ...	218	0	0
British Electrical Transformer Manufacturing Company, Limited, Globe Works, Woodfield-road, Harrow-road, London, W. (Section G) ...	1,194	0	0
Callender's Cable and Construction Company, Limited, Hamilton House, Victoria-embankment (Section H)...	7.517	0	7
Callender's Cable and Construction Company, Limited, Hamilton House, Victoria-embankment (Section I)...	254	18	0
H. E. Keen and Co., The Avenue Cross, Worcester (Section K) ...	29	10	0

BUSINESS NOTES.

TRACTION.

Central London Railway.—The total receipts from July 1 to date (17 weeks) amount to £100,374.

Dover.—The salary of the general manager of the Corporation tramways has been increased by £70.

British Tramways.—The British Electric Traction Company own at present 140¼ miles of tramway route, compared with 100¾ in 1900.

Southampton.—The Town Council have adopted a recommendation of the Tramways Committee relating to the revision of the 1d. stages on the tramways.

Barrow.—A sub-committee of the Town Council has been appointed to discuss the terms of the agreement with the British Electric Traction Company.

Metropolitan Railway Management.—It is announced that Mr. A. Charles Ellis has been appointed general manager of the Metropolitan Railway.

Barsi Light Railway Co.—The directors recommend a further dividend of 3 per cent., making 5 per cent. for the year ended June 30 last, carrying £1,169 forward.

Leeds.—An experimental run on the new line to Bramley has been made with satisfactory results. The line will probably be open for traffic in about two weeks' time.

Sheffield.—On Monday a public service of electric cars to Hanging-water-road was commenced. The further extension to Nether Green is expected to be opened very soon.

Epsom.—It is reported that the London United Tramways Company have abandoned for the present the idea of including this place in their scheme of electric tramways in Surrey.

Leicester.—A standing committee of the Town Council is to be appointed to undertake the management and control of the tramways when they have been transferred to the Corporation.

Tipton.—The District Council on Tuesday unanimously agreed to promote a Bill in the next session of Parliament for the acquisition and electrical equipment of the tramways undertaking.

Liversedge.—The type of overhead construction proposed to be used by the British Electric Traction Company on the new tramways has received the approval of the Urban District Council.

Limehurst.—At the last meeting of the District Council it was stated that a company were seeking powers to lay a line of tramways through Springhead, which would probably include Crossbank.

Isle of Man.—The Douglas Town Council have confirmed the resolution passed at a previous meeting to purchase the town tramways from the liquidator of the tramway company for £50,000.

Oldham.—The Corporation have entered into a fresh agreement, terminable at a week's notice, for the continuance of the tramway company's service in Oldham. The old lease expired yesterday.

Wimbledon.—A local committee, which has been formed for the "protection of Wimbledon interests," has pledged itself to use its best efforts in opposition to any scheme of tramways in North Wimbledon.

Swinton.—The consideration of the proposals of the promoters of the suggested electric tramway scheme between Mexborough and Rotherham was further adjourned at the last meeting of the District Council.

Burnley.—The Corporation have concluded an agreement with the Corporations of Brierfield and Nelson under which the former will pay 2d. per unit for a supply of electrical energy for the new tramways. The first car has arrived.

St. Helens.—The Tramways Committee have decided to allow the tramways company an annual rebate of £3 in respect of each private consumer using the cables which were laid down for the purposes of the tramways system only.

Manchester Tramways Arbitration.—This arbitration is proceeding as regards the price to be paid for the portions of the lines and their equipment to be taken over by the Manchester Corporation and 11 outlying authorities.

Halifax.—In the Bill which they will promote in the next session of Parliament, the Corporation propose to seek powers to double several lengths of existing tramline and to extend the Hebden Bridge tramway to the Todmorden borough boundary.

Lancaster.—The approval of the Board of Trade to the plans for the Scotforth and Park tramways has now been received by the Corporation. It is decided that the cars shall be of the double-deck type, reverse stairway, and small single truck.

Bristol.—A local tradesman has recovered £35 damages from the tramways company for injury to his cart sustained in a collision with an electric car, the county court judge holding that the accident was caused by the negligence of the motorman.

Greenock.—The local magistrates have granted the application of the tramways company for licenses for 20 cars, on condition that the cars are fitted with speed indicators. It is also expected that something will be done towards lowering the steps.

Tanat Valley Light Railway.—A resolution has been adopted by the Denbigh County Council that application be made to the Light Railway Commissioners for an order authorising the Council to advance £1,500 to the promoters of this railway.

Proposed Farnham and Haslemere Tramway.—We learn that one of the largest landowners on the line of route of the above proposed tramway, has written approving of the scheme. Indeed, local opinion seems to be almost entirely in its favour.

Dulwich.—The Highways Committee of the London County Council have agreed to recommend to the Council a modification of their plans for the construction of an electric tramway to Dulwich, which is intended to meet the opposition of the tramway company.

Barnsley.—The British Electric Traction Company have agreed to the proposal of the Town Council to adopt a 4ft. 8½in. gauge for the proposed tramways in the district in lieu of the 3ft. 6in. gauge as originally proposed, and the Council have approved the whole plans.

Proposed London-Dover Electric Express.—A rumour is current that it is intended to apply for powers to construct an electric railway between London and Dover. The London terminus, it is said, would be at Waterloo. Fifty minutes is given as the time for the journey.

Bristol.—The Tramways Committee have arranged with the tramways company that the restoration of the surface of the roads broken

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up for the purpose of laying electric cables from the power-house shall be carried out by the Corporation at the company's expense, instead of the work being done by the company.

Edinburgh.—It is reported that the tramways company are willing to sell the whole undertaking to the Corporation for £200,000. The offer has been considered by the Tramways Sub-Committee, who have asked the company for further information regarding the assets of the company and their income from fares during the past year.

Dewsbury.—A committee has been appointed to deal with all matters in connection with the purchase of the tramways within the borough, which will be transferred on terms to the British Electric Traction Company, who, it will be remembered, have bought from the shareholders of the present tramways their rights and interests in the undertaking.

Wolverhampton.—In deference to the wishes of the shopkeepers in Darlington-street, who complain that should the process of pulling up the old and laying down the new rails be started between now and Christmas, it would affect their business prospects, the Tramways Committee have decided that the work shall not be commenced until after the beginning of the new year.

Ayr.—The results of four weeks' running of the new electric tramways are very successful. The number of car miles run during the period was 14,250, and the number of passengers carried was 181,890. The income for the four weeks was £652, and the total expenses amounted to £547 odd, showing a profit on the four weeks of £105, equal to a profit on the year of £1,365.

Todmorden.—A special meeting of the Town Council on Wednesday decided to make application on or before Dec. 23 for a provisional order for the construction and working by the Corporation of tramways from the Hebden Bridge boundary to Littleborough and Burnley boundaries, thus completing the line of trams from Bradford to Manchester and Bradford to Blackburn.

Willesden.—The District Council will withdraw their opposition to the Middlesex County Council's proposal to have tramlines (Cricklewood to Harlesden) through the heart of Willesden to join the Harrow-road and Edgware-road systems, on condition that the County Council widen the roads to 50ft., wood pave and maintain them, and allow the use of the wire standards for lamp-posts.

Military Tractors—The War Office offer three prizes—one of £1,000, a second of £750, and a third of £500—for the best tractors for military purposes. The trials will commence in the spring of 1903, and be carried out by the War Office Committee on Mechanical Transport. The conditions of the competition are to be obtained on application at the Horse Guards, Whitehall.

Mersey Railway Tunnel.—All preparations for commencing the work of converting the existing lines for electrical working are now complete, and on Jan. 1, 1903, the directors hope to run the system by electricity. As previously stated in these columns, the contract for the whole of the reconstruction and equipment of the railway has been let to the British Westinghouse Company.

Vienna.—A Vienna correspondent states that the local tramway company has been fined an aggregate of £20,000 by the Town Council for 72 offences, including faulty traffic management, insufficient cars, and neglect to build certain projected lines within the contract time. The ultimate aim of the city of Vienna is to municipalise the tramway lines under certain existing stipulations of the contract.

Scarborough.—After prolonged negotiations the Corporation have at length sealed the agreement with the local tramway company, for which Mr. A. A. Campbell Swinton is engineer, for the construction of some six miles of electric tramways within the borough. The recently inaugurated motorcar service in the town is said to have proved quite satisfactory, and two more cars are to be added.

Brighton.—It is said that the Board of Trade will refuse to sanction the inclusion of the Dyke-road section of the tramways scheme in a provisional order, thus necessitating procedure by Bill in Parliament. In view of this action of the Board of Trade the committee of the Preston Park Ward Ratepayers' Association have passed a resolution recording its sense of the absolute necessity of adhering to the scheme.

Middlesex Light Railways.—The Light Railway Commissioners will open a public enquiry to-day (Friday) at the offices of the Willesden District Council, Kilburn, as to the expediency of granting the applications, or either of them, which have been made for orders to authorise (1) the county of Middlesex light railways (extensions) No. 2; and (2) the London United Tramways light railways extensions.

Dunstable.—A syndicate proposes to apply to the Light Railway Commissioners for powers to construct an electric light railway from Dunstable to Luton. In view of the above the Luton Town Council have appointed a Tramways Committee "to consider any scheme which may be deposited with the borough engineer or clerk with reference to the making of tramways for the borough of Luton, and that such committee report to the Town Council."

Newcastle-on-Tyne.—The Tramways Committee decided on Monday to recommend the City Council to include in the next Bill for parliamentary powers a proposal to carry the tramway lines from Gosforth to Gosforth Park gates and to Seaton Burn; the lines from Gosforth to Gosforth Park gates to be doubled, and from there to Seaton Burn single. The estimated cost of these extensions is £55,000. At the meeting of the Council this week the above proposals of the Committee were agreed to.

Bolton.—It has been decided that in future before any manhole in connection with the tramways is opened for fire brigade purposes notice must be given to the borough electrical engineer, and such must not take place except in the presence of a representative of the electricity department. The receipts for the week ending Oct. 20 were returned as £1,533. 8s. 8d., against £1,340. 10s. 3d. last year, an increase of £192. 18s. 5d. The receipts from April 1 to date were £44,650. 1s. 9d., as against £39,577. 16s. 10d. for the corresponding period last year, an increase of £5,072. 4s. 11d.

Bradford.—An agreement has been come to with the Bradford Tramways and Omnibus Company with reference to the acquisition by the Corporation of the unexpired terms of the company's lease from Feb. 1 next. As regards the tramway between Frizinghall and Saltaire, negotiations have taken place as to the basis on which payment should be made to the Shipley Urban District Council in respect of the lease, and as to the price to be paid by the Corporation for electric current which the District Council desired to supply. The parties up to the present have been unable to come to terms.

Liverpool.—The following is among the powers which will be sought by the Corporation in the next session of Parliament: "To authorise the Tramways Committee to bear the cost of improvements, past and future, to such extent as may have or may become necessary or desirable by reason of the requirements of the tramways, or to facilitate the working of the same." Mr. Wm. Henry Muckley has been appointed superintendent of the electric tramcar construction and repairing department at a salary of £300 per annum. A petition has been presented against the proposed tramway along Edge-lane.

Birmingham.—The proposal of the City Council to run tramways to Harborne and the Bearwood district by way of Hagley-road, of Harborne-road, is meeting of considerable opposition. A circular has been sent out, inviting the owners and occupiers of property to join in measures for opposing the application for parliamentary powers, on the ground that the City Council would not commit themselves to the form of traction to be used, and it seemed probable that the overhead system would be adopted. This, the circular states, will seriously depreciate the value of all the present residences and properties on and near to the proposed routes.

Walsall.—It was officially stated at this week's meeting of the Town Council that the purchase from the tramway company had now been completed, and the whole of the legal difficulties overcome. A lease for three years of the line from the Brown Lion, Pleck, to Bloxwich and Mellish-road, and of 21 years of the line from the Brown Lion to the borough boundary on the Wednesbury and Darlaston roads had been executed, and the rent had been paid to the Corporation for the past three quarters of the year. The company had also paid the claim for repairs to the tramway up to the end of June last, so that they were now making a fair start.

Rowley Regis.—The Clerk reported at the last meeting of the District Council that the British Electric Traction Company had intimated their intention of promoting a scheme for the construction of a tramway from Blackheath to Oldbury. The advisability of the Council taking up the order themselves was then considered, and it was decided that a committee be appointed to consider the scheme in conjunction with representatives from Dudley and Oldbury. It was also decided that the Council act jointly with the Dudley Town Council in obtaining the requisite order for the construction of light railways from Dudley through Rowley Regis to Blackheath.

Motors for Heavy Traffic.—At the annual meeting of the Liverpool Self-Propelled Traffic Association on Friday, Mr. Long, M.P., received a deputation urging him to increase the tare limit of motor vehicles for heavy traffic. It was pointed out that at the recent motor trials at Liverpool only one heavy vehicle was within the legal limit. The total loads that could possibly be carried at present on such vehicles, added to the weight of the vehicle itself, was said to be little more than half what was frequently carried on lorries. This seriously interfered with the earning powers of the motor vehicles. Mr. Long expressed himself in sympathy with the request of the association, recognising that motor traffic was bound to develop in the near future.

Camberwell.—In reply to a request from the Borough Council asking the London County Council to reintroduce into Parliament in the next session the scheme of tramways in the borough, the latter body have replied to the effect that the existing lines of the tramways company would be of no use to the Council's system of underground conduit electrical traction, and that they would not be justified in reintroducing the scheme for new tramways unless the Borough Council will undertake to make such arrangements as regards the company's tramways as will prevent the company from renewing before Parliament its claim for the purchase of them by the County Council. In view of the above, the General Purposes Committee of the Borough Council recommend that the London County Council be requested to so arrange their new tramways scheme that the lines laid shall at no point be within one chain of existing lines.

Cardiff.—With regard to the proposed purchase of the tramway company's system by the Corporation, the committee have decided to recommend the Town Council not to accept the offer of the company, reported in our issue of the 18th ult. The company have now been asked to fix a minimum inclusive sum for the whole of the interests of the company in the tramway lines, and also to state the sum per mile of the work of reconstruction which the company have already carried out and had in hand. The electrical engineer reports that good progress has been made with the erection of the power station, and the stokers have been fitted to three out of four boilers. The makers of the crane have also nearly completed their work. The total amount of track bonded up to date is 14,150 yards. As to the overhead equipment, all the brackets have been erected on both of the new routes, and the British Insulated Wire Company have made very good progress with their contract. The borough engineer states that with fine weather the erection of the power station itself will be finished by to-morrow (Saturday).

Salford.—A meeting of the Town Council was held on Wednesday, when the minutes of the Finance Committee contained a reference to a report from Mr. W. Hunt, elective auditor, in which the old tram-

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ways in the borough were described as appearing in the accounts at the "fictitious value" of £92,275. The committee stated that when the capital assets of the old tramways had been reduced by a valuation of the setts, etc., taken from the old tramlines and used in laying the electric tramlines, it was likely that as much as £70,000 would have to be deducted from the amount at which the old tramlines now stand in the books of the Corporation. Whether this amount were reduced by £20,000 or by £70,000, the financial success of the electric tramways would not be affected in the least degree. The question of the construction of a line of tramways in Whit-lane, Cromwell-road, Indigo-street, and Orchard-street, Pendleton, is about to be considered. The Tramways Committee have been instructed to consider the desirableness of providing, as early as possible, a ½d. service of cars in Regent-road, from Cross-lane to Regent Bridge.

London County Council.—The Highways Committee of the London County Council held a meeting on the 25th ult., when the question of constructing underground tramways in London was discussed. It will be remembered that the Council's electrical engineer and tramways manager recently returned from a tour of inspection in the States, and we understand that these gentlemen's experiences of underground tramways there was the subject of discussion before the committee. The possibility of making a shallow underground tramway from Westminster to the Bank, to begin with, was considered, the opinion being expressed that the greatest objection to the scheme was the expense that would be involved. It is regarded as quite possible, however, that the committee will recommend to the Council the advisability of adopting the scheme. Another meeting of the Highways Committee was held on Wednesday for the consideration of the same question. It is understood that the committee agreed to lay before the Council a recommendation in favour of shallow underground tramways, and it was agreed that parliamentary powers should be asked giving the Council the control of the subways in which these tramways will run. It was also further decided that in any scheme of tramway reconstruction the Council must be the sole and only authority, and that no other body should be allowed to interfere. The first experimental subway will, it is now stated, be under the new street from Holborn to the Strand.

Wigan Light Railway.—Before Sir Herbert Jekyll at the Board of Trade on Tuesday the Lancashire County Council opposed the confirmation of this order. Counsel stated that the County Council had on one or two occasions refrained from continuing to oppose the scheme on the distinct understanding with the promoters that certain conditions would be carried out for the protection of the county ratepayer. They found, however, that as a matter of practice both the Commissioners and the Board of Trade did not follow the accepted and universal practice adopted by committees of both Houses of Parliament, and by their action in ignoring these arrangements they were forcing county councils to take a course with regard to the authorising of these schemes which it was not in the interests of the country to be adopted. The county councils were forced to let these orders go in any form that the Commissioners or the Board of Trade chose to settle, and the county councils would have to enter into sealed agreements with the companies to carry out, not the provisions of the order, but the terms of those agreements, notwithstanding anything in the order. The Board of Trade was exercising practically legislative powers without the slightest idea how they were going to be exercised. He submitted for the consideration of the Board that where promoters had undertaken to carry out the scheme under certain conditions these conditions should be fully explained, and that they should be confirmed in the order, subject of course to no question of public policy being involved. Sir Herbert Jekyll promised to take these observations into consideration.

Bury.—The full text of the Tramway Committee's report on the proposed municipal tramways has now been made public. In all there will be 5 miles 1 furlong 5·83 chains of single line, and 5 miles 6 furlongs 4·92 chains of double line, giving a total length of just over 11 miles. The gauge will be 4ft. 8½in. uniform throughout the system. Manchester, Bolton, and Rochdale have already adopted this gauge, so that in view of arrangements being made for through running there was no alternative but for Bury to adopt this gauge. The committee are of opinion that the probable life of the present rails does not justify the cost of bonding them, and the whole of the existing rails will be taken up and new rails of much heavier section substituted. The site of the car depôt is in Rochdale-road, where accommodation will be provided for housing 48 cars, with the necessary repairing shops, offices, and stores. Only 25 cars are included in the estimate of cost, this number being thought sufficient for some time to come. The estimate for permanent way, cars, and car depôt amounts to £112,500. The present electricity works are being extended so as to accommodate the plant necessary for generating the electricity required for the tramway. The estimate for electrical equipment of the system, including the erection of posts, section boxes, overhead lines, feeder cables, and bonding is £30,000. The estimate for street improvements in connection with the scheme, the acquisition of property, and the purchase of present tramways, etc., is £61,500, bringing the total cost of the scheme up to £204,000. The annual expenditure is put at £26,514, while the receipts, on the basis of 600,000 car miles per annum at 1s. per car mile, are expected to reach the sum of £30,000.

Tyneside Tramways and Tramroad Co.—This Company, whose prospectus has just been issued, has been incorporated for the purpose of constructing and working tramways from Wallsend to Willington Quay and North Shields, and a tramroad from Wallsend to Gosforth. The total length of the route from Gosforth to Wallsend is 3½ miles, and from the Wallsend boundary to the terminus at North Shields 4½ miles. At the North Shields end the system will be fed by the Tynemouth tramways, which run from Whitley Bay along the coast through Tynemouth to North Shields to the point where the Tyneside tramways commence, and at the Gosforth end by the Newcastle Corporation tramways, which will communicate with all parts of Newcastle. The Newcastle Corporation are under a pledge to Parliament to extend their tramways to Walker, and when these extensions are completed their lines will join those of the company, and will provide a direct communication between Newcastle, North Shields, and Tynemouth; they will thus serve as an additional feeder of this Company's system. By the Company's system Newcastle and Gosforth will be connected with North Shields. The route followed by the tramroad between Gosforth and Wallsend passes through open country in every way adapted for the erection of residences for workmen and others whose occupation lies in the riverside district, and who will thus be brought into easy and rapid connection with the various works and with Newcastle, Gosforth, North Shields, and Tynemouth by the coast. The trams will also prove of great advantage to the residents of Wallsend and Willington Quay, by providing them with a regular, rapid, and cheap means of intercommunication. The tramways will be worked by electricity on the overhead system, and the gauge will be the one in most general use—4ft. 8½in.—the Newcastle tramways also possessing this gauge. It is estimated that the number of workmen employed in works situated on the Tyne, the great majority of whom will benefit by these tramways, is not less than 20,000, a large number being compelled to travel daily a distance of five or six miles from their work. Further extensions in adjacent districts are also in prospect. The Company's capital is £180,000, divided into 18,000 shares of £10 each. Applications are now invited for £120,000 of the capital, the subscription list for which closes to-day (Friday).

LIGHTING AND GENERAL.

Hackney.—Mr. L. L. Robinson has been elected borough electrical engineer.

Cowdenbeath.—The Town Council are carrying through an electric street-lighting scheme.

Gloucester.—The Electricity Supply Committee are extending their mains down St. Aldate-street.

Leigh.—The Urban District Council intend to apply for a renewal of their electric lighting order.

Islington.—At the meeting to-night it will be proposed to proceed with two extensions of cables at a cost of £843 and £220 respectively.

Leatherhead.—The Urban District Council intend to transfer their electric lighting order to the Leatherhead Electric Supply Company.

Ilford.—Mr. A. H. Shaw's quarterly report on the electric light department shows a net profit for the quarter ended at Michaelmas of £277. 16s. 7½d.

India.—The electrical process of producing aluminium is to be established in Mysore by the use of electricity to be supplied from the Cauvery Falls.

Electric Lamps for Police.—The Berlin detective force has just been provided with electrical hand-lanterns. The lamp resembles a pocket telescope in shape.

West India and Panama Telegraph Co.—The directors have declared a dividend of 6s. per share on account of arrears of dividend on the first preference shares.

Berlin.—We learn that last week a successful start was made with the lighting of several streets by the Bremer arc lamps, which were described by us in a former issue.

Poplar.—Mr. Lewis B. Giles, at present engineer-in-charge of electric generating plant at Messrs. Yarrow and Co.'s, has been elected engineer-in-charge by the Guardians.

Lancaster.—The Street-Lighting Committee recommend that the tramway pillars on the Scotforth route be equipped for lighting, so that they may be used for this purpose if required.

Dewsbury.—At the final meeting for the official year of the Town Council the appointment of Mr. R. H. Campion, of Blackburn, as borough electrical engineer was formally approved.

Albury.—At a public meeting on Monday the question of adopting the electric light for the parish was considered, and further discussion adjourned to the annual meeting of the Parish Council.

Warrington.—The Town Council have obtained sanction to a loan of £15,000 for electric lighting purposes, and intend to apply for sanction to a loan of £1,000 for the purchase of motors.

Manchester.—Application will be made for sanction to borrow £25,000 to cover the anticipated expenditure on electric lighting materials and services during the next two or three years.

Tamworth.—The Guardians have adjourned the question of lighting the workhouse until next week. In the meantime data respecting gas and electric lighting schemes are to be sent to every member.

Louth.—The Council are about to apply for a provisional order, and Messrs. Bremner, Smith, and Bremner have been instructed to prepare the necessary plans and particulars of an electric lighting scheme for the borough.

Eastbourne.—The chimney shaft, 150ft. high, of the Corporation electric lighting works was completed on Wednesday. The new low-level drive is to be lighted by incandescent electric lamps at a capital cost of £490.

North Berwick.—The Town Council have resolved to apply for an electric lighting provisional order. In view of the near approach of the municipal election, the proposed signing of agreement with Messrs. Crompton and Co. will be held over.

Catalogue.—Messrs. Langdon-Davies Electric Motor Company, Limited, 101, Southwark-street, S.E., have sent us a new issue of an illustrated catalogue of single-phase alternate-current motors (W. Langdon-Davies and other patents).

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Electric Heating.—It is stated in connection with to-morrow's Royal train from Portsmouth to Victoria that for the first time in history the Royal saloon will be warmed by electricity, a special installation for this purpose having been put in.

Radstock.—At the last meeting of the Council, it having been pointed out that the Norton Council complained of the two separate schemes for electric lighting not having been presented by the engineers, the clerk was instructed to write Mr. Preece thereon.

Personal.—Mr. L. W. de Grave has severed his connection as engineer and director of John Davis and Son, Limited, and is practising as consulting engineer at Charnwood-street, Derby. We understand he is shortly going to the Continent to report on some mining properties.

American Copper.—It is reported that 5,000 copper miners are idle at Montana, some on account of mine repairs, and others for no apparent reason beyond the determination to reduce the output. The Trust and Competitor Mines, which have both stopped, together aggregate 80 per cent. of the output of the Butte district.

Birmingham.—The Health Committee of the City Council have, in conjunction with the Drainage Board, a project on hand for the construction of a new refuse destructor on part of the sewage farm near Saltley, in connection with the electric light station for the various buildings and offices connected with the Drainage Board at Tyburn.

Liverpool.—It has been decided to apply to Parliament for powers to provide that a person should not be entitled to demand or continue to receive from the Corporation a supply of electrical energy to premises having a separate supply except on terms affording the Corporation a reasonable return upon the capital expenditure involved.

Hampstead.—The Lighting Committee's statistics for the half-year ended on Sept. 30 show that there was then an equivalent of 12,765 8-c.p. lamps connected, as compared with 11,313 on the corresponding date last year, and that the number of consumers connected during the half-year was 227, as compared with 193 in the corresponding period last year.

Cape Cable.—The Cape-Australia cable starts work to-day. Mr. Barton is cabling to the Premiers of Cape Colony and Natal, conveying Australia's congratulations on the completion of direct telegraphic communication between the two countries, and trusts that South Africa will soon be a powerful federation within the Empire. Mr. Barton will also cable a message to Mauritius.

St. Marylebone.—A resolution will come before the next meeting of the Guardians to the effect that £9,039 be borrowed for the execution of works and the provision of fittings and machinery for the purpose of lighting by electricity the infirmary, in accordance with plans which the Local Government Board had approved, and that the sum be repaid within a period not exceeding 15 years.

Ealing.—The District Council have adopted a report of the Electric Lighting Committee recommending, with regard to the application for the extension of the mains to Ascot-avenue and to the new roads near St. John's Church, that pipes be laid in these roads, the necessary distribution cable to be put in when required, the cost of pipes and mains being £201 in the case of Ascot-avenue and £327 in the case of Curlew and Loveday roads.

British Motor Traction Company, Limited, v. Moore.—This motion was brought on before Mr. Justice Farwell this week in default of appearance, and the action was one to restrain the defendant from infringing certain patents belonging to the plaintiff company. The Court granted perpetual injunction against the defendant from using those letters patent, and directed that an enquiry be made as to damages. His Lordship in making the order allowed the plaintiffs taxed costs.

Epsom.—The Urban District Council have been approached by the Epsom Grand Stand Association as to terms for connecting the grand stand with the Council's electricity supply works. The association is desirous of obtaining power to work a lift for the use of the King and Queen at the races next year, and power also for lighting rooms in the grand stand, for which 200 lights would be required. It is stated that negotiations are being proceeded with for supplying the electric power required.

Naples.—The *Times* correspondent says the further one bores into Senator Saredo's mastodonic report on Naples the more one is appalled by the evidence of the almost universal corruption. With regard to the contracts for the water supply, electric light, and electric tramways, such corruption went on that the Marquis di Campolattro resigned his office as mayor, feeling himself to be totally unable to cope with the situation. Summonte, the friend of Casale and chief assessor, was elected mayor in Campolattro's place.

Listowel.—We understand that the Urban District Council are treating with the National Electric Wiring Company, Limited, Dublin, who propose to light the town with 20 500-c.p. lamps at £75 per year, provided the Council would pay for the lamps, posts, and wiring, and at £100 the company to provide all necessary fittings, and to light and extinguish the lamps, and to maintain them in good condition. They also propose to extend the cost of wiring private premises over a period of six years, or 24 quarterly instalments.

Wireless Telegraphy in Italy.—The Rome correspondent of the *Morning Post* states that the Italian naval officers, after many experiments, have succeeded in establishing communication between Spezia and Sardinia, a distance of more than 200 km., with the Marconi apparatus. Seeing that Marconi himself only succeeded in transmitting messages from Antibes to Corsica, a distance of little more than 150 km., the Italian officers are naturally proud of their achievement, which is due to improvements introduced by them into the Marconi system.

Books Received.—"The 'Practical Engineer' Pocket-Book, 1902," 1s. 6d. net, without diary 1s. net; "The Electrical Pocket-Book, 1902," 1s. net; Technical Publishing Company, Limited, 31, Whitworth-street, Manchester.—"Scientific Research," by Dr. Stephen Smith, M.R.C.S., 2s. 6d.; Elliot Stock, 62, Paternoster-row.—"Les Applications pratiques des Ondes Electriques: Telegraphie sans fil. Telegraphie avec Conducteur, Eclairage, Commande distance," by Albert Turpain, Docteur es Sciences (Bibliothèque Technologique), 12fr.; C. Naud, 3, Rue Racine, Paris.

Libel Action.—Mr. Benjamin Charles Pole, an engineer, on Tuesday lost his action against Messrs. Alabaster and Gatehouse, proprietors of the *Electrical Review*, for libel. The case was tried by Mr. Justice Ridley and a special jury. The plaintiff exhibited an engine of his invention, with respect to which he used the word "Poleforcia," as expressing the increased power which he said he could get out of it, as compared with other machinery. The *Electrical Review's* comment upon a pamphlet descriptive of this machine and the capabilities claimed for the same led to the action, with the above result.

Kensington.—It is proposed that electric light be installed at the Warwick-road stables, and that tenders be invited for the execution of this work. The estimate is £190. Notices and plans received from the Kensington and Knightsbridge Electric Lighting Company (Alfred-place East) and the Brompton and Kensington Electricity Supply Company (Redcliffe-street), relative to proposed extensions of their mains in the borough, have been agreed to subject to plans being approved by the borough engineer and by the lighting engineer, and that the works be carried out under their supervision and to their satisfaction, etc.

Newcastle.—The *Newcastle Daily Chronicle* understands that a powerful syndicate is at present being formed for the purpose of erecting a power station in the heart of the Northumberland coalfield, the object of which will be to supply the collieries with light and current for their motive power. The new company will include representatives of the Northern Counties Electricity Supply Company, who are willing to come to an arrangement to take all the current they want for light powers in sub-stations from the new company. The company is applying to Parliament for powers to run trams in the Northumberland colliery district, and are in a position, as soon as the Act is passed, to proceed forthwith with the work.

Presentation.—In commemoration of the twenty-fifth anniversary of the foundation of the firm of Messrs. Johnson and Phillips, telegraph and electrical engineers, of Charlton, a handsome silver bowl was on Thursday evening last week, in the presence of a representative gathering, presented to Mr. Walter Claude Johnson, M.I.C.E., M.I.E.E., at the works, by Mr. J. Macgregor, general manager, on behalf of the staff, foremen, and workmen, as a token of their regard and goodwill. The bowl was suitably inscribed, and there was also engraved on it a representation of a cable ship picking up broken cable by means of a grapnel. Nearly the whole of the 600 or 700 employés of the firm, of which Mr. Johnson is now the only member (Mr. Phillips having died several years ago), were present.

London Gazette.—The last day for receiving proofs in the estate of W. R. Beckton, electrical and general engineer, 35, Stradella-road, Herne Hill, Surrey, is Nov. 9. Mr. E. L. Hough, official receiver, Bankruptcy-buildings, Carey-street, W.C., is trustee.—The last day for receiving proofs in the estate of A. M. Collier, electrical engineer, Claremont-grove, Claremont-place, Gateshead, Durham, is Nov. 8. Mr. J. G. Gibson, official receiver, 30, Mosley-street, Newcastle-on-Tyne, is trustee.—The last day for receiving claims in the matter of the Edwards Electrical Company, Limited, is Dec. 1.—The partnership existing between T. Powlesland and R. Beveridge, electrical engineers, 60, Ebrington-street, Plymouth, has been dissolved by mutual consent.—A petition for the winding-up of the Electrical Regulating and Lighting Syndicate, Limited, has been presented to the Court of Chancery.

Edinburgh.—The City Council have adopted the Electric Lighting Committee's recommendation that the charge for electric energy from Sept. 30, 1901, to Sept. 30, 1902, be fixed at the same rate as last year—viz., private lighting, 3½d. per unit; public lamps, £13 each per annum; motor power, 1½d. per unit. The committee have also submitted a report by the chief electrical engineer on the condition of the plant and mains for the half-year. Mr. Mackenzie said that the Council was no doubt aware that during the summer months the revenue on all electric light and gas undertakings fell off, and that a loss was the result. They were better, however, this year than last. Last year they did not commence to make a profit until the week ending Oct. 10, but this year profit was made a week earlier, and up to date they had made £1,071 of profit, as compared with £220 at the corresponding date last year. Prof. Kennedy had reported that the plant and mains were all in good order.

Stock Exchange.—The Stock Exchange Committee have appointed Nov. 4 special settling day for Urban Electric Supply Company's 30,000 5 per cent. cumulative preference shares of £5 each (£1 paid), Nos. 50,001 to 80,000, and 30,000 ordinary shares of £5 each (£1 paid), Nos. 8 to 30,007; and have ordered the undermentioned securities to be quoted in the official list: Brush Electrical Engineering Company's further issue of 15,731 ordinary shares of £2 each (fully paid), Nos. 90,001 to 105,731, and 60,000 6 per cent. preference shares of £2 each (fully paid), Nos. 90,001 to 150,000; Vickers, Sons, and Maxim's further issue of 200,000 ordinary shares of £1 each (fully paid), Nos. 2,000,001 to 2,200,000; Willans and Robinson's further issue of 10,000 6 per cent. cumulative preference shares of £5 each (fully paid), Nos. 70,001 to 80,000. Applications have been made to the committee to allow the following securities to be quoted in the official list: British Westinghouse Electric and Manufacturing Company's further issue of 50,000 6 per cent. preference shares of £5 each (fully paid); Calcutta Electric Supply Corporation's further issue of 10,000 shares of £5 each (fully paid), Nos. 20,001 to 30,000; Charing Cross and Strand Electricity Supply Corporation's £250,000 4 per cent. debenture stock (redeemable), in lieu of the provisional certificate now quoted.

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Bristol.—Mr. R. W. L. Phillips having obtained the position of electrical engineer of the borough of Bedford, it is proposed that Mr. H. H. Couzens be appointed deputy city electrical engineer to fill the vacancy, and that Mr. Joseph Harding Bolam be appointed second assistant engineer, both at increased salaries.

Yorkshire Municipal Telephones.—At last week's conference the municipalities of Leeds, Bradford, Sheffield, and Halifax it was decided to recommend that all the municipalities of the West Riding should apply simultaneously for licenses to establish municipal telephones. It was agreed that there should be no terminal charges between the various municipalities.

Camberwell.—It is proposed to ask the Parliamentary Committee of the London County Council, as a matter of emergency, to obtain powers in the next session of Parliament for the compulsory acquisition of a site adjoining the Bonar-road Wharf upon the canal for the erection of the necessary works, this being by far the best site for the purpose in the borough.

Hoylake and West Kirby.—The District Council have resolved that in all new streets leading out of streets in which main cables are laid or ordered to be laid, a cable be laid sufficient for lighting the street lamps and private premises, and that electric cables be laid forthwith in Victoria-road, West Kirby; Ferndale-road and Lee-road, Hoylake; and Egbert-road and Ethelbert-road, Great Meols.

Wandsworth.—The Borough Council recently instructed Mr. Walter P. Adams, M.I.E.E., to enquire into the possibilities of utilising their dust destructor at Tooting for generating electricity. Last week he sent in a lengthy report. Although the private lighting is in the hands of the County of London and Brush Provincial Electric Lighting Company, the public lighting is in the hands of the Corporation.

Bootle.—Mr. T. D. Clothier, chief assistant at the Hull Corporation tramway power station, has been appointed borough electrical engineer. Mr. Clothier is the fourth assistant from the Hull Corporation works to obtain an appointment as borough electrical engineer during the past four years. The three previous appointments were: Mr. S. E. Bastow to Barnsley, Mr. H. Gray to Accrington, and Mr. R. Pape to Morecambe.

Sheffield.—The Finance Consultative Committee of the Corporation have agreed to the proposal of the Electric Light Committee to borrow £525,000, which is needed for extension of existing works, and for the erection of a new electric light station and the provision of up-to-date plant at Neepsend. The committee anticipate that when the new works are completed they will be enabled not only to supply light all over the city, but to provide motive power to many of the works.

Darwen Telephones.—The Mayor has asked the Mayor of Blackburn to convene a meeting of representatives of East Lancashire boroughs to discuss the advisability of the establishment of a system of municipal telephones for the districts of Darwen, Blackburn, Accrington, Clitheroe, Whalley, Rishton, Great Harwood, and other places. The matter will be brought before the first meeting of the General Purposes Committee of the new Blackburn Town Council, and the Council have appointed representatives to attend the meeting.

Enfield.—At the last meeting of the District Council the Electric Lighting Committee instructed the clerk to submit to Mr. Hammond, M.I.E.E., of 64, Victoria-street, the agreement submitted by the North Metropolitan Electrical Power Distribution Company, Limited, and the proposals of the Provincial Electric Light and Traction Company, Limited, and to arrange terms with that gentleman for advising the Council which was the most favourable proposal to the district, and whether either or both contained all the points necessary or desirable to be included in an agreement or the provissonal order.

St. Andrews.—A special meeting of the Town Council was held on Monday for the purpose of considering a proposed agreement between the local authority and Messrs. Crompton and Co. with regard to the lighting of the town with electricity. Messrs. Crompton propose to apply for a provisional order, and to carry through the undertaking, the Corporation having the option of purchase on certain conditions. After some discussion it was resolved to oppose the provisional order, and, if so advised, at a later stage applying for a provisional order, and making such arrangements in regard to the undertaking as might be necessary.

Leicester.—The Gas and Electric Lighting Committee in their last report state that, as authorised by the Council, they have thoroughly investigated the charges brought by the district representative of the Boilermakers' Iron and Steel Shipbuilders' Society against Messrs. E. Danks and Co., Limited, Oldbury, who have recently carried out a contract for the supply of boilers at the electric lighting works, with reference to their being unfair employers not paying the standard or recognised rate of wages to the workmen in their employ. The committee are satisfied that there are no grounds for such charges.

Changes of Address.—The British Thomson-Houston Company, Limited, electrical engineers and contractors, who have recently moved their head office to their works out at Rugby, will on Nov. 1 move their showrooms from their present quarters at 26 and 27, Bush-lane, to 83, Cannon-street.—Mr. R. E. W. Berrington, civil engineer, of Bank-buildings, Lichfield-street, Wolverhampton, has opened an office at Victoria-mansions, 28, Victoria-street, Westminster, S.W., where Mr. Ernest Berrington will be in charge of Parliamentary Bill work and any other work south of Rugby. We understand that the London and Wolverhampton offices will be in telephonic communication.

City Lighting.—At the meeting of the Court of Common Council last night the Streets Committee presented a report on the subject of the electrical lighting. They referred to the letter from the City of London Electric Lighting Company, already mentioned in a previous issue, offering to continue the public lighting of the western and central districts at the same price and subject to the some conditions as before, provided that the arrangements as to the public lighting in all three districts (western, central, and eastern), be fixed until 1914, when the Corporation's power to purchase first arises. The committee stated that they had adjourned the further consideration of the letter until February next.

Kilmalcolm.—A proposal is under consideration to introduce the electric light. A circular, signed by Mr. George A. Macdonald, and issued from 116, Hope-street, Glasgow, has been sent to the principal householders in the district, along with an enquiry form asking if the receiver is willing to introduce the electric light, and to state what number of lights he estimates he will require. At a recent meeting Mr. J. L. Napier, consulting engineer, read a favourable report on alternative schemes, and it was after consideration of that report that a provisional local committee decided to circularise the inhabitants. Preliminary negotiations have been entered into with the Clyde Valley Electric Power Company.

Fulham.—The report of the Works Committee submitted on Wednesday recommended the purchase by the Council of 2¾ acres of land in Townmead-road, at £4,000 per acre. The land in question has a river frontage and adjoins the Council's electric lighting works. The river frontage has been embanked with a river wall, and the paving charges in respect of Townmead-road paid for. In the event of it being necessary in the future for the Council to acquire additional land for the extension of their electric lighting, etc., works and depôt in Townmead-road, great difficulty might be experienced should the adjoining land become built over, even if the price was not prohibitive. The Post Office telephone department will shortly commence cabling operations along Fulham-road.

Cardiff.—In a note in our last issue on the recent enquiry into the Corporation's application for sanction to borrow a further sum of £107,611 for extensions to their electric lighting system, we referred shortly to the evidence given by the town clerk and the borough engineer. We are now informed that the borough engineer was the only person, in addition to Mr. A. Ellis, who gave evidence on this subject, and that the borough engineer's evidence referred only to the extensions of the power station buildings, for which he acts as architect. On the other hand, Mr. Ellis dealt in detail with every item included in the application of the electric lighting department, of which he is engineer and manager, and he afterwards spent the greater portion of the afternoon in showing the inspector over the district, including the two power stations

Huddersfield Telephones.—Though the Huddersfield Corporation was not represented at the meeting held at Leeds on Monday on the municipal telephone question, there is said, according to the *Bradford Observer*, to be no deviation from the purpose of those who have in view the establishment of municipal telephones in that borough. The carrying out of the object may be deferred for obvious reasons, but several important preliminaries have been effected which would render the realisation of the scheme no difficult matter. Huddersfield is so far in advance of neighbouring towns on this subject that it is already in possession of authority from the Postmaster-General to establish a system, and an application to the Local Government Board for permission to borrow £30,000 for that purpose will, according to present information, be heard by an inspector of the Board in due course.

Mitchelstown.—A public meeting was held recently, in response to a requisition from the townspeople, for the purpose of considering a proposal to revive the Mitchelstown electric light scheme. In 1896 a Bill was carried through Parliament for the purpose of giving the Mitchelstown Board of Guardians, as local sanitary authority, powers to illuminate the town with electric light. After parliamentary powers had been obtained, the Board of Trade held a local enquiry into the merits of the project, with the result that the provisional order was withheld on the grounds that the water power of the Gradogue stream was insufficient. It is now proposed to go on with the scheme on a much more extensive basis, so that public and domestic electric lighting will be supplied, and for this purpose the promoters propose to utilise the Funcheon River. It was decided to appoint a committee to carry out the provisions of the Act. Mr. Skinner, solicitor, will act as secretary to the committee.

Woolwich.—The Council have decided to give the Blackheath and Greenwich District Electric Light Company, Limited, notice that they disapprove of the company's intention to lay mains in Eltham-road, and that subject to such report the London County Council be asked to disapprove also. The committee also recommended that the town clerk be instructed to oppose the appeal to the Board of Trade, of which the company have given notice, against the Council's notice of disapproval of the laying of the mains in Eltham. The Council intend to apply for authority to the Board of Trade for a provisional order to supply electric light and power in South Woolwich, and to carry into effect the agreement between the Woolwich District Electric Light Company, Limited, and the Council, for the purchase by the Council of the company's undertaking. The War Office authorities have been offered a supply of electricity for all the barracks in Woolwich on the following scale of charges: 3½d. per unit for the first 100,000 units supplied, 3¼d. per unit above 100,000 and not exceeding 200,000, and 3d. per unit above 200,000. The street lamps will probably be lighted up within a fortnight.

Bath.—During a Council debate upon the proposed expenditure for electric lighting, it appeared that the amount of the commitments was £12,994. 8s. 4d., of which £4,000 was in respect of the purchase of land in Dorchester-street, for which a loan has been granted already. The amount required for immediate use was £3,114, which included £450 for plant for softening the water and £750 for the possible extension to Weston. Mr. Teague (the engineer) said about £25,000 would be required for extensions in addition to this £12,000. It appeared that the present plant was calculated to supply 30,000 lamps. At the end of September there were 34,853

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connected, and there were more than that now, and applications were coming in daily. The increase of lamps was just 1,000 during September, and during October there had been 1,300 or 1,400 applied for. The lamps had increased by 9,000 since last Christmas, and the units sold for private lighting were 41,000 in the September quarter against 31,000 last year, while the receipts in the quarter were £800 more than in 1900. The matter has been referred to the Works Committee.

Exeter.—The adjourned meeting of the City Council was held on Monday in order to consider the report of the Electric Lighting Committee respecting the equipment of the new works which are to be erected at the Basin, the Mayor presiding. The committee recommended the placing of the contract for the entire equipment of the station with one firm of contractors, and the adoption of the two-phase system; that subject to the consent of the Local Government Board being given to the raising of the money by loan, the complete tender of the British Westinghouse Company, of £28,989, with an addition of £718 for larger boilers, making a total of £29,707, be accepted. An amendment moved at the last meeting in favour of C. A. Parsons and Co.'s tender to execute the works for £27,981 on certain conditions, the object being to adopt a scheme of steam-turbines instead of the one of reciprocating engines as recommended by the committee, was lost by 28 votes against 20. Another amendment, that, in accordance with the advice of Mr. Hammond, the specification be redrafted and tenders invited from the Westinghouse Company, Parsons and Co., and Messrs. Ferranti, on the basis of the new specification, was then proposed, and finally the debate was adjourned to Tuesday.

Glasgow.—The City Council have remitted to the Watching and Lighting Committee to prepare clauses for introduction into the first Bill to be promoted in Parliament for the purpose of imposing a lighting assessment, payable half by owners and half by occupiers, and abolishing the charge of 10s. per burner. Last year clauses almost to the same effect were recommended by the Council, and were inserted in a provisional order, and on account of the opposition of the Landlords' Association were thrown out. This is a question of considerable importance, because it cost the occupiers £88,000 to light the public streets, the common stairs, and the private courts. It is now stated that the charge of 15s. per burner for private courts does not cover the cost of the lighting by 50 per cent., which does not fall in any direct way upon the proprietors, and thus the whole deficit is made to fall on the occupiers. The cost of lighting of common stairs is about £38,000, and the revenue of 10s. per burner falls short by £21,000 to meet the cost. A further cost of 2s. is allowed to the proprietors for the collection of the rate per burner, and that again places a sum of £5,700 to fall on the occupiers. It is now proposed that occupiers and the owners should be placed in the position of both being alike responsible for the whole lighting of the city.

Luton.—Mr. Snell has submitted an exhaustive report as to the machinery, plant, and installation generally, in which he expressed himself perfectly satisfied with the several works which had been executed. He is of opinion that his estimates would not be exceeded, and if it was so, it would only be to a slight extent. A well is to be sunk for the supply of water for condensing purposes, provision for which had been made in the estimates, and a shed erected for the purpose of placing therein a 3-h.p. motor and pump. Messrs. Hayward Tyler and Co. have been asked for an estimate for the purchase and fixing of the motor and pump in the shed. The resident electrical engineer, in his monthly report as to the works completed and in hand, states that 2,710 units had been generated; that 475 8-c.p. lamps had been connected, making a total of 42 consumers with an equivalent of 1,910 8-c.p. lamps, and including public buildings and arc lighting a total equal to 2,634 8-c.p. lamps; there were applications now in for current to supply 851 additional 8-c.p. lamps. In response to the application of the Luton Industrial Co-operative Society for current to about 76 8-c.p. lamps, cables are to be laid in Hastings-street. The electrical engineer is about to fix a clear globe arc lamp at Park-square, at a cost of about 10s. 6d., as an experiment with clear glass against opal.

Sunderland.—The new Corporation electric light station built on ground off Hylton-road marks an important development, says the *Sunderland Weekly Echo*. The building is capable of accommodating 5,000 h.p., 2,000 of which is now being installed, while the hexagonal chimney will be sufficient for 12 boilers. When the whole station is completed there will be three similar chimneys, each taking 12 boilers. The station is to be equipped with high-speed triple-expansion surface-condensing engines, the circulating water being cooled by towers like the one at Dunning-street. The boilers are of the Lancashire type, with mechanical stokers. When the scheme is completed 18,000 h.p. will be provided, which will be sufficient to serve Sunderland for many years. In the future it is expected that this lighting station will serve the whole of the southern portion of the borough, Dunning-street acting as a tramway power-house, being so admirably situated in the centre of the system. Eventually it is probable that there will also be a lighting station on the north side of the river. Accommodation for 60 cars is to be provided at the Hylton-road station, and for the completion of the whole work it is estimated that £73,000 will be required. The ground on part of which the station stands comprises four acres, and the entrance to it is at the top of Silksworth-row, on the right-hand side.

Wimbledon.—The Electric Lighting Committee reported at the last meeting of the Council that the clerk submitted a report with reference to the proposed supply of electrical energy to authorities or persons outside the urban district of Wimbledon, and read a letter from the clerk of the Croydon Rural District Council, intimating that the Croydon Rural District Council would raise no objection to this Council obtaining powers to supply electricity within the district of Merton, subject to an approved agreement being entered into, providing that the same current price shall be charged to residents in Merton as is charged to Wimbledon residents, and that nothing in such powers shall prevent residents in Merton, who may so desire, from obtaining a supply of electricity from Mitcham or any other parish in the Croydon rural district, and the usual clauses for taking over in the event of Merton obtaining its own electric lighting order or being joined for Local Government purposes to a parish with an order in force. The clerk reported that he had received a letter to the same effect from the clerk of the Merton Parish Council. It was decided to prepare a draft agreement embodying the terms mentioned, and submit the same to the Croydon Rural District Council for their approval. Particulars of the accounts for materials or works certified by the electrical engineer and Mr. A. H. Preece respectively have been prepared, showing the estimated amount required to complete the works to be £14,448. 10s. 10d. Application is to be made for sanction to a loan of £14,500 for the purposes of electric lighting, and £4,000 to cover capital expenditure for the year ending March 31, 1902. Mr. H. T. Lee (of Wakefield) has been appointed assistant electrical engineer.

King's Lynn.—Members of the Corporation, officials, and other gentlemen were present at the Corporation electricity works on Wednesday last week to inspect the new steam dynamo, the completion of which marks the termination of the work in connection with the extension sanctioned by the Corporation last year. A number of speeches were made. Mr. Pilling (electrical engineer) explained that the plant and the engines were of the high-speed type, and worked at 150lb. steam pressure (350 revolutions per minute), giving about 300 h.p. In these high-speed steam-engines the dynamo was coupled to the crankshaft. In the gas-engines it was separate, being driven by a belt, which meant practically 10 to 15 per cent. loss. The output of the small engine was now 4,000 lamps of 8 c.p., all burning simultaneously, and of the larger 6,500—over 10,000 for the two. They could connect about 18,000 lamps; they never had more than 50 or 60 per cent. burning at the same time. The output of the steam-engine was exactly equal to the output of the whole of the gas-engines—200 kw., 6,500 lamps. The latter occupied 10 times as much space as the new engine. The small steam-engine had turned out very satisfactory. They had been running it for four or five months, and it had done practically all the work. The committee were perfectly right in adopting steam for the extension—not only on account of the space, vibration, etc., but on account of the saving. In June they saved £14, in July £20, in August £48, and in September £48. But in September they had to run the gas-engines every night, so that the saving in that month was not what it ought to be. The total saving for the four months (the lightest four months of the year) was £122. The Mayor said they were very glad the Electric Lighting Committee had at last hit the right nail on the head—viz., using steam for electric purposes. The Mayor then turned on steam, and the engine ran for some time almost noiselessly. The party before leaving inspected the premises generally.

London County Council.—At Tuesday's meeting of the Council, with regard to the appointment of chief engineer, the following letter was read by the chairman of the committee: "Borough Engineer's Office, Town Hall, Leicester, Oct. 28, 1901. To the Chairman, Aldermen, and Councillors of the London County Council. My Lords and Gentlemen,—I beg respectfully to express my high appreciation of the honour of being even second on the list of three candidates finally selected to be submitted to you for the appointment of chief engineer and county surveyor. As, however, there is a very strong desire to retain my services at Leicester on terms satisfactory to myself, I beg to withdraw, with your kind permission, from my present position as a candidate. In doing this, I wish to tender to you my sincere thanks for the courteous consideration which I have received.—I remain, my Lords and Gentlemen, your obedient servant, (Signed) E. GEORGE MAWBEY, borough engineer and surveyor." The withdrawal of Mr. Mawbey left but two names before the Council, and Mr. Maurice Fitzmaurice was elected to the chief engineership of the Council, briefly returning his thanks for the honour. The Parliamentary Committee asked to be authorised, subject to the Council of the metropolitan borough of Camberwell undertaking to defray the parliamentary costs involved, to seek power in the next session of Parliament to enable the Borough Council to acquire compulsorily the site fronting upon Hill-street, Peckham, and shown upon a plan submitted to the Parliamentary Committee on Oct. 24, 1901, and to erect and maintain thereon an electricity generating station. The expenditure of a sum not exceeding £80 be sanctioned for the purpose of raising and refixing the boilers in the Blackwall Tunnel electric lighting station was also recommended. The following notices under Electric Lighting Acts and Orders were agreed to: From the Brompton and Kensington Electricty Supply Company, under the House-to-House Order, 1889, of intention to lay mains of high and low tension along a portion of Redcliffe-gardens. The City of London Electric Lighting Company, under the Southwark Order, 1891, to lay mains along a portion of Park-street. The Kensington and Knightsbridge Electric Lighting Company, under the company's order and the Kensington and Knightsbridge Electric Lighting Act, 1893, to lay mains along and across Alfred-place East. The London Electric Supply Corporation, under its order of 1899, of intention to lay low-tension distributing mains across Upper Russell-street, and to construct an underground converter chamber and inspection boxes in that thoroughfare, subject, however, to the following conditions: that the company do give two days' notice to the Council's chief engineer before commencing the works; that the low-tension mains be laid under the footway, 9in. below the underside of the paving, wherever it is found practicable to do so, and the high-tension mains at least 1ft. lower; that where the mains have to be laid in the carriageway they be placed at the same depths below the underside of the concrete, or, if there be no concrete, then at least 1ft. 6in. and 2ft. 6in. respectively below the surface; that where the mains cannot be laid at the depths specified some extra means of protection satis-

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factory to the Council's chief engineer be used to preserve them from risk of mechanical injury; that no pipes of larger diameter than 5in. be used; that separate boxes be used for the high and low tension mains respectively; that, as an additional precaution against accident through defective insulation of the mains, each of the high-tension street boxes be provided with an inner as well as an outer cover; the two insulated from each other as far as practicable, and the outer cover being efficiently connected to earth; that no street boxes be constructed until the positions for, and the mode of construction of, them shall have been submitted to, and approved by, the Council's chief engineer; that all pipes or openings from or into the boxes be of such shape as to remove all risk of injury to the coverings of the cables; that all cables crossing the boxes be supported from below in the boxes; that all service lines or small cables be protected where leaving the boxes by an extra lead covering or by wooden stoppers, and do also have a copper wire of sufficient size carried from the service to the main cable, in good connection with the lead or iron outer casing; that the ends of all mains terminating elsewhere than in a box be securely protected by iron caps, in addition to other covering; that the converter boxes be constructed in all respects in accordance with the drawings (numbered 585 and 586) approved by the Council on Nov. 2, 1897; that all vacant space up to the level of the cover of the wrought-iron case of each of the boxes be filled with sand; that the empty space above the iron case be reduced to the height of 3in., or just sufficient to safely clear the ventilating cover of the case; that the cover of the case be fitted outside with non-conducting material, the earth wire from cover to cover be omitted, and the outer cover separately earthed; and that adequate means be taken to prevent the accumulation of gas in the boxes and conduits. The Metropolitan Electric Supply Company, under the Mid-London Order, 1889, to lay low-tension mains and a pilot voltmeter lead along portions of High Holborn, Little-turnstile, Gate-street, Lincoln's-inn-fields, and Sardinia street and place. The St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, to lay mains along Savernake-road and Courthope-road, along Highgate-road, and The Grove to the Borough Council's new sub-station, along Georgina-street to the King's-road sub-station, and across Kentish Town-road. Notices were also received as follows, under orders granted to local authorities, and under which the Council has no power of approval or disapproval of works: (*a*) dated Oct. 14, 1901, from the Hammersmith Borough Council, under the Hammersmith Order, 1893, to lay mains along Brooklyn-road and Lime-grove; and (*b*) dated Oct. 21, 1901, from the Hampstead Borough Council, under the Hampstead Order, 1893, to lay mains along New-road (two portions), across West End-lane, and along Blackburn-road, Gardnor-road, and The Grove, Holly-hill.

PROVISIONAL PATENTS, 1901.

Oct. 21.

21031. Improvements in and connected with the supporting standard and trolley arm used in overhead electric traction schemes. Robert Lighton Ross, 5, John Dalton-street, Manchester.

21056. Improvements in or relating to electric arc lamps. The Jandus Arc Lamp and Electric Company, Limited, and Adrian Denman Jones, 39, Hartham-road, Holloway, London.

21092. Improvements in coating tubes by electro-deposition. James Greenwood, 4, South-street, Finsbury, London.

Oct. 22.

21170. Improvements in electric cables. Mervyn Joseph Pius O'Gorman, 24, Southampton-buildings, Chancery-lane, London.

21205. Improvements in or connected with electricity meters. James Grieve Lorrain, Norfolk House, Norfolk-street, Strand, London. (Hector Alan Macdonald, France.)

Oct. 23.

21226. Improvements in ball-fittings for electroliers, brackets, and analogous fittings employed in electric lighting. Harry Wakefield, 24, Temple-row Birmingham.

21262. Improvements in portable electric lamps. Otto Ferdinand Hermann, 52, Chancery-lane, London.

21267. An improvement in electric boll pulls. James Newton, 53, Chancery-lane, London.

21285. Improvements in electric batteries. Lars Bristol, 70, Chancery-lane, London.

21288. Improvements in electric igniters for explosion engines. Mervyn Joseph Pius O'Gorman, 24, Southampton-buildings, Chancery-lane, London.

21292. Improvements in electric heaters. Constantin Danilevsky, 18, Southampton-buildings, Chancery-lane, London.

21293. Improvements in electrically illuminated signs. John Henry Goehst, 18, Buckingham-street, Strand, London. (Complete specification.)

21294. Improvements in electric accumulator batteries. Albert Tribelhorn, 18, Buckingham-street, Strand, London. (Complete specification.)

Oct. 24.

21310. Improvements in automatic guards or protectors for electric or other tramway cars, or the like. William Dewar, 41, Reform-street, Dundee.

21328. A waterproof cone, cap, or cover for protecting the holders of electric glow lamps. Samuel Miller, 33, Cannon-street, London.

21333. Improvements in electric measuring instruments. Alfred R. Hakoumoff, 43, Ormiston-road, Uxbridge-road, London.

21337. Protective appliance for electrical conductors. Oscar Frederik Parment, 78, Fleet-street. London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 27, 1901, being date of application in Sweden.) (Complete specification.)

21352. Improvements in and relating to electrical signalling apparatus. Henry Montague Hozier, C.B., and Alexander William Sharman, 45, Southampton-buildings, Chancery-lane, London.

21362. Improvements in secondary batteries. Carl Tunstill John Oppermann, 53, Chancery-lane, London.

21387. Improvements in electrical apparatus for registering the discharge of liquids by pumps. Gerald Spencer Hertslet, Edward Sharman Morris, and Henderson William Knott, 4, South-street, Finsbury, London.

21389. Improvements in apparatus for telephonic and telegraphic systems. The Thomson-Davis Telephone System, Limited, and Arthur Thomas Milnor Thomson, 22, Southampton-buildings, Chancery-lane, London.

Oct. 25.

21430. Apparatus for simultaneous electric signalling between various places connected by the same wire, or system of wires. Charles George Fernie, West Wratting Park, near Cambridge.

21433. Improvements in electric heating apparatus. Tom Vincent Smith and Charles John Watts, 73, Cheapside, London.

21435. Electric wire terminal or adapter for sparking plugs, used on motorcar and stationary gas-engines, and for like purposes. William Mitchell Cunningham, 24, Castle-street, Clitheroe, Lancs.

21446. Electrical pocket lighter for lighting cigars and the like. Max Abramezyk, 33, Cannon-street, London.

Oct. 26.

21485. An improved system of electric conductors. Guy Clement Hurrell, 14, Haydon Park-road, Wimbledon, Surrey.

21565. Improvements in or connected with circuit-closing devices. Ethelbert Thomas Ruthven-Murray and Ferranti, Limited, Norfolk House, Norfolk-street, Strand, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 16.

1900.

18658. System of and apparatus for selective electric signalling and operating mechanism at a distance. De Chimkevitch.

19151. Trolley heads for overhead conductors of electric railways. Urquhart and Goodwin.

19223. Electrical ignition devices for explosion engines. Wirt.

19280. Electric arc lamps. Jandus Arc Lamp and Electric Company, Limited, Gorham, and Jones.

19987. Electrical connection or bond for application to railway or tramway rails. Sykes, Johnson, and Cooke.

19988. Insulating rail joint for railways or tramways which offers considerable resistance to currents of electricity. Sykes, Johnson, and Cooke.

21026. Sectional conductor or like systems, and in braking and signalling arrangements for electric railways. British Thomson-Houston Company, Limited. (Potter.)

21399. Variable resistance electric contacts. Sharp.

22599. Manufacture of incandescence borders for electric glow lamps. Just and Falk.

22958. Safety devices applicable to trolley poles and like current collectors for electric railways and tramways. McCullough, Blaney, and Baron.

23310. Electrical accumulators. British Power, Traction, and Lighting Company, Limited, and Gibbs.

23392. Means for preventing fluctuations in rotary motors. British Thomson-Houston Company, Limited. (Hadley.)

23398. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Steinmetz.)

23455. Enclosed spring trolley standards. Lowdon and Balfour.

23549. Telegraphic transmitting apparatus. Maskelyne and Marr.

1901.

7701. Means for controlling the trolley arms of electric tramcars driven from overhead wires. Milloy and International Trolley Controller Company.

10967. Stationary armatures and field magnets for dynamo-electric machines. Feeny. (Allgemeine Elektricitäts-Gesellschaft.)

14049. Trolley heads for electric tramcars. Bale.

16670. Electrical indicators. Manley.

18155. Regulating electric currents and electromagnetic regulators therefor. Otis Elevator Company, Limited. (Otis Elevator Company.)

18814. Electrical actuation of toys. Dunn.

19037. Electromagnetic traction increasing apparatus. Honey.

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TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Oct. 26	630	612	+ 18	17,507	15,721
Birmingham Tramways	,, 26	4,746	4,563	+ 183	194,581	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 25	539	439	+ 100	21,759	19,350*b*
Blackpool Corporation	,, 24	363	314	+ 49	35,134	26,261
Blackpool-Fleetwood Tramways	,, 26	244	218	+ 26	19,413	18,881*b*
Bolton Corporation	,, 27	1,440	1,254	+ 186	62,835	50,937*b*
Bradford Corporation	,, 27	1,090	544	+ 546	38,563	19,071
Bristol Tramways Company	,, 25	3,895	2,973	+ 922	—	—
British Electric Traction—						
Croydon	,, 25	636	249	+ 387	13,424*b*	12,904*a*
Devonport	,, 25	382	—	—	7,256*c*	—
Dudley-Stourbridge	,, 25	700	527	+ 173	28,441*b*	13,149
Gateshead	,, 25	616	—	—	14,383*i*	—
Greenock-Port Glasgow	,, 25	155	—	—	597*e*	—
Hartlepool	,, 25	231	191	+ 40	9,859*b*	8,681
Kidderminster	,, 23	117	88	+ 19	5,373*b*	4,720
Merthyr	,, 25	189	—	—	7,575*f*	—
Oldham-Ashton	,, 25	507	—	+ 494	21,615*b*	18,891
Poole	,, 25	231	—	—	8,714*f*	—
Potteries	,, 25	1,422	1,230	+ 192	60,174*b*	41,825
Southport	,, 25	145	161	- 16	7,231*b*	9,897†
South Staffordshire	,, 25	810	755	+ 55	33,503*b*	31,071*a*
Swansea	,, 25	449	394	+ 53	19,087*b*	14,904
Taunton	,, 25	65	—	—	935*g*	—
Tynemouth	,, 25	210	—	—	9,202*b*	—
Wolverhampton District	,, 25	85	58	+ 27	2,769*b*	2,177
Carlisle Tramways Company	,, 26	148	137	+ 11	3,383*b*	3,298
Central London Railway	,, 26	6,613	6,102	+ 511	100,374	—
City and South London Railway	,, 27	2,183	1,866	+ 317	32,554	26,458
Cork E. T. and L. Company	,, 24	443	413	+ 30	20,169	17,876*b*
Darwen Corporation	,, 25	204	184	+ 20	8,096	6,602
Dover Corporation	—	—	—	—	—	— *b*
Dublin & Lucan Electric Railway	,, 27	89	75	+ 15	2,190	1,883
Dublin U. T., electric cars	,, 28	3,431	3,403	+ 32	—	—
Dublin S. District, Electric	,, 28	758	740	+ 18	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 26	13,097	9,102	+ 2,695	—	—
Halifax Corporation*	,, 27	2,017	1,428	+ 589	35,059	23,525
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 26	1,606	1,330	+ 276	30,221	23,568
Liverpool Corporation	,, 19	9,373	8,319	+ 1,054	378,308	331,738*b*
Liverpool Overhead Railway	,, 27	1,444	1,518	+ 14	27,890	28,894
Portsmouth Corporation	,, 27	793	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 27	2,611	—	—	—	—
Southampton Corporation	,, 24	888	665	+ 223	—	—

a Part. *b* From Jan. 1. *c* From June 21. *d* From April 1 *e* From Oct. 3. *f* From April 5. *g* From Aug. 21. *h* From March 22. *i* From May 8. * Fortnightly. † Reconstructing.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £115 decrease.
Barcelona Ensanche y Gracia, £20 decrease. Barcelona, £187 increase.
Brisbane, £104 increase.
Buenos Ayres and Belgrano Electric, £491 increase.
Calcutta, £134 increase.
Cape Town (month of Sept.), receipts, £12,467; expenditure, £6,373.
La Capital Traction and Electric, Buenos Ayres (month of Sept.), £5,880 ncrease.
Mexico Electric (month of Sept.), receipts, £17,700.
Perth Electric, £127 increase.
Port Elizabeth (month of Sept.), receipts, £2,934; expenditure, £1,746.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	⅜-½
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	7/16-9/16
—— Ordinary, 1-125,000	1	9/16-11/16
British Electric Works, Ordinary, 50,001-95,000	1	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108	85-90
British Insulated Wire, Ord., 1-70,000	5	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5	5½-5⅝
—— 5 per cent. Mortgage Debentures	100	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	4⅝-5¼
Brush Electrical Engineering, Ordinary	2	1¼-1⅝
—— Non. Cum., 6 per cent. Pref.	2	2-2¼
—— 4½ per cent. Debenture Stock	100	102-105
—— 4½ per cent. 2nd Debenture Stock	100	99-102
Callender's Cable, Debentures	100	111-115
—— Ordinary	5	16-17 xd
—— 5 per cent. Pref.	5	5⅜-6¼
Crompton and Co.	3	3-3½
—— 5 per cent. Debentures	—	100-105
Edison and Swan United, Ordinary	3	⅛-¼
—— 5 per cent. Debentures	5	1¼-2½
—— 4 per cent. Deb. Stock, Red.	100	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	—	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2	1⅞-2¼
—— 7 per cent. Cumulative Pref.	2	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	99-102
W. T. Henley's Telegraph Works, Ordinary	5	16-17
—— 4½ per cent. Preference	5	5¼-6
—— 4½ per cent. Debentures	100	112-116
India Rubber, Gutta Percha, and Telegraph Works	10	22-23
—— 4 per cent. Debentures	100	100-103
Parker, Thos., Limited, Ordinary	10	15¼-16½
Telegraph Construction and Maintenance	12	38-42
—— 5 per cent. Bonds	100	104-106
Telegraph Manufactury, Ordinary	5	10¼-11½
—— 5 per cent. Cum. Pref.	5	5⅞-6⅛
Willans and Robinson, Ordinary, 1-30,000	5	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5	6¼-6⅜
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-⅝
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	97-102
Bournemouth and Poole, Ordinary	10	12-13
—— 4½ per cent. Cum. Pref.	10	9¼-10¼
—— Debenture Stock, Red.	100	102-105
Brompton and Kensington, Ordinary	5	7⅞-8¼
—— 7 per cent. Preference	5	8¼-8⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7¼-8¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14¼ xd
—— ,, ,, £10 Ord.	6	10¾ xd
Charing Cross and Strand	5	9-10
—— 4½ per cent. Cum. Pref.	5	5-5⅛
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	104-106
Chelsea Electricity Supply	5	4⅛-5¼
—— 40,501-50,936	5	4¼-5¼
—— 4½ per cent. Debentures	100	109-112
City of London, Ordinary	10	8-9
—— 6 per cent. Cumulative Pref.	10	11¼-12¼
—— 5 per cent. Debenture Stock	100	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	101-104
County of London and Brush Provincial, Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	10	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	104-107
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	5¼-6
—— 6 per cent. Cum. Pref.	5	5¼-6
—— 4½ per cent. First Mort. Deb.	100	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5¼-5⅜
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	11-12
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10¼
London Electric, Ordinary	3	1¼-1⅜
—— 6 per cent. Pref.	5	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190	96-100
Metropolitan, Ordinary	10	13-14
——4½ per cent. First Mortgage Debenture Stock	100	113-116
——3½ per cent. Mortgage Debenture, Red.	100	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9¼
—— Preference	4	6¼-6½
Notting Hill Electric Lighting	10	15½-16½
Oriental, 1879	1	1¼-1⅜
—— £5 Shares	5	7⅜-8¼
—— £4½ Shares, New	4½	7-7½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	99-102
River Plate Electric Light and Traction, Deb.	100	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	2-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2¼-3
St. James's and Pall Mall, Ordinary, 101-20,080	5	15-16
—— 7 per cent. Pref.	5	8¼-9¼
—— 3½ per cent. Deb.	100	97-100
Westminster, Ordinary	5	11-12
Electric Railways.—		
Central London, Ordinary	100	107-110
—— 4 per cent. Pref.	100	105-108
—— ,, ,, deferred	100	105-108
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	113-118
City and South London, Consolidated Ordinary	100	51-54
—— Ordinary	10	5-5¼
—— 4 per cent. Debenture Stock	100	113-118
—— 5 per cent. Pref. Stock '91	100	129-134
—— ,, ,, ,, '96	100	123-127
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7⅜-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5	3⅛-4⅛
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-128
Blackpool and Fleetwood Tramroad	10	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2¼-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-5 xd
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	6-6¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9⅛-9⅜ xd
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	101-103 p.c. xd
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	14-15
—— 6 per cent. Cm. Pf., 30,001-60,000	10	11¾-12¼
—— 5 per cent. Perpetual Debenture Stock	100	121-124
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅝-2⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100	105-108
—— Prov. Cert., all paid	100	100-103
Cape Electric Tramways, Nos. 1-400,000	1	1⅛-2⅛ xd
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	11¼-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	97-100
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Kidderminster and District Lighting and Traction, Pref.	5	3½-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	104-106
New General Traction, Ordinary	5	2¼-3½
—— 6 per cent. Cum. Pref.	10	3¼-4½
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	98-102
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10¾
—— 5 per cent. Cum. Pref.	10	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10	9¼-10¼
—— 4½ per cent. Debenture Stock	100	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	8s.	7/16
—— £50,000 ,, ,,	1	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c.	40 p.c.
Telephones.—		
National Telephone, Ordinary	5	4¼-4½
—— 6 per cent. Cum. First Pref.	10	12-14
—— 6 per cent. Cum. Second Pref.	10	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	4⅜-4⅞
—— 4 per cent. Deb. Stock, Red.	100	96-99
—— 3½ per cent. Deb. Stock, Red.	100	96-99
Oriental Telephone and Electric Company	1	15/16 1 1/16

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NOTES.

Institution of Electrical Engineers. -The annual dinner of the Institution of Electrical Engineers will be held in the Grand Hall of the Hotel Cecil on the evening of Monday, Dec. 9.

Colour of Ions.—Mr. G. Vaillant, as the result of some colorimetric observations with a Ganz spectro-photometer, has discovered that in solutions of the permanganates of potassium, zinc, and barium, the colour is solely dependent on the concentration of the MnO^1_4 ion.

Telephone Charges.—It is of interest at the present time, when waiting for the publication of the General Post Office charges for telephone connection in London, to note the state of affairs in New York. There the fixed rate for unlimited service is dying out, as out of 60,000 subscribers more than 45,000 pay on scale depending on the number of messages sent. Only some 1,200 still pay on the old system of a flat rate independent of the use of the telephone.

American "Transactions." -The *Transactions* of the American Institute of Electrical Engineers for August and September contains the full text of the following papers on electrical matters: "The Electric Transmission of Power from Niagara Falls," by Mr. L. B. Stillwell; "Notes on Modern Electric Railway Practice," by Mr. Albert H. Armstrong; "Electric Railway Apparatus," by Mr. Ernst J. Berg; and "An Improved Apparatus for Arc Light Photometry," by Mr. Charles P. Matthews.

Reduced Telegraph Rates. -The Eastern Extension, Australasia, and China Telegraph Company notifies that by arrangement with the American authorities in the Philippines, the tariff for telegrams exchanged between Europe and the island of Luzon will be reduced on Nov. 15 from 8s. 7d. per word to 5s. 9d. For the other islands the rate will be 6s. 2d. per word. From the same date considerable reductions of tariff will also be brought into force for local international messages transmitted to and from the Philippines.

Continuous-Current Railway in Berlin.—Berlin has just inaugurated a short electric railway on the direct-current system for the carriage of merchandise between the manufacturing districts on the banks of the Oberspree and the goods stations on the trunk line in Rummelsburg and Nieder-Schöneweide. The whole of the electrical equipment of the line was supplied by the Allgemeine Electrizitäts-Gesellschaft. Three-phase current is furnished from the Oberspree works of the Berlin Electricity Supply Company, which is transformed into continuous current for supplying the two locomotives at present operating on the line.

The Electro-Harmonic Ladies' Night.—For Friday next, Nov. 15, a good programme has been arranged for the ladies' night of the Electro-Harmonic Society. The concert will be held in the banqueting hall of St. James's Hall Restaurant, Regent-street, W., commencing at eight o'clock precisely. The following artistes will contribute to the programme: vocalists, Miss Jessie Stewart, Miss Florence Hoole, and Mr. Frederick Ranalow; solo flautist, Mr. Albert Fransella; silver bells, Mr. Harry Tipper; humorous recitations, Mr. Arthur Helmore; humorous sketches, Mr. Harrison Hill; and Mr. Alfred E. Izard will preside at the piano.

British Exhibition at St. Petersburg.—An exhibition exclusively confined to the produce and manufactures of the British Empire will be held during June, July, and August, 1902, in the Tauride Palace, St. Petersburg, which has been lent for that purpose by the Empress. It was originally intended to hold the exhibition during the forthcoming winter, but owing to the large offers of heavy machinery, which was unsuitable for the interior of the palace, it has been found necessary to erect annexes in the adjoining grounds. Committees have been formed in London and St. Petersburg. Mr. George Collins Levey, C.M.G., has been appointed British commissioner, and all particulars can be obtained by applying to the offices, 22, Conduit-street, W.

An Electrical Inhaler.—An evaporating and inhaling apparatus in which the source of heat is a small electric lamp, is the invention of Mr. K. Schall, of London. From the patient's point of view its chief attraction is the fact that he can inhale the vapour while lying in bed without fear or risk of fire. The drug is dropped on wadding contained in the upper part of the inhaler, which is then connected with a source of electric current, such as a wall-plug or lampholder, or an accumulator if electricity is not laid on to the house. When the lamp is alight, the patient may begin to inhale. The apparatus in its ordinary form is designed for a pressure of 110 volts. The vapour employed can be inhaled through either the mouth or the nose with the help of the indiarubber nozzles sent with the apparatus, or it can be blown into the ear by means of a double bellows.

Armorl Electrical Wonders.—The gentlemen or syndicate responsible for the so-called Armorl system continue to invite the representatives of the untechnical Press to witness experiments which those representatives are quite unable to understand or to describe. We presume, however, that the entertainment offered on these visits must be good from the disjointed accounts of what has been seen which are given by those present. We have a notice before us which occupies 1¼ columns of a well-known London daily paper. Out of that column we can only find about 10 lines to describe what the correspondent actually saw accomplished. The rest of the description contains a number of predictions made by the inventors as to what they will be able to do. While we wish these inventors every success in their endeavours, we should think more of their chances if they did not boom on prophecy rather than on accomplishment.

Italy.—Advices from Monaco state that an experiment is to be made with a service of electric motorcars on the old Corniche road from Nice to the Convent of Laghet. The cars will collect current from overhead wires. The feature of the proposed system is that no running rails will be used, and the advantage anticipated from this fact is that the cars will be able to pass vehicles on the road and round corners and bends in the road without difficulty, the connecting wire being sufficiently long to allow of such deviations. We presume that some such system is to be used as that described at the Bradford meeting of the British Association by Mr. J. G. W. Aldridge, by which a motor trolley runs on two overhead conductors. It will be remembered that the speed of the trolley was made to equal approximately that of the car by driving the trolley by a three-phase motor supply from tappings on the armature of the motor on the car.

American Submarine Launched.—At Elizabethport, N.J., on Oct. 19, the submarine boat "Shark" was successfully launched at the Crescent Shipyards. The vessel is one of five torpedo boats built by Lewis Nixon for the United States Government. The ones already launched are the "Adder," "Porpoise," and "Moccassin." She is 63ft. 4in. in length and 11ft. 9in. beam. The displacement submerged is 120 tons. She has a 160-h.p.

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gasoline engine for surface running and a 70-h.p. electric motor for driving her under water with storage batteries. She is expected to make a speed of eight knots an hour on the surface and seven knots when submerged. She is armed with five Whitehead torpedoes. The only exposed part of the boat when not submerged is the conning tower, which is made of Harveyised steel 24in. in diameter and 4in. thick. We are indebted to the *Electrical World* for the above details of this new submarine.

Trolley Wire Earthing Device.—We learn that Mr. E. M. Hollingsworth, deputy electrical engineer at St. Helens, has patented an emergency earthing device for trolley wires. It is brought into use by the simple process of smashing a small glass disc, as in a fire-alarm, which at once "earths" the whole section on which it is fixed. This brings the circuit breakers at the power station into instant use, and renders every wire on the section dead. The device consists of a switch, which works automatically immediately the glass is broken. It is fixed on a street standard or in any position adjacent to any point which, by reason of the large number of wires or awkward crossings, is more than usually dangerous, and when anything goes wrong can be immediately brought into use by the police or residents of the locality. The device has been tried with success on the town end of the Prescot section at St. Helens, and the section from Croppers-hill to Westfield-street, Bridge-street, and Liverpool-road was "cut out" by the glass of the switch at The Black Bull being broken.

Electromotive Efficiency of Elementary Gases. Some observations relative to a new electrode sensitive to light were recently made by Messrs. Emil Bose and Hans Kochan, who have now published their conclusions. In the experiments a cell with gold electrodes and sulphuric acid as electrolyte was polarised for 17 days. During the process the cathode became coated with a brownish deposit like finely divided gold, whilst on the anode an orange-coloured skin appeared, gradually becoming more powdery and falling to the bottom of the vessel. When the cell was left to itself it was found that the E.M.F. showed remarkable periodic variations, being higher in the dark than in the light, and when it was kept entirely in the dark the variations ceased. Experiments with an arc lamp showed that the oxygen electrode was the sensitive one. Daylight, electric light, magnesium light, and the light from an incandescent gas lamp all lower the oxidation potential at the anode; violet light has the same effect, but red light raises the potential; sodium light has practically no effect. The E.M.F. varies to the extent of 0·1 volt, according to the nature of the light.

Balancing of Locomotives.—At the Institution of Mechanical Engineers on Friday next, 15th inst., a paper will be read by Prof. W. E. Dalby on the "Balancing of Locomotives." The syllabus issued by the institution shows that the object of paper is to explain and illustrate a new method of finding the balance weights for locomotives, the advantage of the method being that it is much simpler than that generally in use, and that it is self-checking for symmetrical engines. The dynamical principle on which the method is based is explained, and its application to various types of engines. The effect of balance weights with regard to slipping is also discussed. A good example of a Lancashire and Yorkshire passenger engine, running at 65 miles per hour, is given, with diagrams showing the modification of permissible turning effort on the crank axle, caused by the balance weights, and showing incidentally many other points of interest. The latter part of the paper deals with American principles of balancing. The whole subject is one which is of great interest to electrical engineers, owing to its intimate connection with high-speed engine balancing.

Australian Postal Bill.—The Federal Bill relating to the postal and telegraphic services of the Commonwealth repeals and consolidates the whole of the existing Postal, Telegraph, and Telephone Acts, 21 in number, of the Colonies of New South Wales, Victoria, Queensland, South Australia, Western Australia, and Tasmania. The Bill gives the Postmaster-General the exclusive privilege of erecting and maintaining telegraph and telephone lines, with the proviso that the railway authorities of each State shall have authority to erect and maintain lines within the railway boundaries. Without the authority of the Postmaster-General these lines must not be used by the public. Authority may be granted for private lines subject to a clause empowering the Postmaster-General to resume possession without compensation for non-compliance with the rules and regulations laid down. The Postmaster-General may contract with other persons to erect and maintain lines. There is the usual saving clause with regard to the construction of electric works of any kind whereby the telegraph line of the Postmaster-General may be injuriously affected. All railways and tramways may be required to carry mails, payment for which if not agreed upon on is to be settled by arbitration.

Radio-Activity of Salts of Radium.—The current number of the *Journal* of the Chemical Society gives a short abstract of a paper by Messrs. P. Curie and A. Debierne, recently published on the Continent, with regard to this subject. It appears that radio-activity may be communicated to distilled water by (1) distillation of a solution of radium chloride which has been allowed to stand several days; (2) placing a solution of a radium salt and distilled water in separate dishes in a perfectly closed space; (3) immersing in distilled water a celluloid capsule containing a solution of a radium salt. Such water may exhibit greater radio-activity than the substance from which it was prepared, but loses its power rapidly in an open vessel, and in the space of a few days if the vessel is kept closed. A solution of a radium salt also soon loses its activity in the open air, but regains it if transferred to a sealed tube. The author therefore considers that the radio-active energy may be transmitted by radiation, and also by a kind of conduction, whereby it passes from place to place by means of a gas or liquid, but not ordinarily through solids. A solution of a radium salt is hence in a state of equilibrium, and in a sealed tube, the loss of activity by radiation being slight, the value of the activity is high, but in an open vessel, the loss by conduction being considerable, the activity is very feeble.

Load Factors.—At a meeting of Glasgow Technical College Scientific Society on the 2nd inst. a paper was read by Mr. J. Gray Scott, A.I.E.E., burgh electrical engineer, Leith, on "Electricity Works Load Factors." Mr. Scott explained his meaning of the term load factor, its importance in the generation of electricity, and the various uses to which it might be applied, and described the maximum-demand system of charging which is based on this principle, and also referred to the various other systems of charging which are in vogue in other towns. He maintained that where the maximum-demand system is in use it should be employed throughout, and deprecated the introduction of alternative systems of charging, and further urged that where employed the maximum and minimum charges should be adjusted to correspond respectively with the capital and running costs of the undertaking. Referring to the undertaking of the Leith Corporation, the lecturer showed by a number of charts the progress made and the influence of the load factor on the working costs of the undertaking.

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The system of charging in use at Leith, he said, was the flat-rate system, and though no system was perfect, that one had a number of advantages. Thereafter he treated load factors accruing to the various classes of consumers, and pointed out the advantage to an electricity works of a tramway supply. The load factor of an electric tramway would be about 60 per cent., and would, of course, increase the load factor of the whole system.

Wireless Telegraphy.—While in nearly every paper we see notices of the successes of wireless telegraphy at sea, it is well sometimes to look more deeply into the matter, and to remember that the successful cases referred to are in every instance accomplished in situations where there are only two sets of apparatus at work. In the reporting of the yacht races in America, where there were three sets of signalling and receiving stations, the results were not all that could be wished. On this point the editors of our contemporary, the *Electrical World*, write in their issue of Oct. 26 as follows: "We cannot refrain from directing attention to correspondence in this issue on the timely topic of wireless telegraphy at the recent international yacht races. The brief report which we made of the mingled success and failure of the system seems to have given umbrage in some quarters. While we cannot change the fact and record a complete success, we regard the work done as encouraging. The fact remains, however, that the moment interference of rival signalling was set up, nothing could be done. This was true of the attempts at the races two years ago, and would imply that selective wireless telegraphy is still a thing of the future. Evidently, it was not feasible to send two messages at once, and it was evidently not less foolish to repeat the same news a minute after it had already gone in over some other etheric service. In brief, etheric telegraphy stands to-day a worse 'monopoly' than anything else in the electric line, for whoever 'does the trick' must have sole use of air, earth, and sea." The letter in question really bears out the editor's statements.

Electrical Canal Lift.—A very interesting feature of the Dortmund and Ems Canal, which is destined eventually to connect the River Rhine with the Elbe, is the electrical canal lift near Henrichenburg. The structure is intended to overcome an average fall of 46ft. between the Dortmund reach and the main reach, and can be used by 950-ton barges 220ft. long, 27ft. beam, and 6ft. 7in. draught. The electrical power for the various movements of the lift is obtained from motors attached to the lift gear. These motors are supplied by two dynamos, driven by steam-engines of 220 h.p. each. Either one of these dynamos, however, will furnish the required energy for the motors, the other being kept in reserve in case of one breaking down. The voltage used is 220, and a current of 800 amperes is required to start the machinery. The Henrichenburg lift is practically a new departure in canal lifts, in that all such structures which have hitherto been constructed have only been able to accommodate vessels of much smaller dimensions. The operation of raising a barge from the lower to the upper reach on the Dortmund and Ems Canal is described as follows: The barge to be raised is brought into its proper position, and the gates at the corresponding shore end and at the end of the trough are coupled together and raised by a capstan, worked by a rack and pinion, the weight of the gates being balanced by suitable counter-weights. The barge then enters the trough, and the gates are lowered again, and uncoupled. If required, the water in the trough is lowered to its proper level by letting off a portion. The trough rises, and is stopped opposite the gate of the upper reach; the gates are then coupled together, and raised, and the barge enters the upper reach.

Induction Motors.—Prof. William Hand Browne, jun., of the University of Illinois, delivered a lecture before the Chicago Electrical Association on the evening of Oct. 18 on the induction motor. In introducing the subject, Prof. Browne said that the induction motor combined the features of static transformers and shunt motors. He then gave a brief elementary review of the fundamental magnetic principles of the induction motor. Some of the early forms of the induction motor having solid iron armatures were described. The methods of starting by the use of an auto-converter and by the use of resistance in the circuit of the armature or rotor were discussed, and it was explained why such large quantities of current are taken by the auto-converter method at starting, and also why the method of introducing resistance in the armature circuit requires much less starting current. In the latter case the torque is larger in proportion to the current flowing, and the total current is also less. Diagrams of the connections of most of the single-phase induction motors that have been actually in use were given with special reference to the Wagner single-phase type. The greatest mechanical objection to induction motors Mr. Browne considered to be the fact that in order to make the power factor low the clearance between the rotor and stator must be very small, so that very little bearing wear is allowable. If the clearance is increased, the power factor is necessarily lowered very perceptibly. In general, the induction motor was said to be suited to all places where the direct-current shunt motor would be used. In places where direct-current series motors are used the induction motor is not by any means as suitable in its present development, because the induction motor is essentially a constant-speed motor. The above report from the *Electrical World* endorses the evidence given in the Underground Railway arbitration on behalf of the District Railway Company.

Electric Railway Signals.—Electricity came into use as a signalling agent shortly after railways were introduced, and it is an absolute certainty that the present speeds which can be attained with regularity on our railways would be utterly impossible were it not for telegraphy. The next use which electricity has been to the railway engineer is for assuring the safety of the trains by means of contacts on the signals, which keep the signalmen always informed as to the position of the signals under his charge. Thus while the railway engineer always endeavours to get a clear view of all signals controlled by a signal box from within the box itself, this is not always possible. It is advantageous even in clear weather, and with signals in view of the operator, to have the movements of the signal arms reproduced inside the cabin. It would seem, however, that this is comparatively a small application of electricity for signalling to what is to be the universal practice in the near future, when electricity will be used to operate all the points and all the signals. A large number of signalling experts are at work on this problem. Thus in England an extensive system of electrically controlled signals and points has been installed at Crewe by the engineer of the London and North-Western Company. We also learn that Mr. Sykes, of the W. R. Sykes Interlocking Signal Company, has a system worked out for trial. The use of electric motors for these purposes has also been successfully installed on certain lines on the Continent and in the States. The advantages of electricity for moving signals and points are exceedingly numerous. Of course the labour which in an ordinary signal cabin is required for the operators is greatly reduced, as instead of having to move by hand labour the points, signals, and heavy connecting gears, the signalman has only to operate an

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electric switch. The reduction of physical fatigue tends to keep the men more fresh, and hence less likely to make blunders which are likely to result in loss of life. Another advantage is that the whole of the controlling gear can be collected together into a small space, so as to be more easily supervised by the operators. Again, the effects of changes of temperature, which play so important a part in the difficulties of the mechanical system, entirely disappear. Last, but by no means least, we would refer to the great advantages which an electrical system offers with regard to interlocking. The cumbersome system of levers and locking bars can be easily replaced by a simple system of electrical contacts, which affect a lock where desired by interrupting all current to the circuit to the points or signals which must not be moved.

Electrolysis of Molten Lead Iodide.—Mr. Gustav Auerbach recently published the results of some experiments conducted by him concerning the electrolysis of molten lead iodide and lead chloride, with particular reference to the application of Faraday's law and the theory of the electrolysis of molten salts. A short account of the experiments is given in the current number of the *Journal* of the Chemical Society, from which it seems that fused lead iodide at temperatures varying from 440deg. to 800deg. was electrolysed by a current of 24 volts and one to two amperes. The amount of lead separated at the lowest temperature was only about 90 per cent. of that which the current should form, and varied greatly in different experiments. As the temperature rises the yield becomes smaller. Faraday assumed that during the course of the electrolysis lead tetraiodide (PbI_4) was formed, but the author finds no evidence in favour of this view. In the electrolysis of lead chloride also the quantity of lead separated falls short of the possible amount. Determination of the quantity of chlorine formed proves conclusively that the carbon electrodes (and to a slight extent the undecomposed salt) absorb chlorine, and consequently the evolution of chlorine depends on the duration of the electrolysis. After the process has gone on for some time, and the carbon has become saturated, the quantity of chlorine liberated is nearly exactly (above 99 per cent.) equal to the amount required by Faraday's law. This is the first time that Faraday's law has been proved for the anode in the case of a molten salt. Lorenz (*Zeit. anorg. Chem*, 1900, 23, 97) has suggested that the formula $a = 100 \cdot \epsilon'/\epsilon$ represents the yield of the current (a), where ϵ is the polarisation of the molten salt, and ϵ' the depolarised value of the same. During the above experiments the polarisation was also determined, and it has been found that Lorenz's formula, although not rigorously exact, gives approximate values. When the lead chloride is mixed with lead oxide, the yield is precisely the same as when fused lead chloride alone is used, but no chlorine or oxygen is evolved. During the electrolysis a metallic "cloud" is given off from the cathode, and spreads through the fused mass. As it comes near the anode it combines with the free chlorine there, and in this way gives rise to the irregularities in the amount of metal deposited, since the amount dissipated as "cloud" must vary greatly, with slight modifications of external circumstances. The "cloud" was examined by Tyndall's method, and it was proved that it is not formed of solid particles, but is a true solution of the metal in the fused salt, which fact is confirmed by the circumstance that metallic cadmium may be crystallised from its fused chloride.

Ventilation of the "Tube."—In his presidential address to the annual meeting of the Incorporated Society of Medical Officers of Health last month, Mr. A. Wynter-Blyth, M.R.C.S. (Eng.), took up the subject of mechanical ventilation, and incidentally gave the results of some observations he had made on the ventilation of the Central London Railway. He found, for instance, that the upward and downward velocities of air varied with the position of the trains; the latter current was slower than the former, and was generally under four miles an hour, while the former, on one occasion, when two trains were entering the station almost simultaneously, reached a velocity of 7·4 miles per hour. The maximum velocity in the middle of the platform due to an approaching train was found to be 5·79 miles per hour. The temperature outside the "Tube" for the time of year was low—56deg. F.; the temperature of the air within was 67deg. This difference of temperature was due to several causes—to the temperature of the earth-crust retaining the summer heat; to the animal temperature imparted by the thousands of persons, each at 98deg., going backwards and forwards; while some portion may be due to the dynamical heating of the air. The amount of carbon dioxide at Bond-street Station was 10·3 parts per 10,000, while on the stairs leading from the station it was a point or two less according to whether the draught was up or down. This, says the author, compares favourably with a sample of air taken in the tunnel between Gower-street and King's Cross Stations on the Metropolitan Railway, which has 25·9 parts of carbonic dioxide. In the tube between stations the amount rose to 11·9. At Notting Hill-gate Station the tubes are not parallel, but one crosses the other, and it was discovered that while there were 10·7 parts in the upper station, there were only 6·9 parts in the sub-station. The reason for this is that instead of depending upon the movement of the trains to effect ventilation, the air is renewed here by means of a powerful fan. The air supply circulates from the surface of the ground into a circular chamber deep down below the lifts and up again by means of downcast and upcast flues. The air rushes down at a velocity of 9·7 miles an hour, giving an hourly air supply of no less than 855,000 cubic feet. The author's conclusion from the research is that where the ventilation depends entirely on the passage of the trains, although there is so much movement of air, so much sucking in from above and blowing out from below, a good portion of the air must be driven backwards and forwards unchanged in the tubes—in other words, the tunnel is diluted, but the whole of it is never swept out, whereas with the assistance of a fan the ventilation is extremely good. In the current number of the *Lancet*, the editor in a leading article supports Mr Wynter-Blyth's views on the ventilation of the "Twopenny Tube." He urges that as time goes on, unless additional and more effective ventilation by fans be adopted, the condition of the tunnel will go from bad to worse. At the present time the impure air has to find its own outlet, which is confined to the stairs of the various stations along the tube, and, as Mr. Blyth shows, it is only common sense that at these places it is met by the incoming current of air, and part of it is forced back into the tube. For ourselves, we believe that the only practical solution of the difficulty will be to introduce a system of ingress and egress shafts for the air at every station, and to pump the air into the tube, and not rely solely on the passage of the trains for ventilation.

Liverpool Heavy Motor Vehicle Trials.—The first meeting this session of the Liverpool Self-Propelled Traffic Association was held recently to receive reports on the trials made this year by the association in heavy vehicles. Mr. W. H. Long, M.P., was present. After introductory remarks by the chairman, Prof. Hele-Shaw said the judges had now the honour to present their report upon the third

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series of heavy motor trials instituted by the association, and in doing so took the opportunity of pointing out the very rapid progress which had been made in the development of heavy motors since the Act of 1896 made such motors legal. It was not in any striking invention of a novel character, but rather in numerous mechanical improvements, in the employment of the most suitable materials, skilful design, and admirable workmanship, that such rapid progress had been made in solving one of the most difficult of mechanical problems. On the one hand, the many tables of results of fuel and water consumption which had been most carefully and elaborately taken by numerous skilled observers showed how the average efficiency in actual work had been gradually raised, while a careful examination of all the working parts—for which wheels, bearings, gearing, boilers, and motors were opened out and stripped for the inspection of the judges at the end of the trials—proved conclusively that the great difficulty of effectively meeting wear and tear, and so making the heavy motor vehicle a commercial success, has been satisfactorily overcome. The special feature of the trials were the automatic records taken by Mr. Fowler, and plotted in curves, of the starting and stopping of the vehicles in the hill-climbing trials. The judges were convinced that the limit of mechanical skill had now been nearly reached, with the result that only one of the 10 heavy vehicles entered for the competition was actually within the legal limit, and that the total loads which could possibly be carried upon these vehicles, so skilfully and carefully constructed, did not bring the total weight of the vehicle and load to much more than half the loads that were frequently carried upon the lorries in this district. Even under these circumstances there was a highly profitable field for their use, but in winter or wet weather the load of five tons must be reduced, and the margin of profit seriously decreased. The judges felt that it could not be too strongly understood that the restriction in tare had the extraordinary result of preventing the makers using wheels of a wider tyre than 4in. Four inches was the legal width which they were compelled to adopt, but they would gladly use 6in. wheels, and thereby secure a very much better action upon the roads were it not for the fact that this would materially encroach the tare margin, which they are already obliged to exceed. The judges had set forth in their conclusions a formidable array of reasons for the increase of the tare limit, amongst these reasons being the practice of foreign countries which had no such restrictions, the injury to a promising British industry, and consequent hindrance of improved means of internal communication, and other reasons. The judges felt convinced from their experience that no injury whatever would result to the roads of the country by allowing vehicles to be built of a more reasonable weight, and the judges and their numerous assistants and observers—more than 40 in number—to whom they were so much indebted, would feel repaid if their labours contributed in any way towards removing restrictions to the advancement of such an important matter as mechanical road locomotion and self-propelled traffic. Mr. W. H. Long, M.P., in the course of an interesting speech hinted that there was every chance of the objectionable weight limit being altered.

Magnetic Tests of Iron.—The following abstract from the *Electrical World* of an article by Messrs. Gumlich and Schmidt in the *Elektrotechnische Zeitschrift* is of great interest. The article in question is a long account with tables and diagrams of an extended series of magnetic tests, made in the German Reichsanstalt, of different kinds of iron. They first investigated the influence of annealing upon the magnetic properties. The maximum temperature was 950deg., the time of heating and cooling three days. The magnetic properties of soft wrought iron are not changed greatly by annealing. The magnetic properties of cast iron are improved by the first annealing, while repeated annealing seems to deteriorate them again slightly. By the first annealing, the coercive force—*i.e.*, half the width of the hysteresis loop on the X axis—is reduced to one-third, the hysteresis loss to less than one-half, the remanence—*i.e.*, half the height of the hysteresis loop on the Y axis—increases by 10 per cent. The results of annealing upon the magnetic properties of cast steel depend largely upon the individual constitution of the material. In general, annealing gives good results. While the values of the remanence vary in an irregular manner, sometimes increasing and sometimes decreasing, the coercive force diminishes and the maximum permeability increases, both values reaching a limit after the second or third process of annealing. The hysteresis loop also decreases with repeated annealing, and is reduced to one-half with some materials. Other results were obtained with dynamo sheet iron for armatures which has been generally annealed before. Two kinds were tested; both were improved in all their magnetic properties by the first process of annealing, while the second process deteriorated these properties again. This deterioration was found to be due not to the formation of an oxide layer on the surface, but to molecular changes. Such sheets for dynamo armatures were found to be very sensitive against mechanical treatment, as grinding or rubbing, so that the authors doubt whether the magnetic properties determined by tests of the sheets before they are made up in the armature, are still valid afterwards in the armature. Solid iron rods were not sensible to mechanical treatment. They investigated whether the process of annealing is best done with the iron sample in iron filings, sand, or charcoal, or in air. Great differences were not found, but the cover of sand was found impractical on account of the formation of clinker. The cover of iron filings seems to give the best results. They further investigated the influence of the process of annealing upon the electric conductivity. As the eddy-current loss increases with the conductivity, the best iron would be that which has a minimum hysteresis loss and a maximum electric resistance. It was found that in general annealing increases the conductivity, but not to such a degree that this disadvantage would balance the advantage due to the improvement of the magnetic properties. By comparison of a great many tests, it was found that in general the greater the hysteresis loss the greater the electric resistance, the greater the remanence the greater the coercive force and the smaller the maximum permeability. But this rule holds good only in general, while several materials greatly differed from this rule. One special material which compared with the other materials tested had relatively very good magnetic properties, and was found to have an electric resistance of about three times the average resistance of all other samples. The chemical constitution of this material is not given, as it was communicated confidently to the Reichsanstalt. But this shows that it is possible to obtain iron with very good magnetic properties and at the same high electric resistance. Further experiments of the authors deal with the determination of the coercive force and with the maximum permeability. They found the following empirical formula for all values in C.G.S. units. The maximum permeability is equal to the ratio of remanence and coercive force, multiplied with a factor which is in general a linear function of the coercive force, but is approximately 0·5 for soft iron and cast iron.

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SOME UP-TO-DATE TRANSFORMERS.

BY W. E. WARRILOW.

(*Concluded from page 627.*)

A firm of comparatively recent date who construct transformers is the British Electric Transformer Manufacturing Company. This company own the Berry patents, and a group of their converters is shown in Fig. 19. It will be seen that they differ from those previously described in that they are circular in construction. It is claimed that with this design the maximum of radiating surface with the minimum of iron loss are obtained, while the best possible protection to the windings is also afforded. A

FIG. 19.—Group of Berry Transformers.

glance at Fig. 20 will show that these claims are well realised in actual practice. The centre of the transformer is occupied by a portion of the core consisting of straight stampings. Over these the primary and secondary windings are placed, and the ends of the core are arranged to take other stampings, which radiate from the common core centre to bundles of core plates, which run parallel to the centre core. These, with the upper and lower radial stampings,

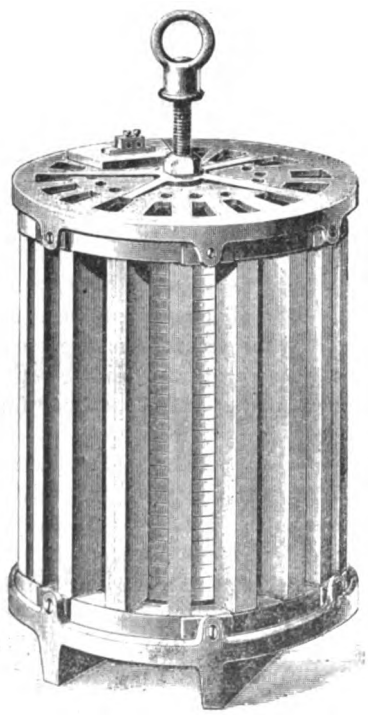

FIG. 20.—A Berry Transformer.

complete the magnetic circuit. A noticeable feature is that the core plates are not subjected to any bending during the process, a circumstance which will assure the molecular formation of the iron remaining unchanged. The subdivision of the core forms a number of triangular spaces all round the transformer, and extending from end to end. A series of ventilating channels are thus formed through which the air continually circulates. The windings are protected from mechanical damage by the arrangement of the core plates as well as being provided with ample surface for the radiation of whatever heat may be formed. The coils form three concentric cylinders, the

FIG. 21.—40-kw. Transformer ready for Street Tank.

primary being placed between two secondaries, an arrangement ensuring not only great safety, but freedom from magnetic leakage. A 40-kw. transformer ready for lowering into its street tank may be seen in Fig. 21, when it will be noticed that the cables are brought through porcelain bushes in the case, and fitted with thimbles for insertion in the various terminals provided in the tank, and a Cardew earthing device is mounted on the top of the cover. The appearance of the top of the tank can be gathered from Fig. 22. The projecting chamber at the side of the tank provides for the high and low pressure terminals, while the high-tension fuses are in a separate

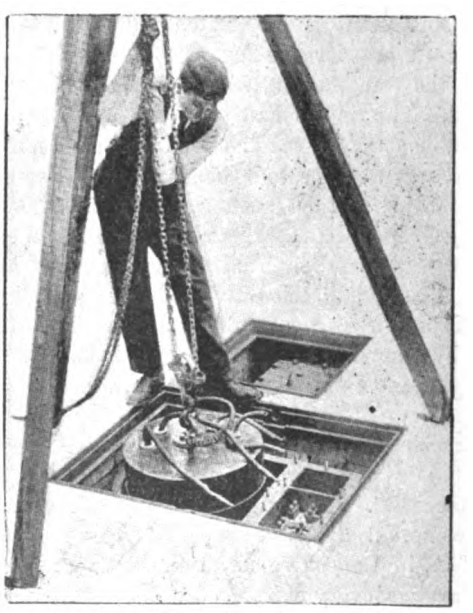

FIG. 22.—Lowering a Berry Transformer in a Street Box.

box. A transformer being lowered into its tank is shown by the illustration, and the different terminal boxes can be plainly seen. This view illustrates the complete transforming station under the pathway. The box on the far side of the pit contains the high-tension fuses, the arrangement of which can be better understood by reference to Fig. 23. The fuse is made up by a number of fine copper strands laid between strips

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of micanite cemented up with shellac. The whole is placed in the hollow of a "D" shaped porcelain tube, the curved side of which, when in position, is uppermost. In the box on the right of the illustration will be seen the terminals into which the fuse contacts drop, the terminal proper being recessed deeply into insulating material to obviate the possibility of anyone coming in contact accidentally with charged metal. The bottom of the box is covered with sheet micanite, while the sides are protected with marble slabs, so that the fuse is entirely surrounded with insulating material. Fig. 24 is a photograph of a 250-kw. converter for working on an 11,000-volt circuit, and the size of the transformer can be gathered from a comparison between its height and that of the man standing by it. A number of these converters have been supplied to the Metropolitan Electric Supply Company quite recently, and they may be taken as typical examples of high-voltage supply.

The transformers of Messrs. Ferranti, Limited, are of special interest, by reason of the reputation the firm have

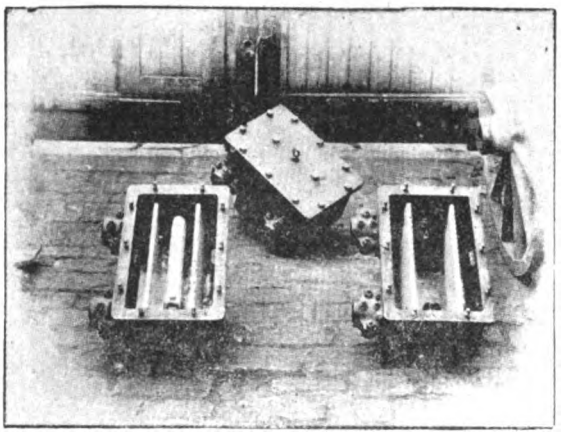

FIG. 23.—High-Tension Fuse Gear.

gained as old-established manufacturers of electrical apparatus. The Ferranti transformer was among the first made, and it has been considerably improved since its introduction. The core is of the U-type, constructed with open

FIG. 24.—250-kw. 11,000-volt Transformer, made by the British Electric Transformer Company.

ends, over which the coils, previously wound on a former, are slipped. Good insulation is provided between core and windings, and between primary and secondary coils, special attention being given to the high-pressure winding to avoid breakdown. When the coils are in position the open ends of the core stampings are bent down to form a continuous magnetic circuit, the joints in the plates overlapping. The whole is then clamped between two plates by the core bolts, and on the upper plate, which forms a suspension plate, the high and low pressure terminals are mounted. A feature of the design of this transformer is its flexibility—*i.e.*, its

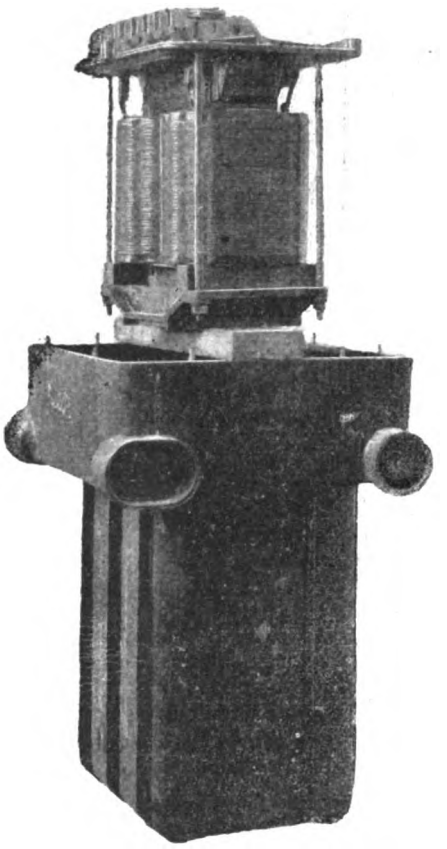

FIG. 25.—A Ferranti Transformer with Street Box.

adaptability to particular circumstances without alteration to core or windings. It can be placed in a street tank, sub-station case, or central-station cover by an interchange of suspension plates, but without any interference with the core or coils In Fig. 25 the converter can be seen ready for lowering into a street tank, and the general appearance of the transformer can be gathered from the illustration. The upper or suspension plate is fitted on one side with low-pressure contacts for plugging on to four concentric cables through switch fuses, and on the other with terminals for connection to

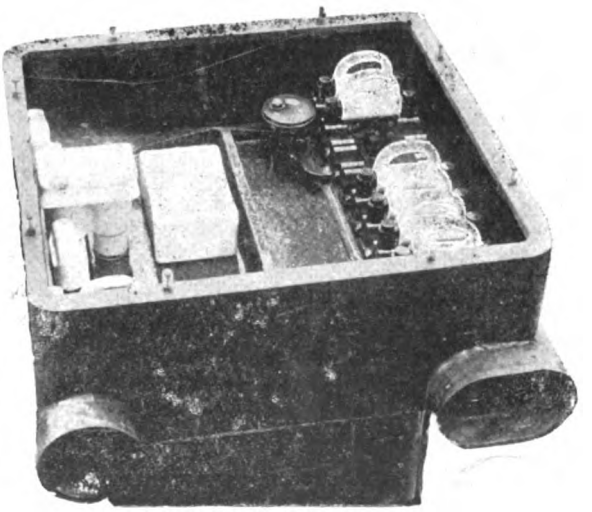

FIG. 26.—Plug Box for Bridging Connections when Removing Transformer.

the primary cables through an oil-break fuse on the inner, and a solid plug on the outer of the conductors. The above contacts are practically part of the transformer. In the sides of the tank are fitted similar contacts, arranged to come in line with those on the transformer when it is lowered into its place. By this arrangement it is possible

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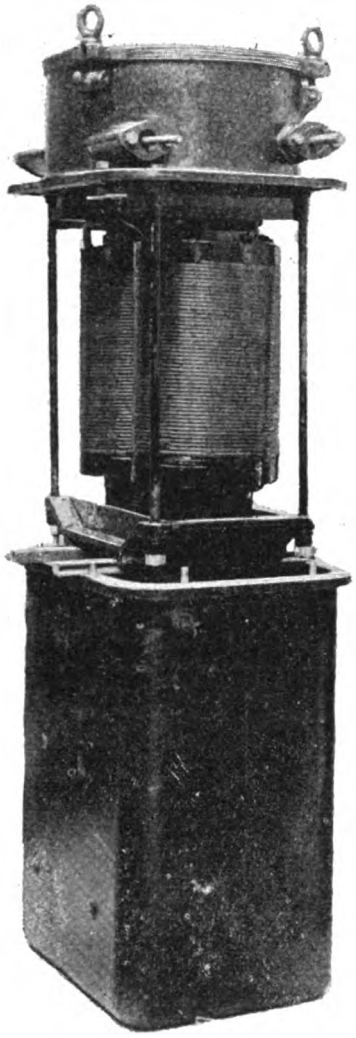

FIG. 27.—Ferranti Transformer with Terminal Chamber on top.

to remove a converter without disturbing in any way the cables entering the tank. In the case of the primary main, short-circuiting plugs are provided, which will maintain the continuity of the cable even though the transformer be removed. The appearance of the tank with plugs, etc., in position, can be gathered from Fig. 26. On the left of the tank are the high-pressure terminals, plugs, and oil-break fuse, while on the opposite side, and therefore quite distinct, are the low-pressure switch fuses and earthing device. A porcelain tray for the reception of calcium chloride to absorb moisture occupies the left centre of the hanging plate. The primary terminals and all charged metal, even to the smallest screws, are carefully covered so as to be out of reach of accidental contact, and similar precautions are taken to prevent short-circuits between

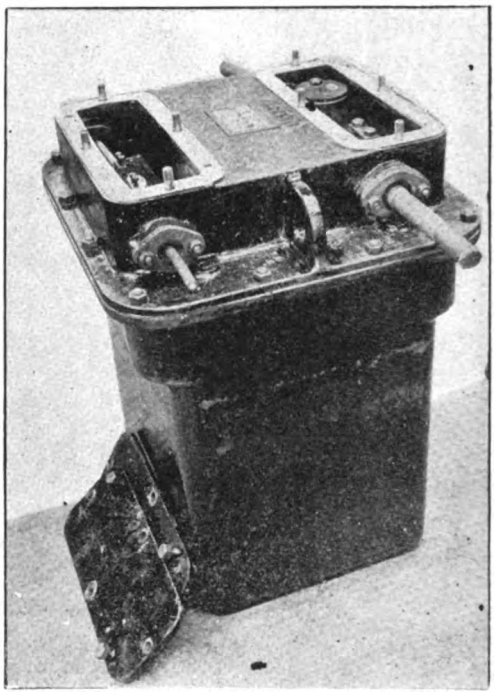

FIG. 28.—Sub-Station Transformer.

conductors entering the transformer. The tank, which is buried below the pavement, will accommodate converters up to 50 kw., and a road-frame with suitable covers is built in the pit during construction.

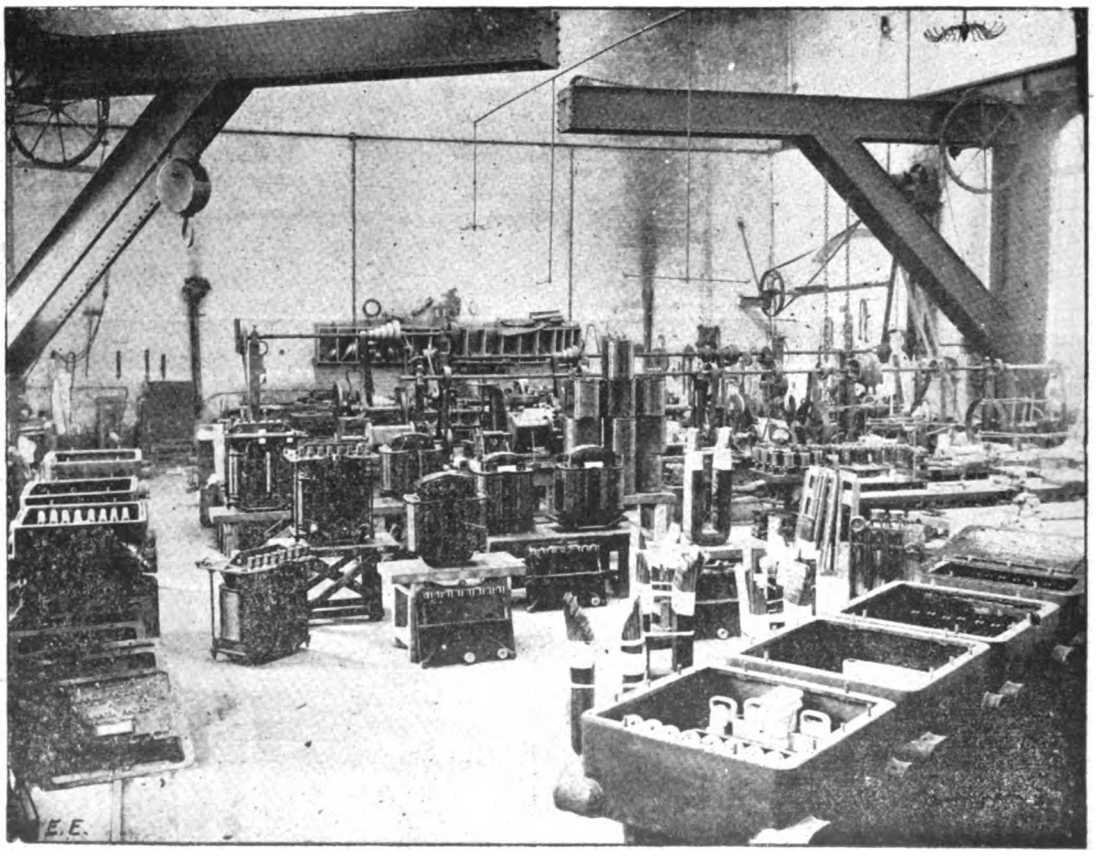

FIG. 29.—View of the Transformer Shop at Messrs. Ferranti's Works.

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In Fig. 27 is shown a transformer placed over a sub-station case, fitted with terminal chamber at the top. The latter is in one piece with the hanging plate, and space is provided for the insertion of a fuse and plugs if required, though it is usual in sub-stations to have the switching arrangements separate from the transformers. A circular lid screwed down with eye bolts on to a rubber insertion completes the arrangement. In the case of central-station or warm sub-stations, the transformers are assumed to be in a dry atmosphere so that the precautions against damp are not needed, it being only necessary to protect the windings from mechanical injury. This is effected by placing round the converter an expanded metal covering, and fitting the terminals in wells on either side of the base-plate. Primary and secondary are arranged on opposite sides for distinction, and the cable ends are sealed to exclude moisture from the insulation by filling the contact wells with compound. A Cardew earthing device is arranged on the secondary side. The adaptability of Messrs. Ferranti's design is well illustrated by Fig. 28, which shows an arrangement for a sub-station transformer where vertical space was limited. The primary and secondary cables, kept distinct as before, are mounted in the upper part of the case, and they are rendered accessible by oblong covers bolting down on to a rubber insertion. An earthing device is also provided for on the secondary terminals. It will be noticed that the joint between the tank and upper cover is improved, in that the entire weight of the transformer and terminal case is supported on the upper face of the tank. Some idea of the amount of work done by Messrs. Ferranti can be gathered from a glance at Fig. 29, which illustrates the winding shop at Hollinwood, and it will be seen by the number of converters in various stages of construction that the efforts of the firm are well appreciated in this direction.

In conclusion, it may be said that a great change has come over the general design of transformers—a change for the better by reason of the experience gained. Almost voluminous information is now obtainable relating to transformer practice, and the results obtained are worthy in every way of the efforts expended. Experience is a hard teacher, and deals some crushing blows at times, but they prove none the less beneficial subsequently. In this respect mention may be made of the lives lost on transformers both in sub-stations and street tanks, but more especially the latter. The particular circumstances have borne good fruit, as a glance at some of the latest converters will show that every possible precaution for the safety of employés is now taken. Electrically also many advances have been made. The continued use of transformers on supply undertakings has elicited a great amount of valuable information from station engineers, who have not been slow to recognise the necessity of reducing the light load loss inseparable in a greater or less degree from all alternating-current systems. The particulars thus obtained have enabled the manufacturers to realise the direction which their designs should take, and a corresponding improvement in all the features of transformers is noticeable. Although the efficiency of the transformer is usually high, the losses have been so thoroughly examined that steps can be taken to as much as possible reduce them to a minimum in designing the apparatus

Considered as a whole, the transformer has so benefited by experience that it now stands unrivalled as an efficient piece of electrical apparatus; moreover, the improvements effected speak volumes for the future of single-phase electric supply. The adjunct of this system which caused so much discredit to befall it may be looked to, to raise the method of generation and distribution to a higher commercial level than heretofore. It is not possible to discuss here the merits of single-phase working; suffice it to say that should the day arrive when the system shall be generally adopted, the transformer may be relied upon to maintain not only its own reputation, but that of one of the simplest methods of the generation of electricity.

Personal.—Mr. W. H. Cross, Post Office engineer for the south section of the Scotland East District, has been promoted to the position of assistant superintending engineer at Cork.

IS ELECTRICITY GERMICIDAL?

BY F. GRAHAM ANSELL, F.C.S.

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To ascertain the answer to this question, I made a long series of experiments on a subject of great and acknowledged difficulty, which has baffled a good many efforts for a good many years, and is still doing so, although it has been attempted by good, sound, scientific men, and is the source of great loss and trouble to a wealthy and important industry. In arises in this way. A brewery sends out a good, sound and perhaps a new cask. The customer empties it in the usual way, and when empty he should be careful to put a cork into the tap hole, and make sure that there is no opening for air to enter. If he does this the cask will return to the brewery in good order, it will be washed thoroughly, and will then be fit for use again; but, on the other hand, if he neglects this simple duty, then most likely, or I might almost say certainly, the cask will return to the brewery foul, and often washing, boiling, and steaming with high pressure for four or six hours will not make the cask fit for use again. Such a cask is generally known as "a stinker," and has to be burnt, or at the best sold for a trifle to put dry non-edible goods in. Hence the loss to the brewery, or at least a claim upon the customer, with annoyance to both. I have examined a good many of these foul casks. In some the damage does not get deeply into the wood, but in others it does, and then it is fatal. I have searched for any definite germ with various microscopic powers from 50 to 650 diameters, but the only one I have found is bacterium termo, the well-known agent of putrefaction. I have also put clean, cold water into such a cask, left it for 24 hours bunged down, and then analysed it and found it bad—*i.e.*, not fit to drink; its taste is somewhat like the odour of the foul cask, a sort of rotten. One would naturally think that these foul casks would be easily treated and cured by ordinary antiseptic methods, but experience proves that it is not so. Hot and cold solutions of alum, boracic acid and borax, chloride of lime, permanganate of potash, bisulphite of lime, caustic soda, common salt, and dilute sulphuric acid have no effect whatever. Filling the cask with dry chlorine gas, with nitrous fumes, or swilling it round with concentrated oil of vitriol also had little or no effect, even although the cask was bunged down and allowed to stand for days with any one of the above solutions in it. But we know that no bacteria could withstand such drastic treatment as this; therefore we are bound to conclude that the germs have penetrated so far into the wood that the chemicals cannot follow them. This conclusion would seem to gain ground by the fact that of many casks returned to the brewery and found unfit for further use, some are thoroughly cleaned by washing, boiling, and steaming at a pressure of 50lb. or 60lb. per square inch for four hours. If this is not thoroughly satisfactory, another four hours' steaming often is; but the really bad incurable specimen of which alone I wish to speak seems proof against all treatment. One of these I put in a hot room, and gradually raised the temperature so much that the wood charred, and although I maintained this heat for two hours the cask was not cured. Having satisfied myself on all the above, I determined to try what electricity could do. I therefore obtained several casks. The first happened to be a mild specimen, although incurable by the ordinary brewery method. This I filled with a dilute solution of sulphuric acid, and then immersed it in a tub of water also acidulated. I then put it in electrical connection with a battery of accumulators giving 100 volts, so that it must form part of the circuit. The anode of platinum foil I placed inside the bunghole, and the cathode I put into the water in the tub outside the foul cask. Of course, I took every precaution to ensure that the wood of the foul cask must be part of the circuit. The current was about half an ampere, and I kept it going eight hours This cask was cured, and beer subsequently kept in it for three months was good. Other similar casks I also tried, but invariably found that reversing the direction of the current by putting the cathode inside the foul cask instead of the anode was useless. I now got a series

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of the worst and most incurable specimens of foul cask, and naturally hoped for success with the above successful treatment, but I was disappointed in every case. Next I tried different electrolytes, hoping that the influence of the electricity, aided by the chemicals, would effect a cure, but again disappointment awaited me. I tried 200 volts and 220 volts direct from the dynamo with hot and cold solutions of chloride of sodium, which, of course, set free hypochlorous acid, and thoroughly bleached and cleaned the inside of the cask. I continued the electrification for eight hours without intermission, but even then the cask was not cleaned. Some casks I treated in this way on four separate occasions with intervals of a few days' dryness or soaking in solution of chloride of lime, but still with no effect on the taint. Chloride of sodium gave the best results on the whole. I tried, however, chloride of potassium, chlorate of potash, permanganate of potash, caustic soda, etc., and I was reluctantly forced to the conclusion that there is no possibility of guaranteeing the cure of these foul casks. Still, however, I was not satisfied, and therefore I wrote an account of the above experiments to the *Brewers' Journal*, and asked all persons interested to be good enough to communicate their experience, and, if possible, to assist in devising a cure for this nuisance, but up to the present I am not aware that there is any cure. Knowing the above, I feel bound to infer that electricity is not by itself a germicide, because undoubtedly the wood of the cask was in every one of these experiments part of the electric circuit. The death of wasps and other insects on parallel circuits from the same dynamo was instantaneous, but I doubt whether bacteria have any nerves for electricity to act upon. It seems to me from the above experiments that if microbes are killed by electrolysis, it is rather by the chemical agents set free and so put into contact with them than by the electricity itself. However, I know by experience that a shock from a 200-volt machine is extremely painful to human beings. Possibly the small bacterium cell is protected by the wood in which it grows, so that it does not form part of the actual circuit, but even then it must be well electrified, and so I doubt very much whether the electricity itself can destroy bacteria, at all events in a practical way.

NOTE ON A REGENERATIVE ACCUMULATOR AND ITS APPLICATION FOR USING EXHAUST STEAM.*

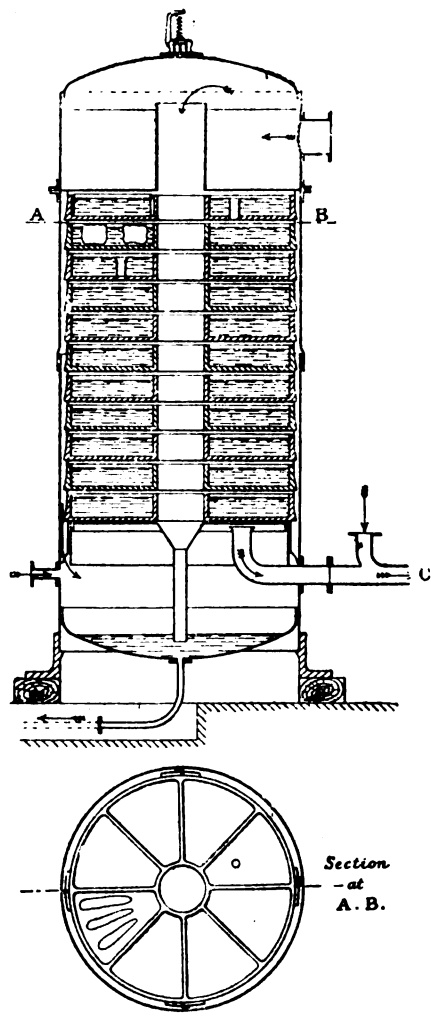
BY M. A. RATEAU, OF PARIS.

The new apparatus referred to in this paper is intended to allow, in a turbine or any other motor, the use of the exhaust steam from machines having intermittent action, such as winding engines or the reversible engines of rolling mills. Engines with intermittent action are well known to be defective in respect of the satisfactory use of the steam, caused by condensation within the cylinders. This inconvenience has no doubt been to a small extent remedied by compounding and also by condensing; but the advantage gained is much less than can be obtained by using the steam at about atmospheric pressure in a turbine provided with a condenser.

The Hon. C. A. Parsons has already urged the use of turbines with low steam pressure attached to continuously-running steam-engines. For instance, if we take a winding engine using 45 kg. (99lb.) of steam per brake horse-power, which is about the maximum for non-compound engines without condensation, these 45 kg. of steam are sufficient to give in a steam-turbine coupled to a dynamo an electric power of at least 2 h.p.; by the application in this case of the regenerative accumulator system, 2 h.p. is added to the 1 h.p. of the winding engine.

The difficulty which this apparatus solves is the following: The turbine requires to be supplied with a continuous flow of steam, whereas the engine working intermittently delivers it at more or less regular intervals of one or two minutes. A reservoir is therefore required between the two engines. An ordinary reservoir would have excessive dimensions, whilst with the apparatus about to be described this excessive size is avoided, and the cost of erection is relatively small.

This apparatus, which may be called a "regenerative steam accumulator," serves the purpose of a reservoir. The solid and liquid materials which it contains form a storage in which the steam gathers and condenses when arriving in excess, and subsequently re-evaporises during the period when the main engine slackens or stops. The variations in temperature necessitated by the condensation and re-evaporation of steam correspond to the small fluctuations of pressure in the accumulator. The pressure rises while the apparatus is filling, and falls while it is being emptied. The amplitude of these temperature and pressure oscillations is not great, 3deg. to 5deg. C. and 0·10 kg. to 0·15 kg. per centimetre^2 (1·4lb. to 2·1lb. per square inch). This variation can be limited to any desired range by designing the apparatus sufficiently large in accordance with the periods of running and standing of the main engine.



Calling the variation of temperature t (which is in practice 3deg. to 5deg. C.), the weight of materials forming the storage of heat P, and the mean temperature of these materials G, the quantity of heat absorbed by the accumulator and restored by it at each period is PGt calories; and 1lb. of condensed vapour then vaporised corresponds to this number of calories, equal to about $\frac{PGt}{L}$, L being the latent heat of the steam.

The apparatus consists, as may be seen from the illustration, of cast-iron annular basins placed one above the other inside a cylindrical vessel of sheet iron. The steam, which enters the vessel by the pipe near the top, reaches the basins by the central channel. The portion which is not condensed, as well as that which is re-evaporated, descends along the lateral partitions of the vessel, and reaches the pipe, C, leading to the low-pressure machine. The water carried away by the steam separates out in the upper chamber, and falls first through holes in the top plate,

* Paper read in Section III. of the International Engineering Congress, Glasgow, 1901.

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thence from basin to basin by the passages in the overflow to the bottom of the vessel, whence it is discharged by the small pipe and an automatic steam-trap. The basins are thus always covered with water. The apparatus is completed with a safety valve and an automatic steam-valve for assisting the turbine by steam direct from the boilers. By

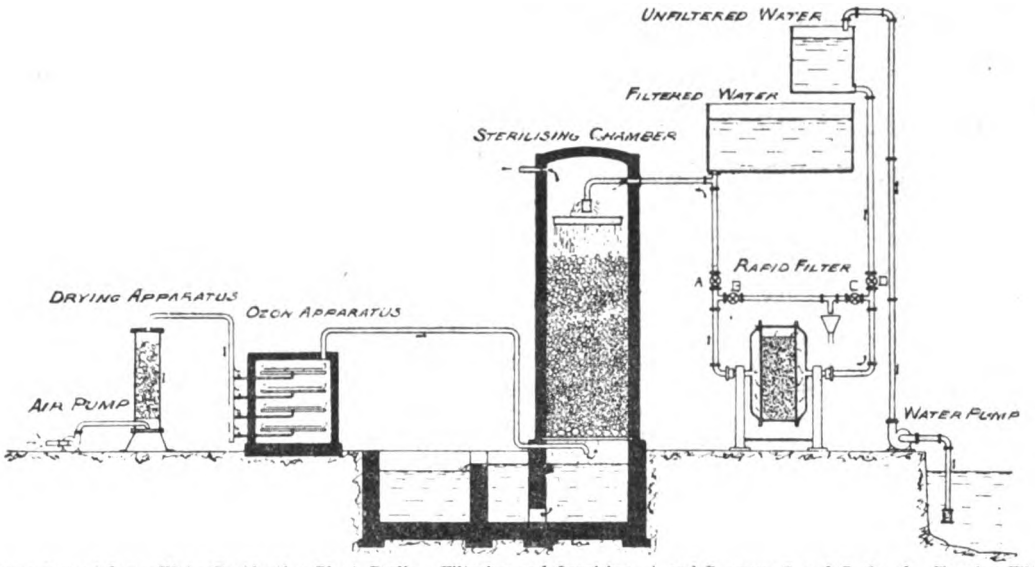

FIG. 1.—Arrangement of Ozone Water Purification Plant, Berlin. Filtering and Ozonising—A and D, open; B and C, closed. Cleaning Filter—A and C, open; B and D, closed. Filtering Only—D and B, open; A and C, closed.

means of this accumulator it is possible to obtain, in an ordinary-sized winding-engine plant, an additional motive power of about 500 h.p., with no expense but the cost of installing the turbine and accumulator, which is not great. An application of 250 h.p. is now in course of erection at the Bruay Mines in the North of France, and will be working in a few months.

WATER PURIFICATION BY MEANS OF OZONE.

Dr. Gg. Erlwein describes in *Schilling's Journal für Gasbeleuchtung und Wasserversorgung* an experimental plant for the purification of water by means of ozone, erected in Berlin some three years ago by Messrs. Siemens and Halske. The plant is designed to deal with 2,200 gallons of water per hour, which corresponds approximately with the requirements of a town of 5,000 inhabitants. The experiments, which have been carried out with the assistance of well-known German water experts and authorities on hygiene, were undertaken with the object of testing the practical utility of the electro-chemical process of purifying or sterilising drinking water on a wholesale scale. The apparatus used to effect the absorption of the ozone resembled a scrubber having small brick chambers filled with fine gravel, in which the water, previously cleansed of suspended matter by passage through a rapid filter, percolated through the fine interstices of the gravel, encountering on its way the ascending ozone. The ozone generators used were of the Siemens plate and tube type, with and without an air dryer. Pressures of from 8,000 to 12,000 volts were used to work these generators, which yielded an average of 20grm. to 25grm. of ozone per horse-power hour, with a concentration of from two to three grammes per cubic metre of ozonised air. After exhaustive experiments with the plant the following report on the bacteriological and

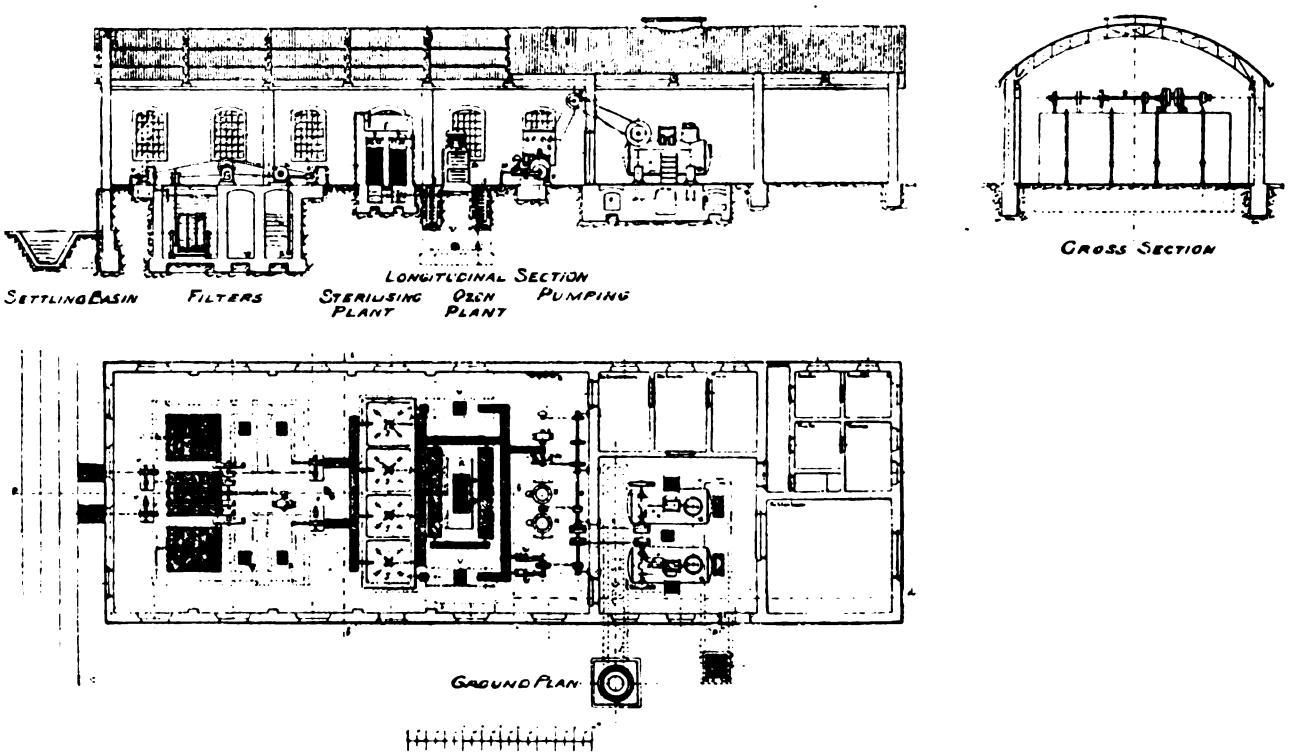

FIG. 2.—Arrangement of Ozone Water Purification Plant for Large Output.

chemical results obtained was drawn up by Messrs. Siemens and Halske:

A. *Bacteriological.*—The river water passed into the ozone chamber, which water contained 100,000 to 600,000

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microbes per cubic centimetre, and before admittance into the chamber was cleansed of suspended matter by passage through a Kröhnke patent rapid sand filter, could in most cases be completely sterilised by the ozone treatment, in spite of its unfavourable quality. In all cases it was possible to reduce the microbes from two to nine per cubic centimetre—a number far below the limit of 100 microbes per cubic centimetre which is permitted in ordinary water-works practice.

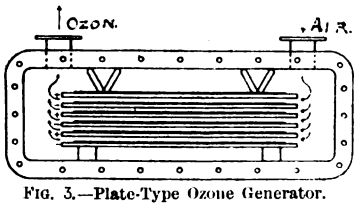

FIG. 3.—Plate-Type Ozone Generator.

B. *Chemical.*—The degree of oxidation of the water experimented with—on an average, 3·76 oxygen or 14·9 permanganate—was reduced about 18 per cent. by the ozone treatment. The free air in the water was increased by 10 to 12 per cent., and the oxygen by 36 to 39 per cent. There was no increase of nitric acid. The water flowing from the service reservoir gave off no smell, and was tasteless, nor were any signs of ozone reaction present. The ozone consumption (O_3) amounted to 2 grammes per cubic metre of sterilised water.

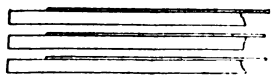

FIG. 4.—Detail of Plate-Type Ozone Generator.

The cost of treating 1,000 gallons of water by the Siemens process in a works designed for an output of of 26,000 to 33,000 gallons per hour amounts in all to ·65d., the power required being reckoned at ·6d. per horse-power hour. Of this amount the cost of energy represents ·41d.; wages, repairs, and filtering, ·086d.; interest on loan and depreciation, ·165d. The total cost of 1,000 gallons of sterilised water delivered at the point of consumption, including filtration, pumping for towers and high-pressure service, with depreciation and interest—allowing for depreciation of the pipe system—amounts to 1·8d. The cost of a plant designed for a capacity of 33,000 gallons per hour, exclusive of service mains, amounts to £6,750, of which £3,000 is represented by buildings, filtering plant, and the pumps for the high-pressure service.

At the end of the report the ozone treatment, in conjunction with preliminary filtration at a rate of 10 to 15 cubic feet per square foot of filter surface per hour, is recommended for purifying surface water intended for drinking purposes. It is also suggested as a remedy, where other means have failed, for iron discoloration in water. The arrangement of the experimental plant erected

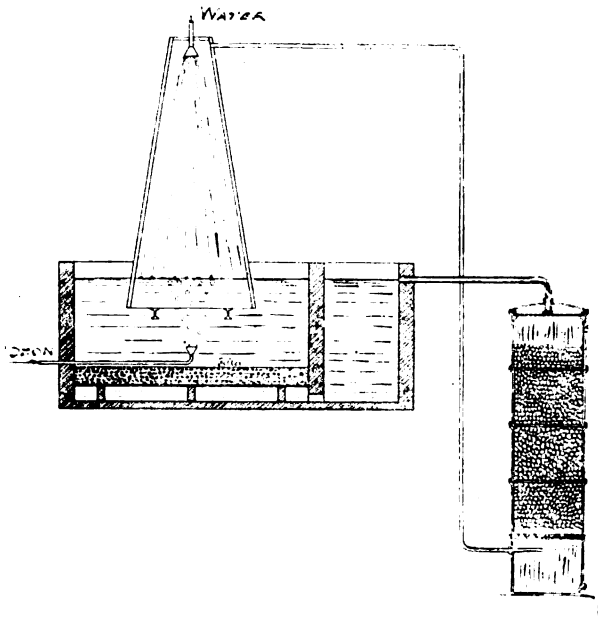

FIG. 6.—Arrangement for Extracting Iron from Water by Means of Ozone.

in Berlin is shown in Fig. 1. There are three parts: (1) a rapid filtering plant, through which the river water is cleansed of suspended matter; (2) the chamber filled with fine gravel, through which the water percolates and becomes saturated with the ascending ozone, and so sterilised; (3) the ozone generator situated in an hermetically sealed box, and consisting of pairs of plates, superimposed and insulated from each other, connected to the high-tension poles, dry air being forced through the discharging space. In

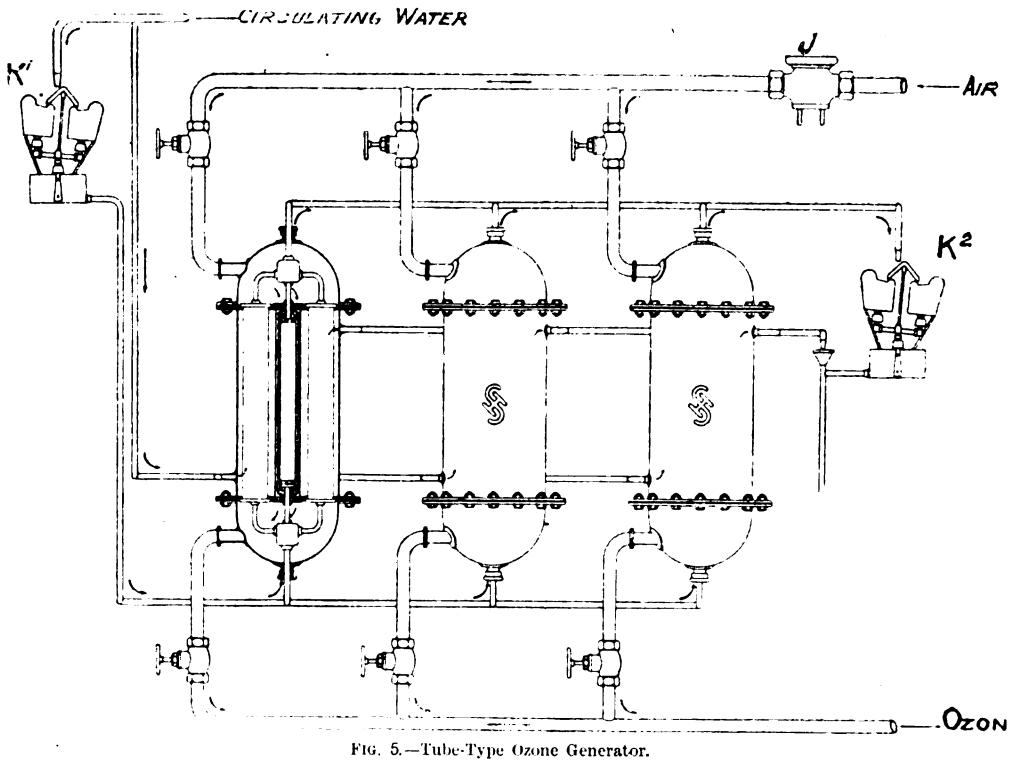

FIG. 5.—Tube-Type Ozone Generator.

Fig. 2 is shown the arrangement of a Siemens ozone water-works plant designed for an output of from 26,000 to 33,000 gallons per hour. Figs. 3, 4, and 5 show the latest types of Siemens plate and tube ozone generators.

In the plate generators the discharging space is formed by superimposed plates, the upper plate of a pair being a glass disc partly covered with this foil, while the lower

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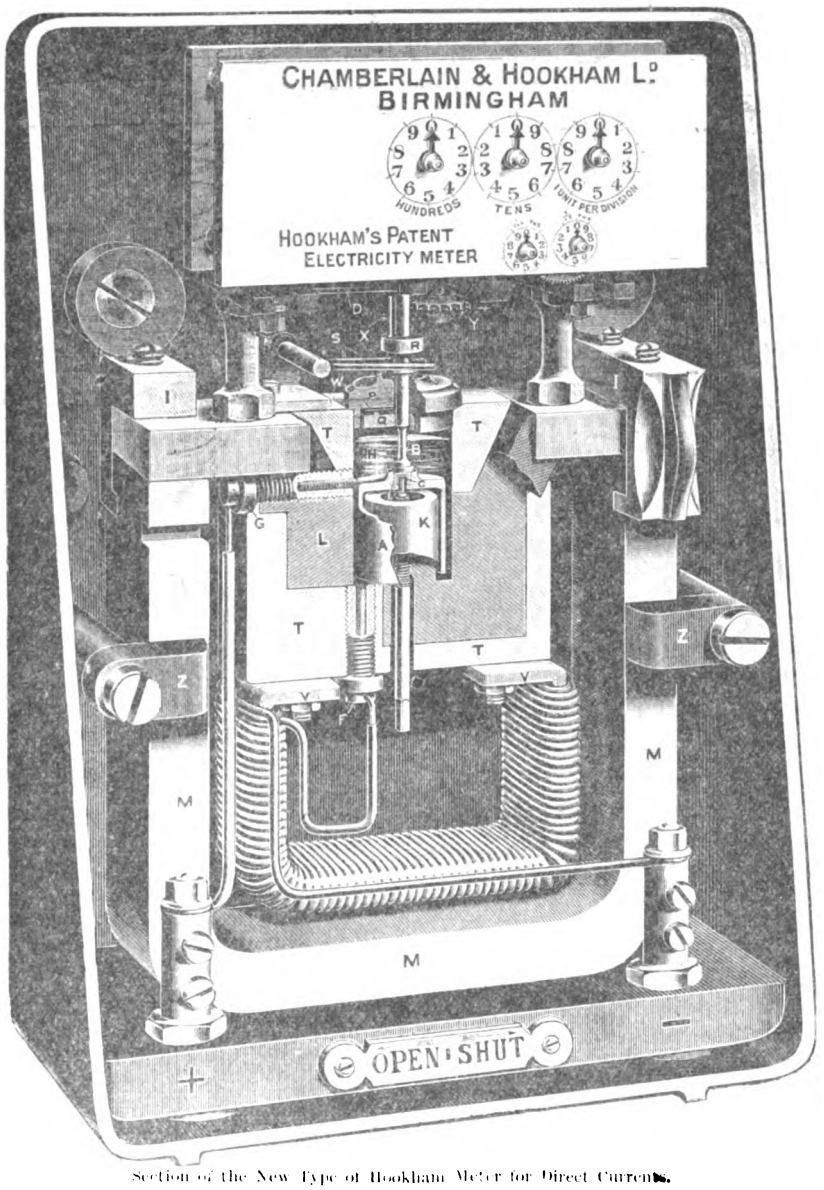
plate, insulated from the upper one by means of glass strips, is an ozone-resisting metal plate. The introduction of the previously dried and cooled air into the discharging space is effected either in the longitudinal direction of the plates or centrally through the lower plate of each pair. Both plates connected to the 12,000-volt circuit are insulated from earth. A pair of plates having a discharge surface of 11 square feet requires ½ h.p. to work it. The plate apparatus yields from 20 grm. to 25 grm. of ozone (O_3) per horse-power hour, provided the volume of air conducted through it be proportioned to yield the 2 grm. of ozone per cubic metre of air which is necessary to ensure sterilisation. On the other hand, the discharging space in the tube ozone apparatus of the firm's latest type is formed by concentric metal tubes, both cooled by means of water. Between the two metal tubes is inserted an insulator in the form of a mica cylinder attached to the inner side of the outer tube. A combination of seven such tubes forms the complete apparatus. The individual tubes are enclosed in a cylinder like fire-tubes in a locomotive boiler, the water for cooling the tubes circulating between them. The outer tubes are earthed by the circulating water.

The inner tubes are likewise cooled by means of water, which is conveyed to and from them by an automatic arrangement, consisting of two cups, attached to an insulated rod and always insulated from earth, which alternately tilt over. This tube apparatus with its water-cooling arrangements also yields from 20 grm. to 25 grm. of ozone (O_3) per horse-power hour, with a concentration of 3 grm. per cubic metre of air. In Fig. 6 is shown an arrangement for clearing water of iron, and consequent discoloration, by means of ozone. On the left is seen a chamber provided with a rapid sand filter, above which is fixed a spraying rose, while on the right is the ozoniser filled, as shown, with fine gravel.

NEW TYPE OF HOOKHAM METER.

The following is a short description of the new Hookham patent continuous-current meter of the 1901 type, manufactured by Messrs. Chamberlain and Hookham. From the London agents of this firm—Messrs. Venner and Co.—we have obtained the following description and illustration of this meter, which consists of a cylindrical copper armature, A, rotating upon a vertical spindle, B, which is supported on a jewel bearing, C, and is held in position by a spring bearing, D. The armature rotates in an annular chamber, H, formed partly by the poles of the meter partly sunk in the antimony block, T. This chamber is filled with mercury to the height shown in a gauge glass at the front. An intense magnetic field is produced between the pole-pieces, K L, by the permanent magnet, M. The current to be metered enters the lower part of the chamber, H, by means of a conductor, F, passes up the armature, and leaves the chamber by the conductor, G, causing the armature to rotate. The brake force of the meter is provided by the Foucault currents induced in the revolving armature by the same magnetic field which produces the driving force. The armature, except at the amalgamated rings where the current enters and leaves it, is protected from the action of the mercury by being plated with platinum. The conductors, F and G, are connected to the terminals, O and N, respectively. The armature chamber is covered



Section of the New Type of Hookham Meter for Direct Currents.

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at the top by a circular ebonite cover, P. The armature spindle, B, carries two balance weights, Q and R, so arranged as to ensure that there is no undue pressure on the steel pivot, E, and that the armature practically floats in the mercury. By means of a lifting arrangement, S S, the armature spindle can be raised and the chamber completely closed by the balance weight, Q, pressing firmly against the rubber washer, W. This arrangement also keeps the jewel bearing, C, from being injured in transit. The upper balance weight, R, carries a vertical steel pin, X, which drives the wheel, Y, and the counting train of wheels, Z. The meter is enclosed in a cast-iron box, and is insulated from it by blocks of ebonite. In order to increase the range and accuracy of the meter, the current to be measured passes round the coil, U, wound upon the iron core, W, this coil being connected in series with the armature. The action of this coil is to weaken the field in which the armature rotates, and to reduce the brake force relatively to the driving force as the current and speed increase, and so to compensate for the slow error at high loads which would otherwise result from fluid friction of the mercury. This object is attained, *not* by opposing or temporarily weakening the permanent magnet, but by diverting part of its field from the poles, K L, to the iron core, V. Therefore, no excessive current passing through the meter, as, for instance, from a short-circuit, can possibly weaken the permanent magnet. This new type of meter has been specially got out for small installations taking up to five amperes, and is supplied in three different sizes, in $1\frac{1}{2}$, 3, and 5 amperes. They are guaranteed to start with 1 per cent. of their maximum current, and to be accurate to within about 1 per cent. at all loads. Last, but not least, the price of these meters is reasonable.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

427. I am trying to demagnetise watches with a coil $3\frac{1}{2}$in. in diameter, through which an alternating current is passed. The current is taken from a 100-volt circuit, but is reduced by a resistance coil to 10 volts. The result is not satisfactory. Can anyone explain why; and also how to test a watch to prove that it has been demagnetised?—E. L. G.

428. Describe exactly why a six-phase rotary converter should have an output about 30 per cent. greater than a three-phase one.—X.

ANSWERS.

Question No. 421.—What class of repairs to tramcar electrical equipments does it pay to undertake with a specially-organised corporation staff, and what should be sent back to the makers to do?

Answer to No. 421 (*awarded* 7*s.* 6*d.*).—The answer depends upon the number of cars, if the "repairs to tramcar electrical equipment" is meant for repair to cars only; but if the tramway electrical equipment repairs is meant, then it also depends on the mileage. The electrical repairs are really small in comparison to the total repairs. To draw up a list of repairs that might be done cheaper by your own staff than sending it to the makers, would be impossible on the information given, as the cost of the repairs sent to the makers will include the railway rate. Again, if the makers are busy they do not want to be bothered with repairs. The great objection to sending repair work away is the time taken, and as there are very few systems with many reserve cars, and the breakdown usually happens at busy times, this point alone ought to decide the question.

The electrical repairs of a tramway system would consist of winding armatures, replacing resistances, wiring cars replacing defective parts in the overhead work, replacing mains and bonds, etc. To rewind magnet coils for the above, only the usual hand tools are needed—such as pliers, soldering iron, stove, and pair of trestles. Of course a lathe would be of great use for winding the magnet coils, etc. The lathe, however, had better have a gap bed, so that the car wheels may be trued up when necessary through flats caused by sliding.

To do the mechanical repairs, a grinding stone, forge, vices, a small anvil, four bottlejacks for lifting the car body from the frame, a hand press for forcing the wheel on and off the axles, a lathe with a centre of 24in. or sufficient to clear the wheel and bed long enough to take the axle are required; but if it is intended to turn the wheel off the axle, then a gap lathe would do. An improvement would be to have some extra speed cones for the lathe, so that wood might be turned. A joiners' shop with benches would be wanted, and a paint shop, armature winding and mechanics' shop. The greater part of the repairs would be renewing brake shoes and trolley wheels. The turning up and renewing of wheels would be a big item, also the contacts on the starters. Then there is all the brake mechanism—nuts and screwed rods, the gear wheel, the bearing brasses, the overhead repairs, etc. These and many smaller repairs would keep the shop busy. If there are only a few cars, it would be only necessary to have an "all-round" man and one assistant, but if there is a number, then it is much better to have a man for each shop, as the time per job would be less and the job would be better done.—T. W. S. H.

Answer to No. 421 (*awarded* 7*s.* 6*d.*).—Any answer to the above question very much depends upon what may be considered as constituting a specially organised staff. The only efficient use of such a staff is that every member of it should find constant employment in that capacity for which he was engaged, so that in organising such a staff special consideration is always given to those repairs which are likely to require almost constant attention. The number of repairs sent back to the maker will likewise depend on the constitution of the staff and the amount and nature of the tools at their command.

Now, assume this staff to consist of a manager who is a practical mechanical and electrical engineer, together with a foreman who is also practical, and that the other consists of a general mechanic such as a good millwright, a general brassfinisher who has had experience in switch and electrical apparatus making; an armature winder "not necessarily for rewinding," but for rewinding sections; a man in whose hands the testing "electrically" of all repairs can be left; also a good joiner who is capable of doing little repairs to cars as well as casing in. With a staff consisting of men as designated above, a great many repairs can be done much cheaper and more expeditiously than returning them to the maker. It would, of course, occupy too much space to name all the repairs such a staff should be capable of, but those which it will be found more efficient to return to the maker may be set down as follows: (1) burnt-out armature or field—when this is slight it can be done by the armature winder on the staff; (2) strained armature shaft; (3) renewal of commutator; (4) final repairs to the controller—the faces of the contacts can, of course, be smoothed by one of the staff; (5) all springs originally supplied by the makers should at all times be obtained from the source; (6) new bearings for the motor should also be put in by the makers. Only those repairs in connection with the electrical equipment have been taken into consideration in the above; the mechanical repairs required on the other portions of the cars will only be too obvious. Finally, the men on the spot, and the nature of the breakdown, are the only two items that determine the efficiency of sending away a repair.—K.

Answer to No. 421 (*awarded* 5*s.*).—The amount of repair work to be undertaken by the corporation depends on the size of the undertaking. In large tramway schemes, with hundreds of cars in use, it should certainly pay to do the

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whole of the repairs, putting down car-sheds and shops fitted with the latest mechanical appliances for the repair of the whole of the plant, motors, wheels, axles, bearing brake blocks, car bodies, and controllers. In the case of a small town running, perhaps, 20 or 50 cars or less, it would probably be better to send back all serious repairs to motors and controllers, such as burnt-out or "grounded" armatures, badly burnt controllers, and the like, as such repairs can only be efficiently executed by a skilled workman with suitable appliances: and in such a small system there should not be sufficient work of the kind to keep a skilled man fully employed. One should then be able to deal with all the less serious repairs with the aid of a thoroughly good wireman, a good mechanic fitter, and a carpenter, with a sufficient number of labourers. It will be found very convenient to have a few spare trucks fitted with motors, so that a car body may be shifted on to one of these and used for traffic next day while the other truck equipment is undergoing repairs or cleaning.

Every car equipment should be thoroughly inspected at least once a week, the motor cases opened and cleaned out with compressed air, and any oil or water removed; the armatures and fields should be inspected and tested, the bearings inspected, cleaned, and adjusted where necessary, new white metal liners being often required. The gear case should also be cleaned out and the gearing well greased. Night work should be limited if possible to dusting and sweeping out cars, greasing motors, and inspecting brushes. Brake blocks will require frequent renewels, especially in hilly districts, while trolley poles not infrequently give trouble from the conductor making contact with the frame. Trolley wheels have to be renewed. Another fruitful cause of trouble is flats on car-wheels. These, if not too bad, can be turned or ground out by jacking up the truck and employing a special toolholder, the motor being run dead slow to turn the wheel. Broken or cracked wheels or axles can be renewed by the staff, a number of spare parts being kept for the purpose.—E. M.

Answer to No. 421 (*awarded* 5*s.*).—I am very strongly of opinion that it pays to do all ordinary repairs, such as rewinding armatures, field coils, making new brasses, turning up commutators, repairing controllers, etc., by a specially organised staff, for two reasons: (1) If a lot of repairs are sent out to be done, the committee will not supply a sufficient stuff for properly inspecting and overhauling the car equipments periodically, and the cars are let to run till they break down, which has the double evil of more expensive repairs and getting the tramway system a bad name; also the committee will not provide proper repair shops, and, in short, the staff are credited with doing nothing. (2) The delay in sending parts away, the expense of carriage and correspondence, and the trouble of getting parts back again, in itself is sufficient to condemn such a system. If commutators are to be turned up in the repair shop, lathes must be provided to take the armatures; therefore, any other turning job could be done. With the Eickemeyer winding, now universally used for the motor armatures, new coils can easily be put on. Field coils only take small machines to wind them, and can also easily be done in the repair shop. The same applies to nearly every detail repairs. It is, however, advisable to have spare armature coils, spare commutators, raw-hide pinions, and other standard parts in stock, which could be bought from the makers. I believe in the saying "If you want a thing done, do it yourself," and this applies very much to tramcars, when it is neither convenient or economical to have a car standing in the shed for a couple of months for some repairs. Doing the work yourself means far more inspection, overhauling, and cleaning than is ever done when work is put out to be done, and you know exactly where you are, and by keeping proper records of what is done one gets to know each car equipment individually. C. L. E. S.

Question No 422.—In a Tudor battery of the H.A. type, maximum discharge 140 amperes for one hour, a soft, white powdery deposit repeatedly collects on the horizontal surface edges of the positive plates. It can be removed with camel-hair brush. Some of the + plates are also somewhat blistered on the *edges*. The battery is a new one, and is kept well charged, but is rarely used up to maximum capacity. Can any reader give the cause of above phenomena, and the remedy?

Answer to No. 422 (*awarded* 7*s.* 6*d.*).—This deposit is composed of peroxide of lead and sulphate of lead, and is formed by the action of the electric current on the lead plates during charging and discharging. A consideration of the work done by the current during these two operations will enable us to understand the cause of the formation of this powder. There is no actual storage of electricity in any leaden secondary battery, but the "charging" current does chemical work on the leaden plates and also on the aqueous solution of sulphuric acid forming the electrolyte, and makes them in a condition to act upon each other; or, in other words, so that their respective molecules can combine to form fresh chemical substances, and the result of this action is to produce electricity. The action of the charging current is briefly this: to deposit metal or hydrogen on the plate attached to the negative pole of the dynamo, and to draw oxygen and acid compounds away from it. This plate therefore has a grey appearance. Any sulphuric acid attached to this plate (see action during discharge below) is set free and is dissolved in the electrolyte, and so makes it "weigh" heavier or increase in specific gravity, as we know it does during charging, and also to draw oxygen and acids to the plate attached to the positive pole of the dynamo. Oxygen acts on the lead to form binoxide of lead (PbO_2), and this happens to be brown, so we get a brown plate. This action involves the decomposition of the water of the electrolyte, and so we get the two gases—oxygen and hydrogen—of which it is composed set free in bubbles. These bubbles, being light, naturally rise to the surface of the liquid, and so keep it in motion. A further action of the charging current is to warm the battery slightly, according to the formula $C^2 R$, and so we get a considerable motion of the electrolyte during charging. If we examine the liquid during charging we find that it is laden with small particles given off from the leaden plates, and these particles, being heavy, soon come to rest on any surface capable of holding them when they fall upon it, and so become the deposit mentioned in the question, having been carried up by the motion of the liquid. This deposit appears grey whilst submerged in the liquid, for reasons which will be explained after the account of the chemical action during the discharge, but in reality it is more a brown powder than a grey one, as will be apparent to anybody who will carefully collect it on a watch glass and look at it after removing it from the battery acid. The battery now being fully charged is in a condition similar to that of a primary battery, in which we have typically a metal (say zinc) easily acted upon by an acid solution, and a metal not acted upon by this solution (say, platinum), but our battery under consideration is composed of a clean leaden plate, quite free from oxidation, ready to be acted upon by the aqueous solution of sulphuric acid, and the brown plate of binoxide of lead, upon which the acid cannot act. Now consider the chemical action which goes on during discharging, and which gives rise to the electric current. It is this: The sulphuric acid of the electrolyte attacks the clean grey leaden plate, and forms a sulphate of lead upon its surface. In doing this, sulphuric acid goes from the electrolyte, and is solidified upon the grey plate, and so the specific gravity of the electrolyte diminishes as the action goes on—*i.e.*, during the discharge. Further than this, hydrogen goes from the electrolyte to the brown binoxide of lead plate, and unites with the oxygen it finds there to form water, which also helps to reduce the gravity of the electrolyte. This constant change of molecular structure on the surface of the lead plates naturally disintegrates them, and so powdered sulphate of lead and binoxide of lead fall off, and the heavier or larger particles fall quickly to the bottom of the cell, while smaller particles are carried up to the surface by the convection currents above mentioned. The sulphate of lead is white, and also is more soluble in an acid solution than in water. Consequently it would be thrown out of solution gradually, although in very minute quantities during discharging, when the acidity of the electrolyte diminishes. This white powder falling upon the brown binoxide would, of course, rob it of its dark colour. A careful examination will show that it falls upon the grey plates and upon the separators as well as upon the brown plates, but the action of the charging current will, of course,

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reduce it to the metallic state, and so it is soon lost from the grey plates, but it is often represented by the spongy substance found upon the top edge of these plates. As I have analysed both the soft white powdery deposit and also the spongy substance this week, I can speak positively upon the subject. The deposit is not a bad sign in a battery, and may fairly be overlooked—in fact, it is quite unavoidable, being a necessary consequence of the action of the battery and only a sample of the deposit at the bottom of the cell.

With regard to the blistering on the positive plates, this is much more serious, and probably arises from too great a charging current, but it might arise from a too rapid discharge. It is a good plan to charge with the lowest current time and circumstances will permit.—F. G. A.

Answer to No. 422 (*awarded* 7*s.* 6*d.*).—The white deposit consists of sulphate of lead; this has been converted from the peroxide of lead (PbO_3) of the positive plates. This sulphate is generally supposed to be represented by the symbols $PbSO_4$, although some authorities give it as being

$$PbSO_4 + PbSO = Pb_2SO_5.$$

The cause of this deposit, and the accompanying blistering, is no doubt due to one or more of the following: solution in cell of wrong specific gravity; solution contaminated with impurities; insufficient charging, or charging or discharging at too great a rate; by standing some time and simply running down. To cure this sulphating many remedies have been proposed in the shape of adding various chemicals, of which perhaps the best known is that of Mr. Barber Starkey, who adds a solution of sodium sulphate (Na_2SO_4).

The method proposed by the writer, although troublesome, may be relied upon to give satisfaction in the long run; it is not only now, but how will the cells be in several years' time. Take, say, the worst cell of the set, and let it be about run down, uncouple and remove the plates. If the plates are not very much buckled, they may be straightened by means of hardwood slips and a little intelligent coercion in the shape of pressing, or even gentle blows with a mallet. The plates should now be well washed with solution from the cell, and after cell has been cleaned out replaced in position. Fill up now with dilute acid (H_2SO_4) solution, and let it be pure, of a specific gravity of 1·17. The cell must be charged until the specific gravity of solution is about 1·2. This will take several charges, the cell in the meantime not being discharged, and to overcome the inconvenience of having to couple up and uncouple cell for each charge, the arrangement shown in sketches will be found very useful. Fig. 1 shows

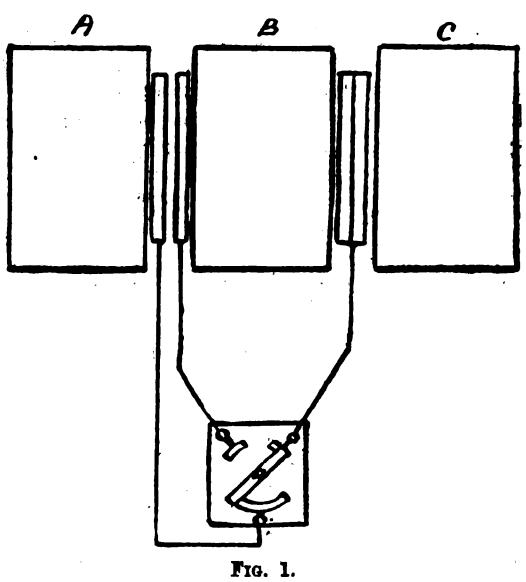

Fig. 1.

cell B cut out for discharge of battery; by switching over on to the other contact, cell may be at once placed in circuit for charging. If two or more bad cells are together, they may conveniently be done at one time. Fig. 2 is clip to fix on connecting bar of cells. Unless some such method is used, the chances are that the cells will not get the desired treatment. Most of the troubles arising with secondary batteries may be traced to the neglect of very plain rules. A fair figure for charging and discharging is six to eight amperes per square foot of positive plate. The capacity may be taken as about 100 ampere-hours per square foot of positive plate.

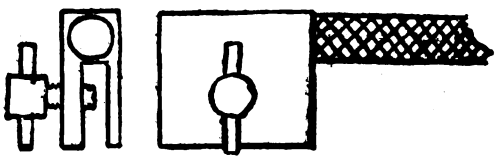

Fig. 2.

It is sometimes said that overcharging is beneficial, but in the writer's experience this has not been so. It would appear that when a cell is well up and gassing freely, the escaping gases do considerable physical damage to the plates. Much deposit is caused, and cells continually overcharged have been noticed soon after to give trouble in various ways. A discussion on this point might be very profitable. Always dilute the acid and fill up cells with *distilled* water.—M.

Answer to No. 422 (*awarded* 5*s.*).—The above results can scarcely be called phenomena, as they are commonly to be found in all new cells of the Planté formation, and need occasion "E. M." no concern. The soft white powder is not peculiar to the positive plates, but will also be found on the negatives as well, if a close examination is made, but owing to the different colour of the plates it is not so noticeable. In all new cells there is always a certain amount of loose peroxide, spongy lead, etc., which gases off during the charge and forms a sediment; during the charge this is held in suspension, but when the gassing stops, and the liquid is still, this settles on the top of the plates and the bottom of the cell in a loose whitish powder. The whitish tint is no doubt given by small particles of sulphate of lead, as a certain amount of sulphating goes on until the cell has been in use a considerable time, when the deposit stops and the plates assume a dark chocolate colour. This, however, is generally a prelude to the collapse of the plates, the very dark ones being found on examination to be almost all converted into peroxide of lead, which, although desirable electrically, is not sufficiently strong to hold together in the form of a plate without the lead core. At this point the positive plates disintegrate rapidly, and the pure peroxide, being very heavy, settles to the bottom of the cell as thick heavy sediment. Impurities in the plates or electrolyte will no doubt cause the powdery deposit to increase in amount, as salts will be formed by the action of the acid. The blistering on the edges is caused by gases under the skin of active material. The action on the edges of the plates is not so strong as on the sides, and consequently a longer time will elapse before the peroxide gets properly formed and fixed, and until this is done a certain amount of blistering will take place. A long violent gassing would for the time clear the top surfaces of the plates, but it would form again afterwards, and no benefit would be gained. If "E. M." follows the instructions given by the Tudor Company as to filling up with *distilled* water and the specified amount of overcharge, taking care not to let the battery stand idle long after discharging and not to discharge below the minimum voltage stated, he need not worry as to results, at any rate judging from the writer's experience of Tudor cells.—C. I. S.

STEEL TUBING AND INSULATION DEFECTS.

At the meeting of the Metropolitan Asylums Board on Saturday last, the Works Committee reported that in the builders' contract for the erection of the head office, £775 was provided for the electric light installation, and the work, which the committee had been informed by the engineer to the Board was carried out in accordance with the specification prepared by the architect's advisory engineers, was entrusted to a firm of sub-contractors nominated by the architect. They had, however, to state

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that from reports which they had received from the architect (Mr. Edwin T. Hall), his advisory engineers (Messrs. Burstall and Monkhouse), and the engineer to the Board, the installation had not proved successful, owing to the perishing of the insulation of the wires; and in spite of the fact that the great majority of the wires had been replaced with new ones the evil still continued, and Messrs. Burstall and Monkhouse reported that there were at present no signs of the damage decreasing. The cause of the perishing of these wires appeared to be that the tubes were laid in the solid concrete, and that moisture was still getting into the tubes and showed no signs of drying out, and in a report on the subject which the committee had received from the engineer to the Board he pointed out that in his opinion this was largely due to the fact that steel tubing with a seam running through its length had been used instead of seamless tubing, which would have prevented any moisture from getting into the cables. Both the consulting engineers and the engineer to the Board were of opinion that the only remedy for the existing state of affairs was to remove the wires from the conduits and rewire the building on the surface where necessary. Under these circumstances, the committee stated that they felt there was no alternative but to recommend the Board to authorise them to obtain tenders upon a specification to be prepared by the engineer to the Board for removing the wires from the conduits and rewiring the office on the surface where necessary. The Board gave the necessary authorisation.

LEGAL INTELLIGENCE.

THE SMOKE NUISANCE.

At the West London Police Court on Wednesday, a number of summonses against the Central London Railway came on for hearing before Mr. Lane.

Mr. Bodkin explained that the summonses were taken out in respect of the alleged annoyance caused by the issuing of black smoke from the two shafts at the electrical generating station of the Central London Railway Company in Wood-lane, Shepherd's Bush. The case had been standing over, as the company had reason to believe they had found a coal which could be used without making smoke. However, the complaint was made that the smoke was worse than before.

Mr. Avory, K.C., who defended, admitted that a Welsh coal was used in September, but on the second of that month the service of trains was stopped owing to it being found impossible to keep up the necessary quantity of steam. During September there were frequent interruptions, and it was found impossible to use the coal to maintain the service. The company felt bound to revert to the use of the old kind of coal to keep up the steam.

Mr. D'Alton, chief engineer to the company, gave evidence to the effect that the Welsh coal was a slow-burning fuel. The new boilers would be in operation in six weeks' time, beginning with the use of Welsh coal, which he thought would diminish the smoke.

In the result the magistrate imposed penalties amounting to £10, with 20 guineas costs.

COMPANIES' MEETINGS AND REPORTS.

W. R. SYKES INTERLOCKING SIGNAL.

The third ordinary general meeting of the shareholders of this Company was held at Winchester House, Old Broad-street, E.C., Major-General C. S. Hutchinson, C.B., presiding.

The **Chairman**, in moving the adoption of the report, stated that Mr. Sykes had now under consideration the working of points electrically. Hitherto his efforts had been confined to working signals electrically, but he now saw his way, he thought, and was carrying out experiments to that end to work points electrically, and if he succeeded in accomplishing the object he had in view it would, no doubt, give this Company a very great advantage over other companies who were working to the same end. For instance, he believed the Pneumatic Company—an American concern which was pushing its interests in England—required not only the pneumatic process for working points and signals, but had to be subsidised by electrical working. The pneumatic and hydraulic working both required to be aided by electricity, so that if they could accomplish the working of both points and signals electrically it would give this Company a great advantage over those systems which required two modes of working. He hoped he would be able to tell them more about this matter when they met next year. He also stated that in six of the signalling cabins at St. Enoch's Station, Glasgow, the electro-mechanical mode of working signals had been introduced.

Sir Allen Sarle seconded the motion, which was carried unanimously.

Dividends were afterwards declared of 6 per cent. and 2½ per cent., less income tax, on the 65,000 shares and 25,000 shares respectively and the meeting terminated.

MONTE VIDEO TELEPHONE.

Presiding over the annual general meeting of this Company at Winchester House on the 31st ult., **Mr. Frank W. Jones** reminded the shareholders that steady progress was the substance of his remarks when he addressed them a year ago. The same words fitly described the result of the past year's working. The starting of the port works at Monte Video was now an accomplished fact. This took place on July 18, just at the close of their financial year, and if the reasonable expectations which this important undertaking had given rise to were ultimately realised, great prosperity was in store for the Republic of Uruguay, in which the Company could not fail to participate. What was stated at their last meeting concerning the probability of their having to make considerable improvements held good with still more force now. The directors had been actively engaged for a considerable time in the preparation and study of a future programme to meet the prospects of new business and the changes and advancement in the workings of telephone systems. These changes and improvements were revolutionising business, particularly in the United States, which he had just visited for the purpose of obtaining information on these subjects, and where an enormous increase of subscribers had resulted in the past two years. Heavy capital expenditure was necessary in this connection, and must, as he pointed out at their last meeting, be looked forward to if the Company's position was to be greatly improved or even maintained. To take advantage of the constant improvements in telephony at a favourable time required a command of capital, and the Board had therefore adopted the policy of building up a strong reserve. It was foreshadowed in his remarks a year ago that a debenture issue to meet extraordinary expenditure might possibly be made during the year. The time had not been propitious for such an issue, and it had, therefore, been fortunate that there had been no necessity for one, but they should not lose sight of the fact that it might be very desirable to make one at, perhaps, short notice, and they should be so prepared by a strong reserve as not to be forced to make an issue at an unfavourable time. The past winter he spent in the River Plate, and on several occasions he visited Monte Video, and had been pleased to note the evidences of prosperity and the undoubted progress which the city was making. Their Company was a well-established institution, and, as the accounts showed, there was a steady increase in the business, which appeared to be well and economically managed. Referring to the profit and loss account, the chairman said that, including £1,886 brought forward, there was a total of £12,205 to be dealt with; and after paying the same dividends as were distributed last year, it was proposed to place £5,000 to reserve, carrying forward £1,063.

Mr. Charles Lock seconded the motion, which was carried unanimously, and dividends were declared for the year ended July 31 last at the rate of 5 per cent. on the preference shares, and of 2½ per cent. per annum on the ordinary shares.

The proceedings closed.

NEW COMMITTEES.

The following new committees have been selected:

BIRMINGHAM.—*Electric Supply:* Aldermen Ash, Beale, and Hart; Councillors Ellaway, Fletcher, Jephcott, Johnstone, and Reading. *Tramways:* Aldermen Beale, Cook, Hallam, and Sir James Smith; Councillors Ellaway, Nettlefold, Toller, and Walthall.

LIVERPOOL.—*Electric Power and Lighting:* S. W. Higginbottom, M.P., R. Dart, H. Campbell, H. M'Cubbin, F. Smith, W. H. Williams, J. Brunskill, J. B. Colton, J. Daly, W. H. Edwardes, J. Harrison Jones, J. B. Light, H. Miles, J. Roby, S. M. Hutchinson, W. W. Walker. *Tramways:* Frederick Smith, A. T. Salvidge, W. H. Williams, J. S. H. Banner, G. J. Lynskey, R. H. Bullen, E. Burns, S. W. Higginbottom, M.P., W. Houlding, Joseph Hunter, S. M. Hutchinson, R. Kelly, E. L. Lloyd, R. S. Porter, F. Saunby, W. W. Walker, W. Craigie, Williams, J. T. Wood. Not a member of the Council: Sir David Radcliffe.

DERBY.—*Electric Lighting:* Aldermen Ann, Bennett, Duesbury, Fletcher; Councillors Brigden, Butterworth, Eaton, Foster, Haslam, Shackleton, Wilkins. *Tramways:* Aldermen Duesbury, Fletcher, Spriggs; Councillors Butterworth, J. Dean, Eaton, Gandy, Johnson, A. Ottewell, Walker, Wilkins.

NEW COMPANIES REGISTERED.

The following new companies have been registered since our last issue:

Hathorn, Davey, and Co., Limited. — Capital, £120,000. Objects: to acquire the business of mechanical and hydraulic engineers and otherwise carried on at the Sun Foundry, Leeds, as Hathorn, Davey, and Co.; to adopt an agreement with Henry Hathorn, Arthur H. Meysey-Thompson, and Hugh Lupton, vendors, and to carry on the business of mechanical, hydraulic, electrical, and general engineers, etc.

Kensington Motor Company, Limited. — Capital, £2,000. Object: to carry on the business of manufacturers and repairers of and dealers in motors, motor-carriages, cycles, and machinery, engineers, electricians, etc.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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READING TRAMWAYS CONTRACT.

The Reading Council have had a lengthy discussion upon the question of the contract for their tramway work. Altogether there were eleven tenders received, one of which, however, was for only a special portion of the equipment. The remaining ten varied in amounts from £83,443 to £136,543, but the committee limited its consideration, so far as their report was concerned, to the four lowest tenders, the highest of which was £85,407. The engineers suggested that the item of points and crossings and special work be eliminated from the tenders and dealt with separately, but the committee recommended the acceptance of the tender of Mr. Edmund Nuttall, of Trafford-road, Manchester, without such elimination, although it stood second on the list. This course was approved by the Council, and the contract will be given to Mr. Nuttall accordingly. There were two or three points brought out in this discussion to which attention ought to be directed. The work of committees in the Reading Council is not open to the public, but Alderman Monck, the chairman of the committee, said its proceedings had been divulged, he believed, through the indiscretion of some member of the committee, and not through breach of confidence by one of the clerical staff of the Council. The chairman also stated that if a similar breach of confidence ever occurred again, he would resign his position as chairman. We commend his view to the various committees throughout the land, and especially to the chairmen. The task of a committee is often a thankless one. If its members, and especially if the chairman, feels the responsibility resting on the committee, the aim will be to really and truly consider the work entrusted to its hands. In the case of contracts, tenders are sent in generally by a number of firms, and one of the most delicate of tasks is to truly apportion the trustworthiness of the tenderers, and the quality of the work each will be able to furnish. Some, certainly, are good; some may be unused to the particular work tendered for, and hence doubtfully suitable. In far too many cases due examination into the past is not made, and owing to this costly mistakes occur. We hasten at once to say nothing of this nature arises from the Reading report, and we only refer to the particular question because of its bearing upon the necessity of secrecy of proceedings in committee. The position of the Press is an exceedingly difficult one, and Alderman Beale, we think, ought to have refrained from appealing to local "editors of papers not to take surreptitious information." It may be to the advantage of everybody concerned that information be given at the earliest possible moment; and if a councillor commits a breach of confidence, it is not the place of an editor to refuse his information, especially when it deals with results and not with the proceedings leading up to these results. The editor, being human, cannot always tell that the information is "surreptitious," and it certainly would not be if given by a member of a committee. In our opinion the most just course for all concerned is for the chairmen of committees to be directly responsible for all matters for publication. This information should only be issued with the chairman's signature attached, and it should be sent regularly to all the local papers. Another grievance, which we think is equally in need of rectification, is the practice of some committees in withholding all information as to the number and amounts of the tenders that have been considered. It is true that by the publication of these it will sometimes be disclosed that the committee have not seen fit to recommend the lowest tender. It is, however, much preferable that this fact should be

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known at once than that a body of members of the council or of the ratepayers should afterwards hear it indirectly. It is not as a rule required that the committee should divulge in their report their full reasons for accepting a higher tender, as these reasons are often likely to hurt the feelings of the tenderer passed over. In any case, the issuing of a complete list of tenders received, in an analysed form if need be, would do much towards keeping clear of the suspicion of jobbery which attaches itself to certain town councils we could mention. In the case of Reading the very appearance of this evil has been avoided. With reference to the Reading tenders there remains one point to be dealt with. There was a long discussion in the Council as to the relative merits of the points and crossing offered respectively by an English and by an American firm. The excellency of the American points and crossings offered by the successful tenderer are above suspicion, and we gather that their price is accordingly high. The English-made points and crossings were to be supplied by Messrs. Hadfield, of Sheffield, and were to be of Hadfield's manganese steel. The hardness of this material makes it especially suitable for the work. There seems, however, still to exist in the minds of a large number of individuals an idea that American-made electric tramway plant has, *per se*, inherent advantages. This idea was in evidence in the debate at the Reading Council, when it was absurdly suggested that Messrs. Hadfield's enormous experience in steelwork was insufficient to supplement their two years' experience in the manufacture of manganese steel points and crossings for tramways. Ultimately we hope that it will be recognised that there is no such unearned increment of value in American-made electric tramway equipments. Those engineers who have had experience of several years in working tramway plant in this country will now testify in the opposite direction, and it will be found that numerous standard articles which tramway engineers in America accept are considered insufficient for English practice either as regards design or the material used.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LIGHTNING CONDUCTORS.

SIR,—I may surprise Mr. Whitehouse and possibly also other of your readers when, in reply to his question in your issue of 25th ult., I state as my opinion, based on a very close study of the question as well as a practical experience extending over the protection of every description of building, that neither the bad "earth" nor bends in the conductor (if there were any) occasioned the damage at All Saints, Nottingham. By this I mean that inductance need not be taken into account, and that even if the "earth" had been made in most approved method the side flash would have occurred in practically the same way. The fault was either in the fixing of the conductor within 4ft. 6in. of the gas-pipe, or *vice versâ*, if the gas-pipe was added later. It is rather strange that the first and second answers to your question *re* bends should quote this occurrence as an example, for it dates back at least 32 years (I am under the impression that it occurred before 1870), and plenty of similar cases have happened since.

These replies are unanimous against bends in conductors, but I consider them all very unsatisfactory, and should very much like to criticise them, but as almost every line is open to hostile criticism I am afraid that I should trespass too far on your space. I should, however, be glad if someone would say on whose authority the statement is made, that bends in a conductor increase the self-induction. I am not advocating unnecessary bends, but I entirely disagree with the opinions that abrupt bends render conductors inefficient. I may point out that to increase self-induction, one would coil a wire into a spiral; for an anti-induction arrangement, one would zigzag it backwards and forwards. My authority for this is Dr. Lodge.

I disagree with "E. M." in the statement that "the ideal way to protect a tall square tower" would be to fix a conductor down each corner. I cannot imagine a case in which the four conductors would be better than one, and, on the other hand, I could give instances in which a tower would be amply protected by a single conductor to earth, while the four would result in failure. I quite agree with him that some of our important buildings are not efficiently protected, but this is owing to conductors being placed only on some elevated parts, and not on all points liable to be struck, or by their not having been applied on scientific and commonsense principles (for the terms are synonymous), and safety would not be secured, but the buildings be probably rendered still less secure, by what I may call exaggerated systems such as he appears to advocate.—Yours, etc.,

ALFRED HANDS.

115, Leadenhall-street, London, E.C., Nov. 5, 1901.

THE APOTHEOSIS OF THE WORKING-MAN.

SIR,—I think your contributor, R. D. Summerfield, in referring to the working class as "a most pampered class," is entirely wrong, and, in fact, displays a most palpable ignorance of the condition of the working classes of this country. He seems to think that they are the most insignificant portion of the community—*e.g.*, he says, "Who ever heard a candidate for Parliament (no matter what his political opinions) make an ordinary election speech of which nine-tenths did not refer directly or indirectly to the working classes?" As if it were not the business of every politician to deal with the working class, seeing that, according to Mulhall, they are about 98 per cent. of the nation. It is, indeed, amusing to follow the flopping of a person who has no knowledge of what he writes: "They pay no taxes, yet their children are educated in palatial schools at other people's expense; reading-rooms, libraries, picture galleries, etc., are provided free, and baths and wash-houses at nominal fees." I would like to know if these things are provided exclusively for the workers? It may be news to Mr. Summerfield, but I am prepared to prove the point that *the working classes pay all taxes*. It is easy to assert "they pay no taxes" because some of them seemingly do not pay directly; but any person with the slightest knowledge of economics will admit that the bulk of the wealth of the country is the product of the labour of the working classes. This being so, all taxation must come from them. And when he complains that "a paternal Government compels employers to carefully fence in all moving machinery, and to pay substantial compensation if through their own carelessness they sustain any injury while at work," it makes one suspect that he has anarchistic tendencies. Does he expect the intelligent readers of your paper to believe that workmen go about while at their work trying to injure themselves in order to get compensation? Is not the workman engaged using the machinery producing profit and dividend for his employer? If the workman was left entirely to the tender mercies of the employer, there would soon be an end of the working class, and the resurrection of chattel slavery would be the topic of the day. Is it consistent to use as a criterion of the character of the working class the assertion "that in scores of cases workmen steal each other's tools, clothes, food, and moneys," and the rest of the foolish and insulting statements *re* the working class, which constitute a most contemptible libel on the people of this country.

On the authority of Sir R. Giffon, the *average wage* per family is about 24s. 9d. per week. Yet you expect workingmen to be what you call thrifty, and you complain that they spend so much on holiday making. My experience is that if a worker gets a week's holiday in a year he is, indeed, a lucky man. Workers are not in the habit of spending a month on the Mediterranean or at Monte Carlo. The working class, like other classes, have their faults, but theirs are generally the result of poverty; while those criminals

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who come from the *non-working class*—such as Jabez Balfour, Pigot, and others—by their grasping ambition and avarice have ruined thousands. It is to be hoped in future that Mr. Summerfield will make himself more acquainted with facts before rushing into print, and condemning the class that have enabled England to be dubbed the workshop of the world.—Yours, etc., A WORKER.

ELECTRIC MINING PLANT.

SIR,—We note that in your issue of Oct. 15 you devote a paragraph to remarks on the installation of a large electrical mining plant at Charleroi, Belgium, for the supply of electric power to three collieries. You do not, however, say by whom this plant is being laid down, and we should be glad if you could find space in your next issue to state that the work is being carried out by our company in Liège. We would say that this is probably the largest electrical mining installation that has ever been laid down, the total contract amounting to nearly £20,000. We secured the work in the face of a good deal of competition as the result of a large previous experience.

We may mention that the generating plant will include two 600-h.p. slow-speed steam alternators generating three-phase current at 3,000 volts. At the Gilly shaft there will be two "Express" pumps direct coupled to two three-phase motors of 200 h.p. each; at the Appaume Ransart shaft one "Express" pump direct coupled to one three-phase motor, 130 h.p.; and at the Fleurus shaft one "Express" pump coupled to a 200-h.p. motor, besides other machinery, electric lighting, etc.—Yours faithfully,

E. KILBURN SCOTT,
(For the International Electrical Engineering Company)

ELECTRICAL ENGINEER (R.E.) VOLUNTEERS—SECOND SOUTH AFRICAN CONTINGENT.

SIR,—You are aware that there are over 100 members of the corps of Electrical Engineers now serving in South Africa. The officers and men at home are, therefore, raising a fund to enable "comforts" to be sent out to the South African detachment in time for Christmas.

Colonel Crompton, C.B., has headed the list most liberally, and it is hoped that members of the electrical profession and other friends interested in the work of the corps will help by sending a subscription, however small.

To make certain of our stores reaching our men before Christmas, it is necessary to dispatch them within a fortnight, and, therefore, subscriptions should be sent to the undersigned without delay.—Yours, etc.,

A. H. POTT (Captain).
Headquarters E.E. (R.E.) Volunteers,
Regency-street, Westminster.

CATALOGUES RECEIVED.

THE PROMETHEUS SYSTEM.—Messrs. O. Berend and Co. have forwarded to us an interesting catalogue on their Prometheus system of electric cooking and heating. The catalogue is one which will be found of great service to central-station engineers and to contractors in installing the better class of houses with electric light, etc. The electric cooking apparatus standardised by this firm are all equipped with a system of contacts which allows of the regulation of the current over wide ranges. In the list of these various articles the current required by each on a 220-volt circuit is given in every case, which is of considerable service when estimating for wiring. The heating apparatus are equally well catalogued and listed with prices, currents, and weights. Amongst the new accessories which we do not remember having seen before is a hair-drying apparatus, which will be highly appreciated by the ladies.

ELECTRIC HEATING APPARATUS.—Messrs. Isenthal and Co. have recently issued a new catalogue of electrical heating apparatus manufactured by the firm Electra at Waldensweil, Switzerland. Messrs. Isenthal are the sole agents for the United Kingdom and the Colonies for these goods, which appear to be exceedingly well made. We notice in looking through the list that electric heating is applied by the firm to much larger ranges and pieces of apparatus than we have hitherto seen. We think it is a pity, however, that the firm should give the consumption of electrical energy of the apparatus in hectowatts, as they appear to have done. It would have been much more reasonable to have reduced it to volts and amperes, or to have left it simply in watts, as the hectowatt is not used by central-station engineers in this country.

FORTHCOMING EVENTS.

SATURDAY, NOV. 9.

Manchester Association of Engineers.—At 7 p.m., ordinary meeting. Paper: "Recent Developments in Fine Machine Grinding," by Mr. Hans Renold.

TUESDAY, NOV. 12.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper: "The Discharge of Sewage into a Tidal Estuary," by Messrs. W. Kaye Parry, M.A., and W. E. Adeney, D.Sc.

THURSDAY, NOV. 14.

Institution of Electrical Engineers (Dublin Section). Ordinary meeting: Paper by Mr. P. S. Sheardown on "An Account of the German Tour of the I.E.E."

FRIDAY, NOV. 15.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Paper: "The Balancing of Locomotives," by Pro. W. E. Dalby.

Electro-Harmonic Society.—Ladies' night. Concert at St. James, Restaurant.

SATURDAY, NOV. 16.

Institution of Junior Engineers.—At 3 p.m., visit to the Standardising Laboratory of the Board of Trade Standards Department, Westminster.

ELECTRIC TRACTION ON THE "UNDERGROUND."

(Continued from page 633.)

THURSDAY AFTERNOON.

The enquiry into the dispute between the Metropolitan District and the Metropolitan Railway Companies as to the system of electric traction to be employed on the "Inner Circle" was continued before the arbitrator, the Hon. Alfred Lyttleton, K.C., M.P., assisted by Mr. H. F. Parshall and Mr. T. Parker, in the Lord Chief Justice's Court at the Law Courts.

Under further cross-examination by Mr. Cripps, K.C., M.P., for the Metropolitan Company, **Mr. James Swinburne** admitted that by the exclusion of rotary converters a degree of simplification in the equipment was obtained, but it led to the more serious complication of having two overhead conductors, as was proposed in the Ganz system. It was true that the alternate-current system was working in Switzerland on some railways, but not with the use of liquid rheostats. Counsel then cross-examined the witness in detail on the statements in the report of Messrs. Preece and Parker after the tenders were received. Mr. Swinburne did not agree that the arrangement of the three-phase motors as proposed by Messrs. Ganz placed the system on the same footing as the continuous-current system. With the direct-current system a strong field as well as a strong armature current was obtained, thus allowing a margin for accelerating. This was not to be got with the alternate current, because if the current were increased above its best value, the torque in starting was lost. He did not regard the fact that commutators were necessary to the direct-current system as an objection, as all commutating difficulties had been got over years ago. Brushes were used in both systems, and there were no sparking troubles with either so long as the system was working properly. As regards the danger to the motorman, he did not say it was impossible to contrive an iron covering or some such device for the motor which would greatly minimise the risk. With the overhead conductors there was considerable danger to the staff in effecting repairs, especially in the case of a sudden breakdown which required to be remedied at the time. Mr. Swinburne was next questioned as to the protective device which the Ganz Company propose to use. Putting it broadly, if the device worked properly, there was no danger from the overhead conductors breaking. He would only admit, however, that the contrivance would tend to minimise the risk. He had a constitutional objection to all such safety devices. The risk to the passenger was only in the case of a wire breaking and hanging down in front of a car or falling on to a platform. He admitted that, save as regarded the rotary converters, the alternate-current system required no moving machinery outside the generating station. Rotary converters required attendance, and transformers could not be left unattended. The main cables were bigger in the alternate-current system. With the continuous current the cables could be put on the ground, but it was incorrect to say that it was impracticable to put them overhead. On the question of the control of the motor, he found fault with the liquid rheostats in the Ganz system in cascade. As far as gradual operation was concerned, there was no objection to the liquid rheostats, but one very important point was that the resistance varied with the temperature. It was quite possible that the liquid rheostats had advantages, but he looked upon them as still in the experimental stage. With regard to the reversal of the motors which was required at junctions, such as at Aldgate East, with the alternate-current system, he denied that the problem would be solved by an arrangement of leaving a gap of, say, 50ft. in the conductors. He did not regard it as practicable.

In reply to the Arbitrator, Mr. Swinburne said there were no electric railways in England where this plan had been adopted, as in all cases

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in this country electric locomotives were used. Any arrangement of the sort must be such as could be used not only on the Inner Circle, but in the open country, where speeds of 60 miles an hour were attained. He mentioned this as showing the difficulty which would be experienced in the generality of cases with a gap in the conductors. On the Inner Circle, the difficulty not only applied to Aldgate East, but to other junctions, such as at Earl's Court, Addison-road, and Brompton.

Re-examined by Mr. Moulton, Mr. Swinburne said there was no difficulty in making high-tension direct-current motors. For practical working, electrical engineers adhered to 500 or 600 volts. With the use of low-tension conductors on the cars, in his opinion there was practically no danger of deadly contact with them. It was quite possible to give an efficient side protection to the cables for the protection of workmen on the lines. Whatever system was used, high pressure always introduced the element of danger, but especially with the alternate current. As a consequence of only being able to strengthen one element in the alternate-current system, the motors had to be very much larger than in the direct-current, in which both elements were strengthened at starting. Again, the air-gap must be small in the alternate-current system, whereas the direct-current armatures worked well with a distinctly larger air-gap. In the former system there was also the disadvantage that when the resistance was gone the top speed had been attained, but with the continuous current it was quite possible to go beyond this point, and the working was equally as efficient. The driver of the direct-current locomotive had the power to regulate the current and to "coast" whenever he desired, and to do this within the efficient range of the motor, but no such use of the engine was feasible with the other system. "Coasting" was not practicable with the Ganz system, because the speed became immediately reduced. Apart from the question of having less efficiency, the alternate-current engine which was proposed was not such an elastic an instrument for traction as that used with the direct current. As the arbitrator had said, it was not so flexible. Further, the alternate-current engine would take a greater amount of power to work. As regards the question of the stator, this was always on the trolley, and the current passing through it would be about seven amperes, partly wattless. There was nothing to compare with this in the direct-current system. The Ganz system in cascade had no advantage even compared with the direct-current shunt machines in series. Shunt machines had been suggested for use with direct current, but they had been universally given up. The consequence of constructing the engines for a speed above that required, as had been suggested by Messrs. Ganz, would be that there would be less torque at starting and larger motors would be needed. Also, running with resistance on the Inner Circle would result in great waste. He did not consider that the return of current by rail was practicable over long distances. With regard to cost, taking the power factor at ·7, and assuming that the two systems took the same amount of energy, the steam plant required in each case would be the same, but the cost of the electrical generating plant would be considerably greater with the alternate-current system. Further, if the cables were run at the same current density in both systems, the copper required in the Ganz system was about 40 per cent. greater than in the direct-current. Again, the transformers, which dropped the current down from 12,000 or 15,000 volts to 3,000 volts, had to be larger because of the extra current and also on account of the low frequency. So far from it being a burden to use accumulators in the continuous-current system, it was an advantage, as in times of heavy load they could be brought into operation, thus obviating the necessity of having the generating plant at the station large enough to meet the maximum demand. In the case of the Inner Circle, the accumulators could be placed between the stations, which advantage was not given to the other system. As regards the railways in Switzerland, the highest voltage which had been applied with the alternate-current system was 750, and no water rheostats had ever been used there. Having referred to the danger arising from leakages with a voltage of 3,000 on the line, Mr. Swinburne stated his opinion that there was nothing to be gained from the use of the alternate-current system on the Inner Circle. He saw no reason for changing from a known system to an unknown system.

Mr. C. T. Yerkes was recalled at this stage, and produced the telegrams he received from Mr. Chapman with reference to the tests which were made of the Ganz system at Lecco. The important message was dated Aug. 28, 1901, and read: "Experiments made satisfactorily last night with Trotter. Leaving this morning." Mr. Yerkes denied that there was anything in this telegram to suggest that the experiments had resulted satisfactorily. The night before the tests were carried out there had been a breakdown on the line, and the message meant to convey the meaning that Mr. Chapman had been successful in so far as he had been enabled to carry out the experiments. Mr. Yerkes further stated that he had never shown this or the other messages from Mr. Chapman to Mr. Blathy. He may have mentioned to Mr. Blathy that he had received the telegrams, but that was all.

The Court then adjourned.

FRIDAY'S PROCEEDINGS.

Mr. James Russell Chapman, examined by Mr. Fletcher Moulton, said he was an engineer of 27 years' experience of railways in the United States. For the last 10 years he had been engaged exclusively on electric railways and tramways, and had had to convert a number of steam railways to electrical working. On the elevated lines in Chicago, with which he had been connected, about 200 million passengers a year were carried, while the minimum service in the afternoons was 61 trains an hour. The minimum scheduled interval between trains was three-quarters of a minute. On all the railways he had been connected with, the direct-current system had been used at a voltage of 550 on the line, but the system of sub-stations had not been adopted in Chicago. In his opinion there were no electrical difficulties in working railways by the low-tension direct-current system. In America he had used the series-parallel control, and with this control he was able to work either with locomotives or with motorcars. He had been engineer to Mr. Yerkes in these concerns, and had nothing whatever to do with the tenders which were sent in for the Inner Circle. Also, he had no interest whatever in any one system of electric traction as contrasted with another, except as regards its working. In his opinion the direct current was the only system which could be worked safely and economically, and be relied upon for the conversion of a railway from steam to electrical working. He had considered the question of the electrical equipment of the Inner Circle, and he was satisfied without doubt that without any electrical risks it could be done on the direct-current system. He had also examined the tenders of Messrs. Ganz and of the British Thomson-Houston Company. The conclusion he had come to was that the British Thomson-Houston tender was for a first-class equipment for the proposition as covered by the specifications, but perhaps a little too liberal as to the power-house equipment. The Ganz tender was not for a first-class equipment. In the former tender the total expenditure was estimated at £519,000, as against £303,000 in the Ganz tender. This showed a great saving in price in the case of the Ganz system, but although the two tenders were for the same work, there was a great deal less provided for in the Ganz tender than in the other. Taking the boiler plant, for instance, the British Thomson-Houston tender provided for 80,000 square feet of heating surface as against 48,000 square feet in the Ganz system.

The **Arbitrator** asked whether the tenders were for the whole of the Circle traffic or only a part.

Counsel said it might be taken that both tenders were based on 220 train miles per hour. As a matter of fact the estimated traffic on the Inner Circle, including that from the interpolating lines, was about 600 train miles per hour. So that the tenders were only for about a third of the actual equipment required for the Circle.

Under further examination, **Mr. Chapman** said he did not believe that 14,000 kw. could be given from a heating surface of 48,000 square feet. As regards the engines and dynamos for the power-house equipment, the British Thomson-Houston tender represented the most modern and effective type, and, in his opinion, they were preferable to those proposed by Messrs. Ganz. With respect to condensers, those suggested by Messrs. Ganz were mere jet condensers operated from a beam worked from each engine, whereas it was practically impossible to run any modern traction plant without independent condensers, particularly when the power-house had got to handle a rise and fall of the tide of 24ft. This latter class of condenser was proposed by the British Thomson-Houston Company, who also provided for a first-class plant in the case of pumps, with ample margin of safety. In the case of the Ganz Company, if the plant were started with the pumps—*i.e.*, two steam-pumps—proposed in their tender, it would be immediately necessary to increase their number. The size of the Ganz pump was not given, and the price was somewhat less than a first-class pump delivering 400 gallons of water a minute could be bought for in this market. Contrasting the two plants from the point of view of the exciters, in the case of the British Thomson-Houston Company the generators were very large machines of 2,500 kw. each, requiring about 3,500 h.p. to drive them. Any one of these could be excited by any one of the four exciters proposed in their tender, but it was customary in plant of this kind to connect all the exciters to one common conductor. From this conductor the necessary current for each of the large dynamos was taken, so that two exciters would generally excite three and possibly four of the large engines. The proposition of Messrs. Ganz was to place an exciter on the end of the shaft of each engine. Therefore, whenever that engine was shunted, the exciter was shunted too, and if anything went wrong with the exciter—which was rather a small and somewhat delicate machine—belonging to one of the large generators, that engine was useless and put out of service. This, in his opinion, was very poor practice, and he did not know of one large traction station in existence where it was in use. In the British Thomson-Houston tender there were two auxiliary engines proposed for driving the auxiliary machinery in the power-house. Messrs. Ganz, however, proposed no such equipment, and he did not know how it was proposed to light the power-house, or to carry on the small work, such as running the stokers, for which some current or steam was necessary. It was not absolutely necessary to have this auxiliary machinery in the power-house, but it was very desirable and in accordance with first-class practice.

Mr. Wallace submitted at this point that the power-house equipment had nothing to do with the system of electric traction to be used. The Metropolitan Company were not bound in any way by the tender of the Ganz Company. They could put down any power-house they liked—the same as was proposed by Mr. Chapman if they wished. He conceded that if the Metropolitan Company were going to put down the works, they should probably put down more perfect plant for moving ashes, carrying coal, etc. The arbitration was not to decide questions of that kind.

Mr. Moulton said they were there as a result of the extraordinary tender of the Ganz Company. He wished to show that there was not the very slightest thorough examination of these tenders, and that they were treated by the two engineers who reported on them as similar things. As a matter of fact, the one gave 14,000 kw. for so little and the other only 10,000 kw. for so much. The one was for a first-class equipment and the other merely a sketchy one.

The **Arbitrator** ruled that the matter was clearly relevant to the enquiry.

Mr. Moulton then examined the witness as to the difference between the two systems as regards the method of conducting. The cost of the cables in the direct-current system, as shown by the British Thomson-Houston tender, was £39,336, which included duplicate cables from the power-house to the sub-stations. The Ganz tender did not provide for duplicate cables, and in his opinion it would not be safe to work the Inner Circle without a duplicate set. Generally

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speaking, the Ganz was a very much lower grade of machinery all the way through than that proposed in the other tender. He had visited Budapest and Sondrio, and had seen the plant that was made to carry out the Ganz system. He did not know of a single foot of electric line in America that was worked with induction motors in cascade. The experimental line at Budapest was not in existence when he was there, but at Sondrio he took part in tests with the Ganz system. He then described the overhead equipment at Sondrio. The trolley wires were supported by wooden poles at each side of the line. These poles were connected with a solid wire, from which the various insulators were hung. The rails were bonded around the outside of the fishplates with a small copper wire, much smaller than would be considered the practice for a direct-current road operating in a small town. The current was collected by means of immense trolleys weighing 357lb. each, and having no less than 300 parts. The accepted form of direct-current trolley, on the other hand, for the same service weighed only 125lb., and had but 45 parts. In the Ganz system there were two trolleys to each motor, and he estimated their cost at about £40 each, while the direct-current trolley was sold for £6. At all cross-over roads, and in the yards, the overhead trolley system with two wires of high potential required the constant introduction of long insulating strips. These were made of wood, and had to stand the continual tension, together with the vibratory action of the wire, which tended to split the wood. As to the efficiency of the Ganz trolley from the point of view of insulation, the piece of wood 8in. or 9in. long between the two rollers becoming impregnated with dust and rust, which always fell from the iron girders in tunnels, would cease to be an insulator, the two currents with 3,000 volts between them would char the wood, and if there was a short-circuit the wood would burn up. This would stop the traffic, and in the case of the Inner Circle the cars would have to be pushed out of the tunnel. The fact was that there was practically no room above the top of an ordinary car for a trolley of that kind. In his opinion, the contact arrangements proposed by Messrs. Ganz would not work on an actual line like the Inner Circle. As to the way in which the wires were supported, he agreed that very much greater care and certainty of action were necessary with a voltage of 3,000 than with 500—nearly six times as much. The wires at Sondrio were suspended from solid guard wires, with the insulators hung on the solid wires. The method of suspension as proposed by Messrs. Ganz for the Inner Circle would not work in his opinion, and the safety device suggested would not give safety. He deemed all such devices to be danger devices until proved. The device also was evidently not complete. He had already counted 25 parts, and there were some missing. It was probably proposed to clamp to the span wire overhead. In his opinion there was room for a span wire to go across the tunnel except where there were iron girders. On the question of the method of suspension, it was always customary to hang the trolley from span wires. His experience of trolley line construction had demonstrated that every particle of weight that was attached to a wire became an anvil, and as the wheel or bar passing along the trolley struck this anvil it immediately started a little break just at the leading point, and after a wire had been up any length of time, at every place where there was a little extra weight that wire would break. He therefore believed that the rigid supports proposed by Messrs. Ganz would not work without frequent breakdowns on the Inner Circle, but, of course, the number of breakdowns would depend on the number of trains operating over the lines. In his opinion it was not practicable in the present case to use such a method of suspension. It would be necessary, in order to effect repairs in the trolley line, to first shut off the current, which would cause serious delay in the service. If there were four hours' interval at night between the trains it would be possible to put up the overhead wires without interfering with existing traffic, but not otherwise. If a wheel trolley were used with a service of a car a minute, a trolley line would last about 1½ years. With a sliding trolley under the same service a trolley wire would last only about 100 days. Further questioned as to the efficiency of the proposed safety device, speaking as a practical man he did not think it would be an effective safety device, and, moreover, its enormous weight would lead to breakages in the trolley wire. Turning to the question of the motors, Mr. Chapman stated that the revolving part of the motors he saw at Sondrio weighed about 2,400lb., and revolved very close to the surface of the stationary part, the clearance being about $\frac{1}{4}$in. In hard work it was not practicable to work with only this clearance. In the direct-current system they could work with an air-gap of $\frac{1}{8}$in. The result of narrowing the clearance was that there was much less wear in the bearings before they had to be renewed. As to the support of the motor, with few exceptions all traction motors in America were geared machines—*i.e.*, one end was supported on the cars and the other end on the truck frame, the truck frame being, of course, spring-hung; therefore, in an ordinary traction motor about one-third of its weight was unspring-borne. Years ago there were gearless motors exploited in America. They were spring-borne, and the car wheel was driven from the end of the armature by a device quite similar to that proposed by the Ganz Company. They did not like them, and they were "scrapped." With regard to the trials at Sondrio, there were present, in addition to himself, Mr. Parshall, Mr. Dawson, Colonel Yorke, Mr. Trotter, Mr. Condo, and a number of employés of the Ganz Company. The contact with the trolley wires was not perfect, and there was a good deal of sparking. They did not have a locomotive, but had a motorcar and three goods trucks to make up the train. The total weight of the train was about 83 tons. The motorcar weighed 114,000lb., or something over 50 tons. They found that the actual consumption was from 65 to 85 watt-hours per ton-mile, depending upon the length of the run.

Mr. Parker remarked that that was a very rough-and-ready way of measuring the expenditure of energy for the acceleration. Continuing, **Mr. Chapman** said the acceleration obtained was $\frac{1}{10}$ft. per second per second. Stated differently, that was one mile per hour per second. The proper acceleration for the Inner Circle was about 1½ft. per second per second. The expenditure on a direct-current system, such as the Central London Railway, was 41½ watt-hours per ton-mile, and the acceleration obtained from this expenditure was 1ft. per second per second.

Mr. Parker: But you have the assistance of the inclines on the Central London Railway.

Mr. Chapman said the figures he had given in that case were for acceleration on the level. Sir William Preece had said that the current used for acceleration on the City and South London line was 38 watt-hours per ton-mile.

Mr. Parker pointed out that the stops were so much further apart. These figures were not correct only for the particular case unless there was a statement, not only of the speed attained, but the length of run, because these watts were taken over a length of running.

Mr. Chapman said they were indicated in the Sondrio experiments, as he had stated. They got from 65 to 85 watt-hours per ton-mile depending upon the length of the run. The longer the run the more favourable were the watt-hours per ton-mile.

Mr. Parshall said the run on the Central London Railway was half-mile.

Further examined by Mr. Moulton on the diagram of acceleration plotted from the results obtained at Sondrio, **Mr. Chapman** said it would be absolutely hopeless, as far as making a schedule of 16 miles an hour was concerned, including stops, to have an acceleration of only $\frac{1}{10}$ft. It took all parties concerned in the Sondrio experiments to get the necessary information for the diagram. Some was obtained on the train, and some simultaneously at the sub-station. The representatives of the Ganz Company furnished the instrument readings, and Mr. Trotter was on the train and acted as assistant in putting down the speed results. The method used for recording the speed of the train was to count the joints on the track at intervals of 10 seconds. The resistances used on the Sondrio motors were water rheostats. There were two on each car, operated by compressed air from the Westinghouse air-reservoirs. He thought that water resistances of this kind were wholly unadapted to the requirements of the Inner Circle. As regards the lighting of the train, Mr. Chapman said that in the Sondrio train, at midnight, it was lighted from an accumulator. This accumulator was underneath the car, and was charged from a rotary converter at some other point on the line.

Mr. Moulton: Now, do not take away the character of the other side. A rotary converter?—I am sorry to say such was the fact.

Mr. Moulton: Do they touch the evil thing in that way, and actually carry a rotary converter on their motorcars?

Mr. Chapman said they could not charge a storage battery of an accumulator from an alternating current, and it was, therefore, necessary to run a rotary converter in order to change the current from three-phase to direct. He then gave a description of the car used at Sondrio. When the roller trolley was in contact with the wires the current passed through a 3,000-volt static transformer, which was another device on the car. From the secondary termnials of that transformer it was able to operate three-phase lamps at a frequency of 15 With this frequency an ordinary electric lamp could not be used by itself. There must be three legs in each lamp in order to get a steady light. For all these auxiliary purposes there was not the slightest difficulty with the 500-volt system. By transforming the current into this voltage direct all complexities were abolished. Questioned as to the practical difficulties of junctions and crossings, his opinion was that they could not be got over with multiple-unit trains of variable lengths. With locomotives there would have to be established a dead section, and the train would have to come to a stop on that section. There the current would be reversed. This would be a very serious disadvantage in such a line as the Inner Circle. The difficulty with the multiple-unit control would be greater than with anything else. The dead section or gap would have to vary with the length of the train. With a suitable distribution—*i.e.*, with two outside rails side by side, or with one centre rail and one outside rail—this difficulty did not occur in the direct-current system. He was absolutely satisfied with the working of the direct-current system for all classes of traction. As far as his experience went, the safety of the system with the collecting rails on the ground was practically assured. He had built and maintained in Chicago over 50 miles of elevated road, every inch of which was equipped with contact rails at 550 volts. He also maintained 500 miles of trolley. Covering a period of seven years, he never killed or seriously injured a man on that whole system.

Cross-examined by Mr. Cripps, Mr. Chapman said that more generating plant would be wanted with the Ganz system at a frequency of 15 than with the Thomson-Houston system at a frequency of 25. There would be no difference, however, in the equipment of the generating stations in the two systems, and assuming the power factor were the same, there would be no difference in the cables to the sub-stations. In Chicago it was the practice not to have sub-stations, but to generate direct current in the first instance. Continuing, the witness said he had an estimate of a sub-station for 7,500 kw. capacity, such as was proposed for the Inner Circle. The rotary transformers, the switchboards, and the static transformers were estimated at £6 per kilowatt capacity—*i.e.*, £45,000. Against this the Ganz Company would put a price of simply the cost of the static transformers. The tenders were only for 220 train miles per hour, but if the demands were doubled this estimate of £6 still held good, whereas the Ganz price did not, because the rail for the return of their current, even on the basis of their present proposition, was fixed for 13½ volts drop. With double the number of kilowatts, the drop in the rail would be practically prohibitive; they would have to have twice the number of sub-stations. With the direct-current system on the Inner Circle it was proposed to use accumulators for operating an automatic signal system, to move the traffic at night, to allow for cleaning the high-tension switchboard in the sub-stations. It was assumed that the Circle would have an all-night service at quite frequent intervals. On the basis of an all

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night service at an interval of half an hour, he estimated the cost of the accumulators at £7,500. It would not be necessary to use accumulators in the day service. He denied that it would be impossible to work satisfactorily on the Inner Circle by means of rotary converters without accumulators. With sub-stations at Earl's Court, South Kensington, Charing Cross, and Whitechapel, and a service at 1½-minute intervals, he estimated that about £10,000 worth of direct-current copper would be required. Sixty miles of collecting rail at 80lb. to the yard would cost £68,950, which would complete the Inner Circle. He had made no estimate of the exact cost of the Ganz overhead conductors. He estimated that a train would take 50 minutes to run round the Circle, allowing 20 seconds for each of the 27 stops. Cross-examined as to the method of suspension suggested by Messrs. Ganz, he repeated his assertion that rigid supports would not be satisfactory for the overhead wires; also that the suggested safety device was wholly unreliable. As regards the life of the wires, he stated that if the trolley bars slided instead of rolled, as would be the case, the wires would not last for even 1½ years The weight of the motor at Sondrio was 8,360lb. The air-gap of ½in. was not practicable commercially. As regards acceleration, the highest speed attained at Sondrio was 40 miles an hour; it took a little over a mile to reach that speed. The expenditure was from 65 to 85 watt-hours per ton-mile, but with cascade brakes about 10 per cent. of energy was sent back to the line. To go round the Inner Circle in 50 minutes, he would not only want but would have to have an acceleration of 1½ft. per second per second. He denied that it would be possible with an alternating motor to get an acceleration of 2½ft. per second per second, unless you could get your current at practically no cost. In a commercial undertaking you could not afford to buy coal to get that acceleration from three-phase motors. Electrically, it was a very serious matter to design a three-phase motor for such an acceleration. Of course, if you could take a motor 12ft. in diameter and could furnish current at practically no cost, you could accelerate at 5ft. per second per second. He further considered that there would be great difficulty in getting an acceleration of even 1½ft. per second per second from a three-phase motor, because with the Burgdorf-Thun motors, which were the best three-phase motors that had ever been produced, the best acceleration obtained was 1·017ft. per second per second. They were not in cascade, and if they were they could not do so well. It was almost impossible to satisfactorily construct a motor for three-phase current if one were limited to, say, 4ft. for the height of the car floor. There would be the same difficulty with a geared motor as with a gearless motor.

At this stage the **Arbitrator** again raised the point as to the tenders being based on 220 train miles per hour. He thought there ought to be some agreement with regard to the matter. Could they not have an estimate of what the actual equipment of the whole of the Inner Circle would cost in each case? He wanted to get a comparison *similia similibus*.

Mr. Chapman said he had not got the conditions under which he could give an estimate of the cost of the actual equipment.

Mr. Moulton said that a serious estimate of what people would do it for, would be putting them to an expense which he was certain would be many hundreds of pounds.

Mr. Cripps said he would do what he could to bring a comparable thing before the Court when his turn arrived.

The Court adjourned.

Saturday's Proceedings.

The cross-examination of **Mr. Chapman** was continued by Mr. Cripps, K.C. On the question of the tenders, the witness admitted that the Ganz engines had the advantage of 11lb. of steam per i.h.p., as against 14lb. in the case of the British Thomson-Houston's proposals; but the two propositions could not be compared, because it was not stated what number of degrees of superheat it was proposed to use. He agreed that it would be an enormous advantage in favour of Messrs. Ganz if they could with better engines obtain more power than the British Thomson-Houston Company with less boiler surface, but he did not admit that the engines proposed by Messrs. Ganz were at all comparable with those proposed in the other tender. It was not true to say that the tender of Messrs. Ganz was on the basis of 21,300 h.p., as against 18,000 h.p. in the case of the British Thomson-Houston. In the one case the service was guaranteed, and in the other it was not. The normal capacity of the generators in one case was 2,700 kw. with three engines only, and in the other case the normal capacity was 2,500 kw. with four generators. Machines which were made of any reasonable construction would stand 100 per cent. overload momentarily, 75 per cent. for two hours, and 50 per cent. for six hours. Therefore, the only safe way in which to rate plant of this class was by taking the normal kilowatt capacity on the boiler capacity which furnished the steam. Mr. Cripps then cross-examined the witness as to the diagram of acceleration plotted from the results obtained from the tests on the Valtelina line, and suggested that the portion of the acceleration—*i.e.*, that at starting—which was most favourable to the Ganz system had been excluded. Mr. Chapman explained that this could not be avoided, as the acceleration for the first few yards could not be recorded at the starting of the train, because the "clicks" in passing over the joints were not audible. It was impossible that equal acceleration could be obtained with either the direct-current or alternating-current motors. He could only say that at the present time with the direct-current the required acceleration was being obtained on hundreds of railways, whereas with the alternating motors it had never yet been obtained, and he doubted whether it could be with any reasonable expenditure of current.

Re-examined by Mr. Moulton, Mr. Chapman repeated that the acceleration of the train at Sondrio could not be recorded accurately at the start, but after 10 miles an hour perfectly accurate observations were made. Referring to the tenders, in his opinion, with the same steam pressure and degree of superheat, the Ganz engines could not do so well as the British Thomson-Houston engines. Again, it was impossible to get the same power from the boilers as specified in the one tender as from the other boilers. Messrs. Ganz proposed to superheat steam and the British Thomson-Houston Company did not. It was true that it was possible to do work with a less amount of steam superheated than it was with saturated steam, but one had to take into consideration that Messrs. Ganz required superheaters and steam to this, which made all the difference. It was absolutely impossible with superheaters to get the same effect from 48,000 square feet of boiler surface as from 80,000. Thus, the Ganz engines would not give out 21,000 h.p. against 18,000 h.p. in the case of the British Thomson-Houston Company. They might get it for about two minutes but for no longer. In the British Thomson-Houston tender there were arrangements for lighting the trains, the line, and the central station.

In reply to the Arbitrator, Mr. Chapman said that taking the tender of the British Thomson-Houston as it stood, there was no other source of power than from the trolley wire. With the direct-current system, however, accumulators could be used, but these were not included in the British Thomson-Houston tender.

Further questioned by Mr. Moulton, the witness stated that it was on his experience with an elevated railway in America that his calculations as to the current output required per ton-mile were made. The number of tons moved on that line was exactly the same as would have to be operated on the Inner Circle, and he estimated that the current output on the American line was 60 watts per ton-mile. The average speed was 16 miles an hour. Questioned as to the safety device suggested by Messrs. Ganz, the witness said that until it was tried it was not worthy of manufacture. As to the type of motor proposed by Messrs. Ganz, it appeared from the tender that they did not intend to use geared motors.

The **Arbitrator** asked if it were not a fact that they enjoyed a wonderful immunity from accidents in America.

Mr. Chapman said it was. As to the protection afforded against the third rail in the States, in the case of some of the steam railways that were converted to electrical working a board was put on the face of the rail, but on all the new lines on the third-rail system the rail was quite unprotected. Its safety consisted in the current being comparatively harmless or inaccessible to the public. The only risk was to trespassers or to the staff through carelessness.

Mr. Philip Dawson was the next witness. Examined by Mr. Fletcher Moulton, he stated that he was chief engineer to Messrs. R. W. Blackwell and Co., and had carried out a large portion of the traction work in the United Kingdom, as well as in the Colonies and on the Continent. He had built some 1,000 miles of electric tramways, and installed over 250,000 h.p. for the purpose. He had no interest whatever in any particular system. He was familiar with all the important three-phase traction systems which were working. These were mostly excursion lines in Switzerland, and only run in summertime. The Burgdorf-Thun Railway was the most important of these. On this line the train service varied between eight and twelve trains in either direction per day. The number of trains running on the total length of 25 miles at one time varied between two and five in the summer time. In his opinion three-phase motors were very bad for high acceleration. The consequence of having a large air-gap was that the magnetising currents would become much greater, and the power factor would be lowered. The rigid suspension proposed by Messrs. Ganz had long since been given up. The damage done with this method at the points of suspension and the places where the trolleys struck the anvils was very serious. He attributed most of the breakages in trolley wires to the hammering of the trolleys at the joints. It would be absolutely unsafe in his opinion to instal high-tension wires on the Inner Circle in the way proposed by Messrs. Ganz. Nowadays the aim was to get as flexible a suspension as possible. In his opinion it would be absolutely unsafe to instal a high-tension wire or any wire in the way proposed to meet the difficulties of the tunnel. He was certain the wires would frequently break, and the repairing of them would cause serious interruption to the traffic, because the current would have to be cut off from either end before they could be carried out. To repair one break in the trolley line might take anything from one to five hours' time. Speaking as a practical man, he did not think that high-tension wires as proposed ought to be permitted in a tunnel. Also he thought it would be very difficult, if possible, to deal with the junctions on the Inner Circle with the Ganz system. From experience gained at Sondrio, he was very sceptical of the working of the trolleys with rollers. These rollers were made of very thin metal, and the wires, he thought, would wear this out. Again, the proposed wooden insulation would not be sufficient for 3,000 volts on the line. He did not consider that water rheostats were mechanical appliances suitable to traction work. He had never known them used for the purpose with the exception of some experimental lines. Their resistance would vary with the proportions of the solution and with the temperature, and they would not stand any shaking. The method of control at Sondrio was practically automatic. The motorman had not the control over his engine that was given with the direct-current system. Broadly speaking, he had only two speeds—viz., half speed and full speed.

Cross-examined by Mr. Cripps, he admitted that theoretically water rheostats were the best, but not in practice. As to the method of control, he did not agree that there was no difference between the direct-current and the alternate-current motors. With continuous-current engines it was possible to very nearly instantaneously reverse the motors and use them as additional brakes. In the Ganz system it was necessary to go through the whole cycle in getting up speed again. There was very little difference on the direct-current system between putting both the conducting rails inside the 4ft. way, or one inside and one outside. At the present time it had not been decided which method would be adopted on the Inner Circle.

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Re-examined, the witness said he saw no practical solution of the difficulty of reversing the motors on the Ganz system.

Mr. George Estall, M.I.C.E., examined by Mr. Fletcher Moulton, said he was resident engineer and locomotive superintendent to the District Railway. Long before the experiments on the experimental line at Earl's Court, in which he took part, he had viewed overhead wires with great anxiety from a maintenance point of view, and he was now convinced that they involved considerably more trouble and anxiety than the rail conductors. One important objection to overhead wires was that on the Inner Circle there would practically be no headway between the top of the cars and the roof of the tunnel. At the present time a service was run on the Inner Circle for 20 hours out of the 24. It was proposed when the line was converted to electrical traction to run for the whole 24 hours.

Cross-examined by Mr. Cripps, the witness said he was present at the consultations of the joint committee of the two Boards on the question of the electrification of the Inner Circle, but he did not suggest any objections to the alternate current at that time. He was there simply as a servant of the District Company, and his views were not asked for. He did not know whether or not it would be necessary with the Ganz system to raise the platforms on the Circle. The conducting rails in the Earl's Court experiments were outside the 4ft. way, but he did not known what the District Company's proposals as to this matter were. He was firmly of opinion as regards the overhead equipment on the Ganz system that the adverse circumstances in which the traffic would have to be conducted on the Inner Circle would be of an appalling character.

This concluded the case for the District Company.

Tuesday's Proceedings.

Mr. Cripps, K.C., in opening the case for the Metropolitan Company, said it was sufficiently obvious that on some points of electrical science and electrical working connected with this question there must be conflicting evidence. The three important points to which the evidence up to the present had been directed were safety, efficiency, and cost; and he did not propose in the course of his address to shirk anything that had been said under any of those heads. At the outset he claimed that on all three points the Ganz system had the advantage, but he proposed to deal with each question specifically in order to show what his clients' views were. As regards the history of the dispute, he might claim in a sense that the Metropolitan Company were the predominant partners in the Underground Railway in that they had greater interests both in the Inner Circle and the outside traffic than the District Company. The Metropolitan Company owned about 50 miles of outside extensions, and it was quite possible that ultimately the electrical working, when a proper system had been determined upon, would be applied to these lines. Referring to the work of the joint committee of the two companies which considered the question of electrical equipment, he pointed out that it had come to a conclusion which would undoubtedly have been carried out but for the intervention of Mr. Perks and his friends. What gave Mr. Perks and his friends the opportunity of intervening was the financial difficulties of the Metropolitan District Railway Company. So far as the Metropolitan Company were concerned, they were a perfectly solvent company, and in a position to carry out anything that might be decided upon. He submitted that the financial state of the District Company could not be urged against the solvent company as an argument in derogation of the polyphase system if it were declared the better system. Before the intervention of Messrs. Perks and Yerkes everything was going on by agreement between the two companies, and negotiations had been opened with the Board of Trade to see whether the polyphase system could be adopted or not. The joint committee was constituted as follows: Colonel Mellor, Captain Pavey, and Mr. McLaren, representing the Board of the Metropolitan Company; and Mr. Forbes, Major Isaacs, and Sir Charles Dalrymple for the District Company. The question the committee had to deal with was a complex problem, and the committee accordingly appointed as representatives of the two parties two eminent engineers—Sir William Preece, representing the District Company, and Mr. Parker, representing the Metropolitan Company. These two gentlemen gave their best attention to the solution of the problem, and were united in thinking that the best solution was the polyphase system called the Ganz system, because it happened to be connected with the tender of Messrs. Ganz in this case. Mr. Cripps then dealt with the report of these two engineers on the tenders as criticised by Mr. Chapman in his evidence in support of the direct-current system. The learned counsel contended that Sir Wm. Preece quite understood the tenders of the Ganz Company and of the British Thomson-Houston Company, and that the conclusions they came to were perfectly accurate. In the first place, the Ganz tender stood out against all others on the question of price. Again, there were certain additional factors absolutely necessary to the continuous-current system which were not found in the alternating system. For instance, there were the rotary converters and the extra cost of the feeding conductors with the direct-current system; and he might say that it was not so much a continuous-current system as a mixed system. It was proposed to bring the alternating current to sub-stations, and, subject to the question of the power factor and given the same electrical equipment, little difference would probably be found between one system and the other. It was when one came to the question of distribution that the additional cost of the feeder conductors and the sub-stations had to be considered. The criticism of the District Company on the question of equipment was that, as regards the boiler plant, the square feet of heating surface was very much greater in the British Thomson-Houston tender than in the Ganz tender—80,000 square feet in the one case and 48,000 in the other—and that Sir Wm. Preece and Mr. Parker were wrong in saying that the Ganz system was the better in the quantity of power offered. He would remind the Court that the Ganz Company proposed to superheat the steam, and if there was any controversy on the point, he had it from Prof. Ewing that with the superheating system the square feet of boiler surface would be 73,300 in the polyphase system as against the 80,000 square feet of the British Thomson-Houston Company. But so far as the engines were concerned, it had been shown that less steam was required with the Ganz system than with the British Thomson-Houston engines, the difference in steam consumption being 11lb. as against 14lb. respectively. He further claimed that these two engineers were quite accurate in their statement that "in their apparent adaptability to the present and future requirements of the companies the polyphase system is the best." He would point out on the question of cost that the saving under the head of sub-stations in the case of the Ganz system was about £70,000. With the direct-current system they must not only have rotary converters—which were very expensive—but they had to supervise them, whereas the polyphase sub-stations—which were no more than transformers—required practically no supervision. On the question of supervision, it was well known that the Board of Trade would not allow machinery of the class of rotary converters to be used without constant attendance. In the cost of working, that was a very material consideration. The engineers also, he contended, were correct in stating that "it (the Ganz system) also reduces the weight of line conductor to a small figure," and, finally, that "it simplifies the whole electrical equipment." It had been suggested against the polyphase system that it was a more or less automatic system. He would call evidence to show, however, that one of the claims in favour of the Ganz system was that it got rid of the human element required in the direct-current sytem for the supervision of the rotary converters. Also, he would show that the experimental element in the Ganz system had been very much exaggerated. Taking the report of the two engineers—Sir Wm. Preece and Mr. Parker—as a whole, he contended that the conclusions they came to on the two systems were quite accurate, and the real controversy now was as to whether the quantity of power in each case was properly estimated, but he would not deal with this point on the tenders. Mr. Cripps then went on to review the proceedings of the joint committee with a view to showing that so far from putting obstruction in the way of the electrification of the Inner Circle, the Metropolitan Company had from the outset been most desirous of coming to an amicable agreement as to the best system to be used. He also criticised the agreement between the District Company and the District Electric Traction Company, contending that from a financial point of view no protection was given to the District Company in this agreement. The agreement was a relationship based on the fact that the persons who had got control of the District Company and those who had floated the Traction Company had made up their minds that they would not give an impartial consideration of the question, but were determined to have the continuous-current system. Dealing now with the purely electrical questions involved, the first point was as to the relative safety of the two systems. He contended that the three-phase system had had ample experiment, in the sense that from the practical as well as from the scientific point of view it could be thoroughly trusted. With the continuous-current system there must always be an element of risk if they had easily accessible contact rails which had a voltage of about 550 volts. In the case of the Ganz system, if the overhead wires were properly protected and made inaccessible there was no danger. Electrically, there was no more risk with the one system than the other. Referring to the evidence of Mr. J. Swinburne, he pointed out that that witness practically admitted that there was no difference between the two systems as regarded acceleration and efficiency, and that the diagram which was put in of the acceleration obtained in the tests at Sondrio had been found to be incorrect, and had been withdrawn. It was said that an acceleration of 1·5ft. per second per second was required for the Inner Circle. With the Ganz system they had not the slightest difficulty in getting an acceleration of 2·5ft. if necessary. He contended that the criticism of the District Company on the question of acceleration had broken down, and there was no doubt that on this point there were the same advantages in the one system as in the other. Then, as regards the question of speed, it was claimed on behalf of the continuous-current system that there was a margin of speed which was not given to the alternating motors. He would point out, however, that the alternating motors could be geared up to any speed, but when the maximum speed was reached the greatest efficiency had been obtained. From the point of view of economy and efficiency, the best speed of an alternating motor was 25 miles an hour which was about the speed required on the Inner Circle. As regards the advantage of the alternating over the continuous current motor, he claimed that the system as a whole told far more favourably when the electrical force was carried over long distances than over short distances. It was generally agreed among experts that the longer the distance, the more advantageous it was to have a high pressure and small current. It was put forward again, that they had not the same control with the alternating motor as with the continuous-current motor, but he pointed out that high efficiency of braking power was obtained in the Ganz system from the double action of the electrical brake and the cascade brake. On the question of cost, he did not suggest that there was any substantial difference in the cost of the generating station whichever system was used. In the case of the British Thomson-Houston tender, the estimate was £80,000 for four sub-stations and £72,000 for conductors. The views of his expert engineers were that it would be absolutely necessary to have six or eight sub-stations in order to deal with the traffic on the Inner Circle. He, therefore, estimated that the total cost for sub-stations and contact conductors in the case of the continuous-current system would be £207,000 or £247,000, according to whether there were six or eight sub-stations. This estimate was also allowing for extra conductors which would be required, at a cost of £15,000. As against these figures, the cost of equipment in the case of the Ganz system was £35,000 for the transformer sub-stations and £40,000 for the overhead wires—a total of £75,000, as against £207,000 or £247,000 in the case of the continuous current. In the

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British Thomson-Houston tender 80 per cent. of the cost of the sub-stations was attributable to rotary converters, whereas they were not required in the Ganz system. His case was that from its nature the continuous-current system required equipment of a more costly character than the alternate-current system. As regarded economy in cost of working, the Ganz estimate was that there would be a leakage or a loss of energy between the generating station and the motors of 13 per cent. more in the continuous-current system than in the alternating-current system. That meant that in order to get the same power on the motors they would have to generate 113 units in the case of the continuous-current to every 100 in the Ganz system, and the extra cost of coal for this purposes would always be an additional expense against the continuous-current. They had been told that the Ganz tender gave a power factor of ·7, but as a matter of fact this should be ·82. For the rotary-current system the power factor claimed was practically unity—viz., ·95. It was quite possible in the Ganz system, however, by putting more copper in the conductors to get the same power factor, but in the case of the continuous current they always had the extra cost of coal to take into consideration for generating the 13 per cent. of lost energy, and this would result in a difference of £6,000 or £7,000 per annum in working cost. Compared with the Ganz system the wear and tear in the continuous-current system, particularly in connection with the use of electric brakes, he estimated at an additional £4,500 in working cost per annum. If these figures were maintained, the Ganz system showed an annual saving of close on £15,000 in working cost and an annual saving of £150,000 in initial expenditure over the continuous-current system, which was an enormous balance in favour of the Metropolitan Company's case. Of course, if it were shown that in safety or in efficiency the continuous-current system was the better, he admitted that the question of cost became of less importance. Dealing with the question of rigid suspension of the overhead wires, his case was that the Ganz method of suspension had been in actual operation, and had worked exceedingly well. The criticism of the other side with reference to the proposed safety device was that the whole action of the contrivance depended entirely on the springs, but he submitted there was no inherent vice in the device more than in any other mechanical contrivance. Liquid rheostats were suggested by the Ganz Company, but he would point out that it was not necessary to use them. They were proposed by Messrs. Ganz because they were undoubtedly the best form of rheostat. The next point was as regarded the running of the trains at triangular connections, such as at Aldgate East. The Ganz Company proposed leaving a gap of about 50ft. in the overhead conductor in order to get over the difficulty of the reversal of the motors at these junctions, and he submitted that even if the driver neglected to reverse the connections in time no harm would be done. There would only be a slight retrogradation required in order to make the connections complete. Another point raised was as to the air-gap of ½in. proposed by the Ganz Company, and he would bring evidence to show that perfect working of an alternate-current motor could be obtained with an air-gap of this size. Again, nothing could be more simple than the air-pressure control they proposed. As a practical working contrivance, they had just as good a control as with the continuous-current motor. He also would bring evidence before the Court to show that in the matter of overhead trolley wires they had a great advantage over the other system. Where the overhead wires were used on the Central London Railway for shunting purposes, they were very much preferred to the contact rails. In conclusion, he submitted that no one could doubt that the Metropolitan Company had been actuated throughout by one desire—viz., to get the best possible system of electrical working for the Inner Circle. Having regard to the actual conditions of the traffic, the question for the arbitrator was which was likely to be the most safe and most efficient system, and which was likely to be carried out under the most economical conditions. He claimed that under each of these heads the Ganz system had the advantage, and this would be borne out by the witnesses he proposed to call.

Mr. Otto Titus Blathy (manager of the electrical works of Messrs. Ganz and Co. at Budapest), examined by Mr. Cripps, said that for 18 years he had had experience of all kinds of electrical machinery. It was at the beginning of 1885 that his firm introduced the alternate-current system of distribution, and the first successful use of transformers was then demonstrated. His experience of alternate-current used for traction work was of about six years' standing, and the first experimental line with alternate-current three-phase motors was built at Budapest in October, 1896. Since that time his firm had devoted much attention to the investigation of problems connected with electric traction, the design of motors, and other equipment for the successful operation of such a system. The experimental line at Budapest was put in operation in December, 1899, and had been kept in operation for two or three hours every day for the last 15 months. It had worked entirely satisfactorily. He would go so far as to say that the motors had never been opened for inspection until the experts visited Budapest this year. They had behaved perfectly, and the same might be said of the liquid rheostats. The pressure on this experimental line was always 3,000 volts. As had already been stated, polyphase railways were in operation on several lines in Switzerland, but the voltage there never exceeded 750. The Valtelina line in Italy was now completed. It was 67 miles long, and would be put in operation at the end of the present month. The delay which had occurred in the opening of this line was not due in any sense to any difficulty with the electrical equipment, but to the lack of water power. His firm's experience with the three-phase system was, in his opinion, quite sufficient to solve the problem of electric traction on the Inner Circle. The basis they had proceeded on in considering the question of electrical equipment, was that the Inner Circle was 30 miles long, with 27 stations somewhat more than half a mile apart, and that the train ervice would be at least equal to that which was now provided. A ½-minute service on the whole Circle would be adequate, and to perform this it would be necessary to have 40 trains in continuous operation, working at a rate of 620 train miles per hour. In dealing with the whole of the suburban traffic, it was proposed to have all the trains, whether fitted for electrical working or not, of the same length. But for bringing in and taking out the long-distance traffic an electric locomotive would be employed. The Inner Circle and suburban trains would be composed of six cars, of which the first and last would be motorcars. The motorcars would weigh from 30 to 40 tons each, and the trailers 13½ tons. Each car would have seating capacity for 64 passengers. On the whole train there would be 31 tons of electrical equipment, consisting of motors, trolley apparatus, etc. Originally it was proposed by Messrs. Ganz to use gearless motors, but now it was intended to have geared motors; so that the two systems were similar in the respect that they both would use geared motors. With gearless motors it was necessary to use a frequency as low as 15, which was the frequency on the Valtelina line, where all the motors were gearless. On the Inner Circle it was now proposed to use a frequency of 25, as this made the generators, transformers, and motors slightly cheaper, and still allowed of the advantage of the use of cascade connections. The polyphase system was characterised by the use of the polyphase current throughout. In the power station the high-tension three-phase current would be generated at between 10,000 to 11,000 volts at 25 periods, and at this voltage the current would be transmitted to sub-stations situated at some or all of the railway stations round the Inner Circle, where, by means of static transformers, it would be transformed down to a tension of 3,000 volts. No attendance would be required at these sub-stations. These 3,000 volts would be carried by two overhead conductors, and the current collected by two pairs of trolleys with rollers on each of the motorcars. There would be two groups of motors on each motorcar. The regulation of the speed of the motors would be effected by liquid rheostats operated by compressed air, the same as that used for the Westinghouse brakes. As he had said, one characteristic of the Ganz system was the use of polyphase current throughout, which obviated the necessity for rotary converters at the sub-stations. Other advantages of the system were the use of groups of two motors with cascade connections, and the current was returned to the lines. With the continuous current the whole of the energy was dissipated. The salient point in the Ganz system, however, was the fact that rotary converters were not used.

In reply to the Arbitrator, the witness said that the polyphase current was transformed down to 330 volts for the secondary batteries on the cars.

Continuing, he stated that in starting a polyphase motor the current from the rotor must be regulated by resistances. After half speed the secondary motors were brought into use, and they were enabled to get nearly double the power as though they used a single motor. Experiments with motors in cascade had been made in America and Elsberg, but the reason why some of these experiments had not been successful was that ordinary motors were used. If they took the very best ordinary polyphase motors that were made and put them in cascade, the result would not be satisfactory. The reason for this was that the advantage of cascade coupling would not show itself except when the motors had a very high power factor. The power factor of commercial polyphase motors was anywhere between 85 and 90 per cent., and one of the witnesses had stated that the motors that were put to test in America had power factor of between these two limits. The power factor of the main motors it was proposed to use on the Inner Circle was 92½ per cent., and of the secondary motors of 4 per cent. It was the power factor of the secondary motors which was the more important of the two. Messrs. Ganz had no difficulty whatever in constructing these motors now, although some two or three years ago the problem was not so simple. It had been suggested that an advantage could be got from continuous-current shunt-wound motors, but these had been proved not to answer. Tests made on the Valtelina Railway had shown that the recuperation on an ordinary run was about 30 per cent. of the total energy supplied to the trains. On the standard run on the Inner Circle the recuperation would be about 9 per cent. of the energy required to start. This question of recuperation, however, was not of so much importance on the Inner Circle as on the outside lines. In the Ganz system, in order to economise, a certain amount of energy which was required for the magnetisation of the motors, as soon as synchronous speed was reached three of the main motors were entirely switched off and only one motor was kept in circuit. As each of the motors was of 300 h.p., and only about one-half of this was required to keep the train at full speed on the level, one motor was quite sufficient. After some time this motor was switched off, and the train would be run by its momentum. To bring the train to a stop the cascade connections were put on, which brought it down to half speed, and the air-brakes did the rest. All the polyphase motors had four poles, and with 25 frequency their speed was 750 revolutions per minute. This gave a running speed of very nearly 25 miles an hour. The main motor had a brake capacity of 300 h.p. Its efficiency, excluding friction, was 94½ per cent. full load, and including friction 89 per cent. Its power factor was 92½ per cent., but if the motors were in cascade the efficiency was 85 per cent., exclusive of frictional losses, and 80 per cent. including friction. The power factor in cascade was 77½ per cent. One advantage of polyphase motors was that no carbon dust could enter the motor. The continuous-current motor had not this advantage Another was that the protecting part overhung the bearings, and it was, therefore, permissible to have very much longer bearings than in the other motors. As regards the motors themselves, it had been said that the alternate-current motors must be very heavy and costly, but the practice of all large firms on the Continent was in direct opposition to that theory. As a matter of fact, a 300-h.p. polyphase motor weighed 2·7 tons, whereas a 150-h.p. continuous-current motor weighed nearly 2½ tons. The maximum induction of the main motor of the Ganz system was 8,000

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lines of force per square centimetre. In the case of the continuous-current motor the induction was very much larger than that. His experience with polyphase motors on tramways was that on one system on the Continent, which his firm equipped two years ago, the average distance run by one motorcar was 50,000 miles. On another system the average run by one motorcar was 31,000 miles. By ordinary wear and tear no repairs whatever were required in the two instances he had given. For the motors it was proposed to use on the Inner Circle very ample and long bearings had been provided for, and his experience had shown that these had the longest life.

At this stage the Court adjourned.

WEDNESDAY'S PROCEEDINGS.

Mr. O. T. Blathy, further examined by Mr. R. W. Wallace, K.C., for the Metropolitan Company, gave evidence as to the rate of acceleration obtained with the alternate-current motors. In the case of the Ganz motors, in the first half of acceleration—*i.e.*, up to half speed—the acceleration was 2·6ft. per second per second, and in the second half 1·44ft. per second per second. Several weeks ago he took part in some tests made on the Valtelina line, when the acceleration was found to be 1·5ft., which was exactly what it should have been according to calculations. This was with a motor geared for a maximum speed of 41 miles an hour. With a motor of the maximum speed of 25 miles this acceleration would be increased with the reverse proportion of the speed. It would then be as high as 2·5ft. or 2·6ft per second per second. According to the proposals of Messrs. Ganz for the Inner Circle, they would require an energy of 71 watt-hours per ton-mile taken from the trolley wire to get round the Inner Circle in 50 minutes with 27 stops of 20 seconds each. As the losses in acceleration were proportional to the work done, decreases in the maximum speed would also reduce the losses in the rheostats, and that was one reason why a low speed, if possible, should be adopted. It was claimed for the direct-current system that the train would start with an acceleration of 1½ft. per second per second. In the tender put in by the Westinghouse Company for the Inner Circle the maximum speed was shown at 26½ miles with an acceleration of 2·2ft. per second per second. In the proposal of the Ganz Company the suggested maximum speed was 25 miles an hour, and taking the maximum speed with the direct-current system to be 27 miles, the energy to be supplied would have to be 6 per cent. more. To this must be added the loss in the rheostats. In the case of the Ganz system this loss was 50 per cent., whereas in the direct-current he admitted the loss to be only 22 per cent. It was agreed, however, by the other side that the recuperation in the Ganz system would be 10 per cent. more than in the direct-current. He estimated that the economy in working conditions with the alternating system was about 5 per cent. Comparing the Ganz tender with that of the British Thomson-Houston Company, the latter gave the energy supplied from the rotary converters as $93\frac{3}{10}$ watt-hours per ton-mile, from which must be deducted 10 per cent. for loss in the lines and 6 per cent. for the lighting of the trains. This gave $77\frac{1}{10}$ watt-hours supplied to the motors, as against nearly 71 in the Ganz tender. In the Westinghouse tender, with an acceleration of 2·2ft. and half-mile runs, the energy required was 68 watt-hours per ton-mile to get round the Circle in 50 minutes. As the run between the stations on the Inner Circle was about 35 yards less than half a mile, this figure was brought up to about 69, which was very nearly what the Ganz Company claimed. The reason why it was easier in practice to obtain economy with the alternating system was that at the time when the driver shut off the current the supply of energy was at the rate of 126 kw., while in the case of the continuous current it was somewhere near 400 kw., the loss of efficiency in the alternating system being only $\frac{7}{10}$ per cent., as against 2½ per cent. in the other, besides which the energy in the former system was recuperated, while with the continuous current it was entirely lost. On the Central London Railway an energy of 41½ watt-hours per ton-mile was required. This was sufficient in that case, because the mean speed on the Central London Railway between stops was something more than 15 miles an hour, while on the Inner Circle the mean speed was 19 miles an hour between the stations, which accounted for the small amount of energy required on the "Tube." He then gave figures to show that the less stops there were the smaller would be the power required. For instance, under certain conditions the watt-hours per ton-mile, with half-mile runs, would be about 70; with one-mile runs, 52; with two-mile runs, 43; and with runs of indefinite length, only 34 watt-hours per ton-mile would be required. It was, therefore, very difficult to compare railways of different lengths and different conditions. From the figures he had given, it would be seen that on the given lines there was no perceptible difference in the amount of energy necessary in the two systems. The Ganz Company claimed 71 watt-hours, the British Thomson-Houston Company 66 or 67, and another continuous-current system 68 or 69. One advantage of the Ganz system was less complicated transmission of energy to the motors. Further, the loss in the overhead conductors was only 1 per cent., and 3½ per cent. in the transformers. On the rotary converter system there was a loss of between 8 and 10 per cent. in the contact rails, an energy loss of 7 per cent. in the rotary converters, and of 2½ per cent. in the transformers, the total loss being 17½ or 19½ per cent., against 4½ per cent in his system. This made a difference of 13 or 15 per cent. less power required in favour of the Ganz system. The average power factor with the alternating current as applied to the Inner Circle would be 82½ per cent., and in the rotary converter system 95 per cent., but, as he had pointed out, about 13 per cent. less power was necessary in his system.

At this stage the further examination of Mr. Blathy was postponed.

Mr. Gisbert Kapp, M.I.C.E., M.I.E.E., was next called, and gave evidence in favour of the alternate-current system. Examined by Mr. Wallace, he said he was editor of the *Elektrotechnische Zeitschrift*, and lecturer in electrical engineering at the Technical High School, Berlin. He had had special experience with three-phase motors made on the Continent by leading firms. The tendency now was to use multiphase motors for heavy railways there, as distinct from street tramways.

Mr. Moulton thought they ought to have the names of these railways.

Mr. Kapp explained that at present there was only a tendency to use multiphase motors for heavy railways. Continuing, he said that two leading firms on the Continent had formed an association to study the question of working of heavy railways by electricity at high speeds. They had devoted a large sum of money—nearly £100,000 — to experiments with particularly large rolling-stock, and they had agreed that nothing else than alternating current would do. Experiments were now being made on the military railway in Berlin, which was just over 20 miles long. It was proposed to get a speed of 120 miles on this line, but up to the present the highest speed which had been attained was 70 miles. The reason why alternate current was used on this line, was that enormous power was required to be put into the train. The only polyphase railway he had seen was the Valtelina line, between Lecco and Sondrio. His comparison between the direct-current system and that proposed by Messrs. Ganz was this. As regards power required there was very little difference between the two, and the little difference there might be would be due to local conditions. The amount of energy which had to be put out from the central station, however, would be more in the continuous-current system, because the conversion from alternating to continuous current was less efficient by perhaps 13 per cent. Of course, this difference in energy ultimately meant a difference in coal consumption. The size of the high-pressure feeder cables, and the arrangement of the cables from the generating station to the sub-stations, would be almost the same in both cases. The material difference in the two systems, however, occurred in the outlay in the transformer stations on account of the high cost of the rotary converters and the switch gear required in the direct-current system. And then there would be a difference in cost due to the heavy conductor which was required in this system, whereas the alternate current only required two light overhead conductors. As to the cost of working apart from the cost of plant, with rotary converters you must have attendance in the sub-stations, and there was also the cost of repair. With regard to the drop of voltage in the rails, it had been suggested in reference to the Ganz system that there would be a very large increase of apparent resistance, so that the rails would only carry the return current with a large drop. He had calculated the drop that would occur on the Inner Circle in the worst case, and he found it would only be three volts out of a working pressure of 3,000. He thought that in a single track where there were no crossings there was slight risk with the contact rails on the ground, but where there were crossings and branches he considered that the ground contact rails were dangerous, especially to platelayers and other workmen who had to go about in a confined space like a tunnel. In the open country he did not think the danger was appreciable, but trouble might arise on the extension lines from the formation of sleet and ice on the contact rails; but there would be no risk of this in the tunnels. In the case of floods, however, the service would have to be shut down. His opinion was, that for safety the conductors ought to be placed overhead out of reach of both employés and passengers. He also thought that the pressure on the line should be fairly high, so that the current should not be too high. Mr. Kapp then referred to some experiments he made about 18 months ago with a 10,000-volt overhead line on the alternate-current system. The sparking was considerable, but there was no burning of the metal. He tried the same line with continuous current. The pressure was only about 750 volts, and the contact sparked badly. On the Valtelina line he noticed some sparking, but very slight and only occasionally. It usually occurred at the points of suspension. If two trolleys had been used as was originally intended, and as was now proposed for the Inner Circle, there would practically have been no sparking at all. On the occasion of his visit to the Valtelina Railway he was sent by Mr. Ellis to report upon the line. His object was first to see if the running was at all practicable, and, secondly, to measure the losses, speed, acceleration, traction losses, consumption of energy, and the handling of the trains. He was assisted in the tests by a Mr. Goodworth and a Mr. Lamb, representing Major Cardew and Prof. Ewing. Altogether they made runs of an aggregate mileage of 34 in one day. The highest speed recorded was 40½ miles per hour, at which speed the train ran perfectly smoothly, and it was under perfect control. On one run the driver saw a cow ahead on the line only about one-third of a mile away, but he was able to pull up the train in time with ease. He was able to set the speed of the train to anything short of maximum. The cascade braking was under perfect control and the acceleration was 2ft. per second per second uphill, and when not going full speed the train was run in cascade. On the Valtelina line there were long grades up to about 22 to 27 in 1,000. There was less jerking when the cascade braking was applied than when the Westinghouse brakes were used. With regard to the working of the trolley road, there was some slight sparking, but not much. He made one run especially to determine the acceleration of the motors, the records being made by a calculation of the rail joints. At starting the joints were counted by sight and afterwards by sound. There were three observers on the train, so that the results obtained might be accepted as quite accurate. The increase in speed was a constant—viz., 1½ft. or 1·55ft. per second per second. This test was made with the motors in cascade. Calculations from the diagram of acceleration which he put in showed that the draw-bar pull was 3,060 kg. The train of six cars weighed 54 tons, and the conditions of the experiments were as nearly as possible the same as those on the Inner Circle. If they had used a longer train, the tests would not have been so valuable in that they would not meet the conditions of the Inner Circle. Having regard to the results at Sondrio, he considered that on the Inner Circle they would get an acceleration of 2·6ft. per second per second. As to the power and energy required, he put in another diagram of results. He found that the energy shown by this diagram

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was 21,960 kilowatt-seconds. Calculated by theory, if he had no tests to go by the energy would be 22,200, which was practically the same as that shown by the experiments. He had applied the same manner of calculation to the Metropolitan Railway, and the results were correct in that case also. The efficiency obtained from these figures was 65 per cent. On the Inner Circle it would be 75 per cent. Under the conditions of the Metropolitan Railway he obtained the following results: The total energy required for propulsion was 70·6 watt-hours per ton-mile. The power factor of the motors in cascade was ·77. This power factor lasted for about seven seconds. In the following 12½ seconds, with the motors running single, the power factor was ·92. The draw-bar pull in cascade was 14 tons. The maximum current taken by the train at the start in cascade was 219 amperes, and when running single 211 amperes. Running at top speed, the current dropped down to 28 amperes. The average power factor was ·892. The mean power used during the run was 164 kw., whereas the maximum was 1,000 kw. The energy required was 71 watt-hours per ton-mile.

Questioned now as to the manner of excitation adopted in the power-house, the witness said that nowadays it was more a question of fashion than anything else. The modern practice in Germany was to couple the exciters direct to the main dynamos, so he did not consider that method an imperfection. As to the use of liquid rheostats, they had been used, to his knowledge, for the last 13 years in stationary work, and more recently for movable cranes. They were also used on the military railway in Berlin. He did not consider the use of liquid rheostats a drawback in traction work. At Sondrio they gave no trouble at all, and he thought they were much the best practice. He agreed with Mr. Blathy that the saving in energy in the case of the Ganz system was about 13 per cent. There was no difficulty whatever in working over triangular junctions with this system. On the grounds of safety, efficiency, and capital, and working cost, he considered that the alternate-current system was the better proposal for the Inner Circle.

Mr. Fletcher Moulton cross-examined the witness with a view to showing that he had never had any practical experience with heavy electrical railways, and that his knowledge of the same was merely theoretical. **Mr. Kapp** replied that, although he had never been in charge of an electric railway he had had a lot to do with such railways was no different from the other witnesses who had been called in this respect. He did not agree that all the best engineers were against using alternate current for traction purposes. All the alternate-current railways he knew of had been put down by Messrs. Brown, Boveri, and Co. It was true this firm had discarded the use of cascade connections, but they were bound to get poor results because they used the wrong motors for the work. It was not correct to say that the breaking down of a transformer in one of the sub-stations in the Ganz system would result in a stoppage of the traffic. In every sub-station there would be three transformers, and if one broke down the other two would be sufficient to work the line as usual. It would be downright waste of money to have attendants in these sub-stations. His calculations of what would be attained on the Inner Circle with alternate-current motors, it was true, were made on drawings of the motors, but in this there was nothing exceptional. It was often the case that an engineer had to advise on drawings alone. Mr. Kapp was further cross-examined on the question of acceleration, but he stood by the figures he had given as to the tests on the Valtelina line, and his calculations of what would be obtained on the Inner Circle. Re-examined, he stated that in his experience he had had ample opportunity of advising on all questions where the working of railways and tramways by electricity was involved. With regard to the cascade connections, it was an invention which did for the alternating current what the series-parallel control did for the continuous current. Assuming a breakdown on the line with the Ganz system, such as the snapping of one of the overhead wires, it would only be necessary to take the current out of the particular section involved in order to effect repairs. There would be no switchboards in the Ganz sub-stations; a few switches on pillars were all that would be required. These would practically require no attendance. He had no doubt whatever that with the alternating system on the Inner Circle they could get sufficient acceleration with a very good margin; indeed, quite equal to that obtained with the continuous current. He also thought it would be quite possible to use solid rheostats if found necessary.

Mr. Blathy, further examined by Mr. R. W. Wallace, K.C., said that on the Valtelina line they had provided 6 h.p. in the motors per ton of train. On the Inner Circle they proposed to provide 8 h.p. per ton. On the Italian line they were not so concerned with getting a high average acceleration, and hence had not made the same arrangements on the locomotives to that end as they would do for the London line. He had again looked into the question of the relative advantages of the two systems, and concluded that at the power-house there would be about 10 per cent. in favour of the Ganz system. In reply to Mr. Parshall, Mr. Blathy admitted that he proposed to use the rails as a conductor, although this was expressly forbidden in the specification issued by Messrs. Preece and Parker. The drop in the rails would be about 5 per cent., but he did not agree with Mr. Parshall that this only corresponded to a 2½ per cent. loss of energy. In reply to Mr. Wallace's numerous questions as to whether he had anything further to say on any subject, Mr. Blathy explained that with a 25-mile maximum speed and a 16-mile scheduled speed, including 20-second stops, he would have a three minutes' margin in the whole Circle run. In other words, they could do the journey in 47 minutes by running longer at maximum speed, and then applying at once the cascade brake. For the trains which worked mostly on lines outside London he would use a different gearing for the motors; they could then run, say, at 47 miles per hour, but when on the Inner Circle at slower speeds the efficiency would be not quite so good. He explained to the arbitrator the varied parts of the controlling gear that he had in court, and claimed that compressed air was quite satisfactory as a system of control. An automatic valve controlled by a solenoid would keep the acceleration constant in the usual way. A second valve controlled by the driver would enable him to work independently of the automatic control where desired. Although the driver could control all the motors from the front car, he could only use the motors under that car for running in the reverse direction. This, he thought, would be quite sufficient. He thought that the system of circulating the solution in the liquid resistance would ensure its keeping cool. As regards the triangular junction, a special signal would be given to the driver at a certain point that he had to reverse his motor connections. In doing so he would switch all the motors behind his car, and they would have to run into the next station with reduced power. In that station the throw-over switches on the motorcars would be operated by the guard. In the event of the driver running past the point, the mechanical shock to the passengers would only be equivalent to a negative acceleration of ½ft. per second per second, as the motorcars would only be reversed one at a time. With respect to the collecting gear, they suggested the use of a roller instead of a trolley wheel, in order to avoid the shock which a trolley wheel experienced in passing the suspension points on curves. The rollers would be mounted on ball bearings. All the high-tension gear and circuits would be completely enclosed in an earthed metal envelope. This switch gear could only be got at by opening a door with a key, which was also used to admit the compressed air into the trolley-raising cylinder. This key could not be withdrawn from the trolley-cock unless the trolley was down, out of contact. In the same way, when the key was in the lock of the cover of the high-tension switch gear, it could not be withdrawn unless that cover were closed and locked. This prevented the trolley being raised again in contact with the overhead wire until the operator had protected the high-tension gear. He thought that this removed all chance of danger to the driver. With respect to the overhead wires, these could, if it were wished, be replaced by I-shaped girders, weighing 8lb. per yard, for an additional sum of £5,000. Mr. Blathy then referred to the overhead wires erected in the shunting yard of the Central London Railway.

In course of the argument, **Mr. Parshall** said these were not erected for additional safety in place of the usual contact rails beside the track. He thought they must have been put there for ornament, as steam locomotives were used for all the shunting operations.

In the sub-stations **Mr. Blathy** said they would use three single-phase transformers, with a fourth transformer as spare. He attributed the difference in the boilers offered under the two tenders to the fact that the Ganz Company proposed to superheat the steam to a very large extent.

The cross-examination of Mr. Blathy by Mr. Fletcher Moulton was postponed until the next meeting of the Court of Enquiry on Monday, the 11th inst.

APPOINTMENTS VACANT.

Junior Assistant Engineer, Birkenhead Corporation electric tramways, 30s. per week of 56 hours, Nov. 11. Full particulars in our advertisement columns.

Switchboard Attendant, Birkenhead Corporation electricity supply, 27s. per week of 56 hours, Nov. 11. Full particulars in our advertisement columns.

Engine-Driver, Borough of Leigh Tramway and Electricity Department, 35s. per week of 56 hours, Nov. 16. Full particulars in our advertisement columns.

Chief Assistant to Superintendent Engineer, Bradford Corporation Electricity Works Department, £150 per annum, Nov. 11. Full particulars in our advertisement columns.

Shift Engineer on central station, to take charge of eight-hour shift 30s. per week. Full particulars in our advertisement columns.

Junior Meter-Room Assistant, with experience in calibrating meters and demand indicators, and in general testing, 25s. per week. Full particulars in our advertisement columns.

Draughtsman, used to the manufacture of switches, automatic cut-outs, measuring instruments. Full particulars in our advertisement columns.

Assistants wanted in test-room of instrument factory (London, W.). Full particulars in our advertisement columns.

Resident Electrical Engineer (Mersey Railway Company) to superintend construction and working of electrical plant. Full particulars in our advertisement columns.

Wiremen (2) for light, telephone, and bells. Full particulars in our advertisement columns.

Electrician, with a knowledge of engineering, to take charge of an electric installation (including storage battery) in a brewery, 35s. per week. Full particulars in our advertisement columns.

Various.—Appointments are vacant at Hackney electricity works, including fitters, jointers, storekeeper, drivers, etc., Nov. 12. Full particulars in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Brighton.—The Council invite tenders for the supply of meters for a period of one year from Jan. 1, 1902. Tenders by Nov. 25. Details in our advertisement columns.

Great Eastern Railway.—The Directors invite tenders for the supply of various stores and materials. Tenders by Nov. 22. Details in our advertisement columns.

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Leigh.—The Tramways and Electricity Committee invite tenders for the supply of triple-concentric cables during the 12 months ending Oct. 31, 1901. Tenders by Nov. 16. Details in our advertisement columns.

Farnworth (Lancs.).—The Urban District Council invite tenders for wiring and fitting up the tram depot, Albert-road, for electric light and power. Specification, etc., may be had from Mr. J. D. Pember, electrical engineer, Electricity Works, Albert-road, Farnworth, R.S.O. Tenders by Nov. 11.

Dundee.—The Town Council invite tenders for the delivery of eight electrical car bodies. Specifications, etc., may be had on application to Mr. Peter Fisher, tramway manager, Town House Buildings, Dundee. Tenders by Nov. 11.

Dundee.—The Town Council invite tenders for Brill trucks and complete electrical equipment for eight tramway cars. Specification, etc., may be had on application to Mr. Walter H. Tittensor, city electrical engineer. Tenders by Nov. 11.

Croydon.—The Town Council invite tenders for building an underground electricity sub-station in Addiscombe-grove. Specification, etc., may be obtained at the Borough Electrical Engineer's Office, Factory-lane, Croydon. Tenders by Nov. 18.

Coventry.—The Electric Lighting Committee invite tenders for the supply and erection of triple-expansion low-speed vertical marine type engine and 400-kw. direct-coupled alternator and exciter. Tenders by Nov. 27. Details in our advertisement columns.

Islington.—The Borough Council invite tenders for electric lamp columns, complete with crutches and bases. Specifications, etc., can be obtained on application to the Borough Electrical Engineer, 50, Eden-grove, Holloway. Tenders by Nov. 26.

Woolwich.—The Borough Council invite tenders for the supply of electrical instruments. Specification, etc., may be obtained on application to Mr. John B. Mitchell, borough electrical engineer, Council Offices, Maxey-road, Plumstead. Tenders by Nov. 15.

Wimbledon.—The Urban District Council invite tenders for the wiring of their electricity works, Durnsford-road, Wimbledon. Specification, etc., can be obtained on application to Mr. F. Barnes Spencer, electrical engineer to the Council. Tenders by Nov. 14.

Newport (Mon.).—The Monmouthshire County Council invite tenders for the electric lighting of the new County Council-chamber and offices, also the existing offices at Newport. Specification, etc., may be seen at the office of Mr. William Tanner, F.S.I., county surveyor. Tenders by Nov. 11.

Aberdeen.—The Tramways Committee invite tenders for the supply and erection of overhead linework, the supply and laying of cables, and the bonding of rails (bonds supplied by the Corporation) for the equipment of their Union-street and Holborn-street tramways. Tenders by Nov. 26. Details in our advertisement columns.

RESULTS OF TENDERS.

Kingston (Surrey).—The tender of Prestwich and Burt has been accepted for the wiring of the Yewsabit Works at £29. 10s.

Fulham.—The Guardians have accepted the tender of C. W. Clarke, 117, Queen Victoria-street, E.C., for installing the electric light in the St. George's Chapel and at the committee rooms, Fulham Union.

Batley.—The Electric Lighting and Traction Committee will recommend the Corporation that the tender of Abm. Graham and Sons, of Longroyd Bridge, Huddersfield, for the construction of the permanent way of the Batley tramways, be accepted.

Blackpool.—The Corporation have accepted the following tenders: Lowdon Bros., Dundee, traction poles; British Insulated Wire Company, Prescot, cables; J. F. Simpson, Hopton, near Burnley, overhead line bonds and materials; British Thomson-Houston Company, 20 cars electrical equipments.

Bristol.—The City Council have accepted the following tenders: Babcock and Wilcox, pipework £2,911, coal-conveying plant £2,756; S. Z. de Ferranti, Limited, switchboard, £2,295; Buchanan and Curwen, electric light installation, £325; Mereweather and Sons, altering pipe and sump at the Avonbank Estate, £70.

Northampton.—The following tenders have been received for the electric lighting of public portion of Emporium-arcade, Northampton, for the Northampton Estates and Improvements Corporation, Limited, by Mosley and Scrivener, Fish-street-chambers, Northampton:

F. Watkin, Northampton	£171	0	0
Lea and Warren, Kettering	168	10	0
Mansell, Northampton	130	0	0
National Electric Wiring Company, London (accepted)	117	18	0

Erith (Kent).—The Urban District Council have accepted the following tenders: (Section A), two Lancashire boilers, with fittings, economiser, feed pumps, etc., Spurr, Inman, and Co., Limited, Wakefield, £1,870; (B), pipework, etc., in engine and boiler house, Babcock and Wilcox, Limited, 30, Farringdon-street, London, E.C., £921. 3s.; (C), surface-condensing plant, Wheeler Condensing and Engineering Company, Limited, 179, Queen Victoria-street, E.C., £607; (D), three steam alternators (vertical enclosed high-speed engines direct coupled to three-phase alternators), International Electrical Engineering Company, Clun House, Surrey-street, Strand, £3,070; (E) main switchboard and connections, International Electrical Engineering Company, £980; (F), 10-ton engine-room travelling crane, Carrick and Ritchie, Waverley Engineering Works, Edinburgh, £218; (G), transformers, sub-stations, and equipment, British Electrical Transformer Manufacturing Company, Limited, Globe Works, Woodfield-road, Harrow-road, London, W., £1,194; (H), underground mains, conduits, and roadwork for private and public lighting, Callender's Cable and Construction Company, Limited, Hamilton House, Victoria-embankment, E.C., £7,517. 0s. 7d.; (I), arc lamps (open type) and posts, Callender's Cable and Construction Company, £254. 18s.; (K), station lighting, H. E. Keen and Co., The Avenue Cross, Worcester, £29. 10s.

Reading.—The Town Council have received the following tenders for the construction of the electric tramways:

Dick, Kerr, and Co., Limited, London	£83,443	0	0
E. Nuttall, Manchester (accepted)	83,882	3	8
R. W. Blackwell and Co., Limited, London	84,644	0	0
W. Griffiths and Co., Limited, London	85,407	0	0
C. Chadwell, Blackburn	87,085	0	0
Osman, Southampton	90,143	0	0
A. Faulks, Loughborough	91,605	0	0
G. Law, Kidderminster	95,163	0	0
B. Cooke and Co., London	104,000	0	0
W. Pattinson and Sons, Ruskington	136,543	0	0

Limerick.—The Corporation have received the following tenders for the supply of electric plant required for the Corporation electric lighting scheme:

P. Dillon, Thomondgate	£16,289	0	0
Porte, Sykes, and Co.	17,590	19	6
Crompton and Co., Ltd.	16,868	10	0
Handley and Shanks	19,265	13	5½
Johnson and Phillips	19,153	19	10
F. Suter and Co.	16,513	6	4
British Schuckert Electrical Co., Ltd.	17,203	19	0
Allgemeine Electricitäts	16,381	0	0
W. Coats and Sons., Ltd.	17,597	17	8

The tenders have been referred to Mr. Enright.

Whitby.—The Urban District Council have received the following tenders for the wiring of the electricity works, Church-street, the sub-station under the Council's offices, the Council offices, Flowergate, and the public shelters, conveniences, and bandstand, Pier-road, Whitby:

Walker and Hutton, 37, Huntriss-row, Scarborough (accepted)	£126	1	0
Tattersall and Smith, 100, Linthorpe-road, Middlesbrough	138	15	6
G. F. Wells, Waterhouse-lane, Scarborough	140	14	9
Jackson and Co., York-road, South-West Hartlepool	146	13	5
L. G. Tate, 20, Bucklersbury, E.C.	149	5	0
A. Dickinson, 19, Upper Mill-hill, Leeds	166	9	0
C. Clark, 36, Princess-street, Scarborough	167	14	0
Gresham and Stephenson, Flowergate, Whitby	186	18	6
W. Wharam, Claypit-lane, Leeds	196	10	0
Cox-Walkers, North-Eastern Electric Works, Darlington.	198	6	0

BUSINESS NOTES.

TRACTION.

Blackpool.—The tenders for the Corporation tramway extension have been placed.

Ilkeston.—Work in the construction of the electric tramways for the borough has been commenced.

King's Norton.—The District Council have appointed a Tramways Committee to consider all questions relating to tramways.

Stanmore.—A largely attended meeting of ratepayers has passed resolution protesting "very strongly" against the proposed light railways.

Halifax.—It has been decided to ask for powers in the Bill which the Corporation are promoting to construct a new tramway from Pellon to Wainstalls.

Finchley.—The Urban District Council have sealed their agreement with the Middlesex County Council as to the latter body's scheme of light railways for this place.

Poole and District Electric Traction Co.—This Company have made a further issue of 2,793 ordinary shares of £10 each to discharge the remaining debt on the construction of the line.

East Ham.—Statistics show that since the trams commenced running on June 22 up to Oct. 7, a period of 15 weeks, 2,251,579 passengers were conveyed, or nearly 150,000 per week.

Coseley.—The District Council have agreed to the track for the electric tramway from the Fighting Cocks being placed in the centre of the road instead of at the side, as at first proposed.

Keighley.—The shareholders of the Keighley Tramways Company have agreed to the voluntary winding up of the concern, the sale of the undertaking to the Corporation having now been completed.

Newbiggin.—The application of the Northern Counties Electrica Supply Company for provisional sanction to lay down a system of tramlines will be considered at the next meeting of the Council.

Stapleford.—The District Council were notified at their last meeting of the intention of a syndicate to apply for powers to construct a light railway, to be worked by electricity, from Nottingham to Stapleford.

Newcastle-on-Tyne.—A meeting of councillors only was called for yesterday afternoon to consider "the action taken by the aldermen whereby they seek to have eight of their number upon the Tramways Committee."

Personal.—Mr. H. E. Tatham, engineer-in-charge at the Birkenhead Corporation electric tramway generating station, has been appointed second assistant engineer under the Blackburn Corporation electric tramway department.

Batley.—With the sanction of the Board of Trade the Town Council have sealed a notice, which will now be served upon the local tramways company, requiring them to sell to the Corporation so much of the undertaking as is situate within the borough of Batley.

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Brighton.—The Town Council have confirmed their decision to promote a Bill in Parliament for a tramway along Dyke-road. It has also been decided to consider the expediency of applying for power to run motor-omnibuses in connection with the municipal tramways.

Matlock.—From the tramway engineer's last report it appears that the profit from the tramways amounted to £13. 1s. 5d. last month. An alteration in the present method of using the cars is recommended, and it is thought that a smaller and cheaper car will reduce the working expenses.

Leeds.—The City Council will be recommended to apply for a provisional order for the extension of the tramways to the boundaries of the city at Thwaite Gate, Whitehall-road, and Elland-road; and also for an extension of the system from Oldfield-lane to the Whitehall-road line near New Blackpool.

Aberdare.—With reference to the proposal of the Urban District Council to construct electric tramways in the district, a deputation of the residents of Cwmaman will wait on the Council with a view to getting the Council not to carry the main line beyond Aberaman, and to arrange to make a branch simultaneously to Cwmaman.

Durban (S.A.).—The Town Council have decided to purchase a McGuire electric tram for street watering at a cost of £978, and a smaller one at a cost of £768. Delivery has been made of a portion of the order for electric tramcars placed by the Durban Corporation with Messrs. Macartney, McElroy, and Co., Limited, London, S.W.

Broughty Ferry.—At the last meeting of the Town Council the Provost intimated that he had been approached by two gentlemen, representing different promoters, with a view to taking up the project of a tramway from Dundee. The Provost was empowered to arrange with one of the parties to meet the Town Council at an early date.

Brighton.—The Board of Trade inspection by Colonel von Donop of three sections of the new electric tramways took place on Tuesday. These comprised the routes starting from the south end of the Victoria Gardens and known as the Lewes-road section, the Elm-grove and Queen's Park-road section, and the Viaduct-road and New England-road section.

Willenhall.—Writing on Nov. 2 to the District Council, the British Electric Traction Company state that the work of reconstruction of the old tramways and construction of the new lines authorised will be started in the course of a few days. A contract is now being fixed up, and it is hoped to have the whole or greater part of the tracks ready for running for the month of May next.

Southport.—The Tramways Committee recommend the appointment of a sub-committee with power to improve the steps of the open-type cars. The receipts from the undertaking for the fortnight ending Oct. 12 last were £566, and for the fortnight ending Oct. 26 £494. It is also proposed to appoint a sub-committee to report on the receipts and expenditure of the company.

Swansea.—A joint conference of representatives of Swansea and the Glamorgan County Councils has been held for the purpose of considering the question of the control of the proposed new Swansea tramways beyond the borough boundaries. A definite decision was deferred, it being suggested that the subject might be dealt with in the Bill Swansea is about to promote next session.

Proposed Haslemere and Farnham Tramway—The proposal to construct an electric tramway between Haslemere and Farnham *via* Shottermill and Grayshott was considered at the last meeting of the Haslemere Parish Council. After some discussion, during which some adverse criticism was offered with regard to the overhead trolley system, the question was postponed for further particulars.

Bamford.—A numerously-signed petition from residents of Bamford was received at the last meeting of the Rochdale Town Council Tramway Committee asking that the tramways should be extended from the borough boundary into Bamford. The committee decided some months ago that they could not adopt this suggestion, and this decision was confirmed at the last meeting of the Town Council.

Bury.—After a lengthy discussion at the last meeting of the Town Council, a recommendation was adopted from the General Purposes Committee to adopt the Parson's-lane route for the tramways as an alternative route for Fleet-street, Rock-street, and Stanley-street, but leaving it to the Corporation to hereafter decide the actual position of the proposed new Tithebarn-street. Subsequent to this, however, a town's meeting has passed a resolution protesting against the decision f the Council.

Dewsbury.—The shareholders of the Dewsbury, Batley, and Birstall Tramway Company have been asked to reply before the 15th inst. to circulars which have been sent as to whether or not they are prepared to accept the offer of the British Electric Traction Company to purchase the shares of the company. It is stated that the price at which the traction company have offered to purchase the undertaking is sufficient to pay £4. 17s. 6d. on the ordinary shares, and to pay the preference shareholders in full.

St. Pancras.—At Wednesday's meeting of the Borough Council, a letter was read from the London County Council intimating that notice had been given to their lessees, the North Metropolitan Tramways Company, that the County Council purposed enforcing the provisions of the lease relating to the adoption of electrical traction for the working of the tramways. The Highways Committee of the County Council were, however, "unable at the present time to give even an approximate forecast as to the date when the lines will be worked by that system."

Manchester Tramways Arbitration.—The arbitration proceedings before Sir F. Bramwell, to determine the price to be paid by Manchester and the neighbouring districts, who are purchasing the tramways owned by the Manchester Tramways Company, have concluded. The company ask £510,000 as the purchase price, and the Corporation and the various districts offer £150,000. These figures depend not only upon the difference of valuers' estimates, but mainly upon the different construction placed upon the words "suitable to and used by the promoters for the purposes of their undertaking."

Presentation.—An interesting presentation has been made by the employés of the Bolton Corporation tramways department to Mr. H. England, who is vacating the post of general manager under the Bolton Corporation to take up a similar position under the Corporation of Sunderland. The gifts took the form of a valuable and elegantly-designed gilt timepiece, with a pair of ornaments to match, tobacco cabinet, and case of pipes. The timepiece was inscribed: "Presented to Mr. Harry England by the employés of Corporation Tramways Department as a mark of esteem on leaving Bolton, Oct. 31, 1901."

Preston.—A meeting of owners and occupiers has passed a resolution in favour of promoting in the next session a Bill for the following purposes: (*a*) the alteration of the gauge of the existing and authorised tramways in the borough to the gauge of 4ft. 8½in.; (*b*) the providing a site in Holmrook-road as and for a generating station and tramway depôt, in substitution for the site authorised to be used as a generating station by the Preston Corporation Act, 1900; (*c*) the extension of authorised or existing tramways, and the construction of new tramways within the borough and the urban district of Fulwood.

Taunton.—Last week the British Electric Traction Company gave a banquet at Taunton to celebrate the successful inauguration of the system of electric tramways in the town. At present the line only runs through the principal thoroughfares from the Great Western Railway station to the eastern boundary of the borough, but it is contemplated to effect important extensions at an early date. The provisional order was obtained by the Taunton and West Somerset Electric Railways and Tramways Company, but the work was afterwards taken over and successfully carried out by the British Electric Traction Company.

Hertfordshire.—Mention was made at the last meeting of the County Council of the proposal of the Council to construct a light railway from Whetstone to Barnet. It was stated that a line for Middlesex was about to be promoted by a syndicate. The general opinion of the Council, however, was that if they were to have tramways in the southern portion of the county, it would be better for them to be in the hands of the Council. It was resolved to enter into a supplemental agreement with the North Metropolitan Tramways Company, by which the County Council will pay certain costs incurred by the company in connection with their application for an order from the Railway Commissioners for the construction of a light railway at Cheshunt.

Paignton.—At last Monday's meeting the Urban District Council approved the principle of a scheme of tramways proposed by the Power and Traction Company, Limited, for Torquay, Paignton, and district. A week or two ago the Council received a similar proposal from the Provincial Electricity Supply Company, two of whose representatives have since met the Paignton Council in committee. The Power and Traction Company propose the overhead trolley system for the trams, as do also the other company, with this exception—that in the narrowest portions of the Torquay streets the open-conduit system would be used. The Provincial Company also propose to run the track along by the side of the roads, and to keep the roads in repair 1ft. on either side of the track.

Middlesex Light Railways.—The Middlesex County Council have resolved to negotiate for the purchase of the whole of the North Metropolitan Company's system within the county, and to take steps to get Parliament to recognise the Council as the tramway authority. Application is to be made by the Council for an order for the construction of the following line of light railway in substitution for the section of line, which was withdrawn from the Council's extension order: a double line commencing at a point opposite the Green Dragon-lane, in the district of Southgate, passing through land forming part of the Bush Hill estate, and thence *via* Village-road and Park-avenue, in the district of Edmonton, to a point in Enfield Town. That the county engineer be directed to prepare the necessary plans and estimates.

Manchester.—According to the local newspapers, a number of gentlemen representing most of the districts on the south and south-east side of Manchester have resolved on the registration of the Manchester Suburban Electric Railways and Land Syndicate, for the purpose of laying a service of electric trams from Sale to Stalybridge, by way of Northenden, Gatley, Cheadle, Cheadle Holme, Hazel Grove, Rose Hill, Marple, Charlesworth, Broadbottom, and Mottram, with branches for the main line at Northenden for Withington, at Mottram for Hyde, and at Mottram also for Glossop. These services, connecting up with the Manchester, Stockport, and Hyde systems, it is thought will form a comprehensive system of suburban tramways, and the promoters are convinced that with the development of the land through which their cars will pass the scheme, which is to be started as a commercial venture, will be a success.

Rhondda Valley Light Railway.—Mr. F. J. S. Hopwood permanent secretary to the Board of Trade, heard an application on Wednesday from the British Electric Traction Company for the confirmation of an order of the Light Railway Commissioners authorising the construction of a tramway about 2¾ miles in length between Porth and Tonypandy. The application was opposed by the Rhondda Valley Urban District Council and the Taff Vale Railway Company. At the conclusion of the arguments Mr. Hopwood said the Board of Trade would carefully consider the points urged. Fortunately or unfortunately, the Board were barred from considering the matter from the point of view of the public interest. They were fettered by restrictions which had been deliberately put upon them. He added that the decision as to the preamble would be communicated by letter, but as to the other matters it would be necessary for them to meet again.

Proposed Shallow Underground Tramways.—The Highways Committee of the London County Council at their last meeting

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recommended (*a*) that the standing orders of the Council relative to applications to Parliament for powers be suspended in order that the Council might consider the following recommendation: (*b*) that the Council do apply in the next session of Parliament (1) for powers to make subways in streets for the reception of pipes, wires, and other things where desirable, and for electrical traction and other purposes of locomotion; and (2) powers to construct a subway and to construct tramways therein for electrical traction from the Victoria-embankment, along Wellington-street, across the Strand, through the new street thence to Holborn, under Holborn and Southampton-row, and to take such tramways by an inclined plane to the tramways terminus in Theobald's-road, or to the tramways authorised to be constructed in Rosebery-avenue, as may be considered most expedient.

Ealing.—It was reported at the last District Council meeting that the surveyor had visited the tramway company's works at Hanwell, and found that men were engaged, both mechanically and electrically, on the cars, with a view to reducing the noise occasioned by their running. The promises of the company are that: (1) the points and crossings opposite Florence-terrace are to be removed; (2) the company will endeavour to limit the pace of the cars to 12 miles per hour, and will censure severely any driver who exceeds that pace—if such driver still persists he will be discharged; (3) the noise caused by the cars is recognised by the company, and strenuous efforts are being made to minimise it; (4) drivers will be instructed to be careful in approaching places of worship during the usual hours of divine service on Sundays, not to ring bells (except in cases of urgent necessity) or travel at a high speed; (5) the engineer asks that he may be given until Nov. 1 to make certain improvements in the construction of the lower part of the cars, with a view to lessening the noise. If no improvement should be then apparent, he will not consider an enquiry unreasonable.

Cardiff.—Some members of the Tramways Committee have inspected several bores in the concrete laid beneath the track which the tramways company are reconstructing in Newport-road in order to see whether this work is adequate for electric traction. It is reported that all the places where inspections were made showed that there was ample concrete, and on the top of the old concrete 3in. to 5in. of new concrete had been laid where it was found necessary to alter the level of the road. The committee have also inspected the power station, which is now advancing rapidly. To the request of the Corporation to be informed of the minimum inclusive sum which the tramway company would accept for their undertaking, the company have replied to the effect that they will be prepared to accept the sum of £52,500, plus £2,000 for the parliamentary expenses, making a total of £54,500. If this offer be accepted the company would give possession of the lines on Jan. 1, but the payment could be made at any time convenient to the Corporation, interest at 5 per cent. running of course from Jan. 1 until payment. This sum is exclusive of the lands, depôts, buildings, rolling-stock, horses, plant, and equipment of the system.

Stoke-on-Trent.—A communication was received at the last meeting of the Town Council from the Light Railway Commissioners enclosing copies of the Potteries light railway (extensions) order which they had submitted to the Board of Trade for confirmation. With reference to the Council's objections to various clauses in the draft order, the Town Clerk said the company would under the present order have to provide such a service of through cars between Stoke and Newcastle, *via* Trent Vale, as the Corporation might reasonably require. The company would also be required to provide a waiting-room on the Stoke and Newcastle line, *viâ* Hartshill, at the latter place the Corporation granting a suitable site at a reasonable rent. The order also contained a provision for workmen's fares at ½d. per mile, with a minimum fare of 1d., before 8 a.m. and after 5 p.m. on ordinary weekdays, and between noon and 2 p.m. on Saturdays. The company were further required in the widening of the roadway at Trent Vale to make provision for a footpath at each side of the road, their original scheme only providing for one side. The Commissioners suggested that the questions of ½d. stages for the general public and of the paving with setts 3ft. on each side of the loops should form the subject of agreement between the parties. The communication was received with considerable satisfaction. The town clerk was instructed to write to the tramways company asking if they were prepared to come to some agreement with the Corporation on the questions suggested by the Commissioners.

Light Railways.—Last Friday the Light Railway Commissioners conducted an enquiry into an application by the North Metropolitan Tramway Company for an order empowering them to construct a light railway from the main road at Tottenham through Walthamstow to Epping Forest. The Walthamstow District Council, who propose to construct and control their own system of light railways within their district, opposed the application, it being urged by the District Council that they wished to take the population further out into the unoccupied portions of the district, which the present scheme would not do. The Commissioners, upholding the objection of the Walthamstow Council, refused the order asked for. Another enquiry was held at Willesden to hear applications for light railway orders for lines from Cricklewood, through Harlesden, to Willesden, and from there to Harrow; Edgware to Stanmore and Harrow, Cricklewood to Kilburn, and Harlesden to Acton. Proposals so far as the lines at Acton, Ealing, and Chiswick were concerned were withdrawn. Evidence was taken as regards the other proposed lines, and the decision will be made known shortly. The Light Railway Commissioners have also concluded their enquiry into proposals by the Middlesex County Council to connect the whole of the existing lines from London and those sanctioned by the Commissioners and the tubes from Charing Cross to Hampstead and the Marble Arch to Cricklewood by means of electric tramways at a total cost, approximately, of two millions sterling. The scheme affords very valuable means of transit from all parts of London to the northern, north-eastern, and north-western districts of Middlesex, the population of which during the last 10 years has increased 41 per cent., while means of locomotion are admittedly inadequate. The projected lines are 8½ miles in length. Excepting one small part from Cricklewood to Hendon, the Commissioners sanctioned the scheme. The Earl of Jersey and Colonel Boughey, Light Railway Commissioners, have opened an enquiry into the proposal of the Middlesex County Council to construct light railways (1) from High-road, Southgate, along Oakleigh-road, over the Great Northern Railway, into the Great North-road; (2) from High-road, Southgate, along part of Friern Barnet-road; (3) along Woodhouse-lane to the Great North-road; (4) from the parish and county boundary in Finchley-road, along Regent's Park-road and Ballards-lane; and (5) from Ballards-lane, along Redbourne-avenue, to Hendon.

Reading.—As will be seen from another column, the Corporation have accepted the tender of Mr. E. Nuttall, of Manchester, for the permanent way of the proposed electric tramways at £83,882. In their report the engineers (Messrs. John Bowen and I. E. Winslow) state that, owing to the range of the tenders received being so wide in amount, they only specially considered the four lowest. These were, besides the one accepted, from Messrs. Dick, Kerr, and Co., £83,443; Messrs. R. W. Blackwell and Co., £84,644; and Messrs. W. Griffiths and Co., £85,407. As regards these four tenders the engineers found: (1) That the tender of Messrs. Dick, Kerr, and Co. fully complies with the specification except as respects the points and crossings and special work, which latter are Hadfield's Steel Foundry Company, Limited; Messrs. Dick, Kerr, and Co. include English rails, Sykes's conduits made by the Albion Clay Company, Limited, Burton-on-Trent; Messrs. Dick, Kerr, and Co. is a well-known firm of high reputation and large experience in this class of work. (2) That Mr. Edward Nuttall tenders in accordance with the specification, and includes English rails and Sykes's conduits; Mr. Nuttall is a contractor in a large way of business, experienced in tramway work, and now engaged, *inter alia*, in the construction of the Newcastle tramways. (3) That Messrs. R. W. Blackwell and Co., Limited, tender in accordance with the specification excepting in respect of setts. The tender includes English rails, but American stoneware conduits, and an extra price must be paid if Sykes's conduit is supplied. Messrs. Blackwell is a firm of high standing, but have hitherto confined their attention to the electrical side of the tramway work. (4) Messrs. W. Griffiths and Co. This tender complies with the specification. The rails are English and the conduits are Sykes's (Albion Clay Company). This firm is a well-known London firm of the first rank, whose experience in paving setts and street works has been of the most extensive kind. They have had experience in tramway construction. With reference to the points and crossings being manufactured at Hadfield's Steel Foundry, in Sheffield, the engineers reported that the borough surveyor had visited the works of Messrs. Hadfield, at Sheffield, to inspect the manufacture of manganese steel points and crossings, and the town of Bolton and Salford, where their points and crossings had been used. The hardness of the metal could not be doubted, and evidently it possessed some ductility, but it appeared equally a fact that the experience of Messrs. Hadfield's was inferior to the Lorain Company. The Lorain points were longer, and should thus ensure easy running. The Lorain price for points was more than 33 per cent. higher than Hadfield's. They, therefore, recommended that the points and crossings and special work be omitted from the tenders, and that a tender be accepted subject to this condition. The Council would then have the opportunity of purchasing directly from the Lorain Steel Company, or from Messrs. Hadfield's, or from both in the proportion they might think expedient, and probably at closer prices than those now before them. Eliminating the amounts for the points and crossings from the total tenders, the reduced amounts would be as follows: Mr. E. Nuttall, £77,579; Messrs. W. Griffiths and Co., £78,724; Messrs. R. W. Blackwell and Co., £79,244; ditto, with Sykes's joints, £79,827; Messrs. Dick, Kerr, and Co., £81,006. The Tramways Committee having considered the above report of the engineers, recommended the Council as follows: "That the tender of Mr. Edmund Nuttall, of Trafford-road, Manchester, be accepted, subject to the condition that the rails to be supplied be English-made rails manufactured by a firm to be approved by the committee, and also subject to the insurance company to be offered by the contractor as security for the due performance of the contract being approved by the Mayor and the chairman of the committee." After a long discussion this recommendation was adopted by the Council."

LIGHTING AND GENERAL.

Barrow.—Extensions of electricity mains to cost about £190 are to be made.

Bray.—The Council have decided to expend £7,000 on the electric light works.

Heytesbury.—Work has been commenced with the electric light installation for the church.

Beckenham.—The Urban District Council are extending their electricity mains at a cost of £180.

Newport (Isle of Wight).—The workhouse at Parkhurst is to be placed in telephonic communication with Newport.

Sale.—Particulars of a sale at Newtown of dynamo and gas-engines (one high-speed) will be found in our advertisement columns.

City Lighting.—At the last week's court a special committee was appointed to deal forthwith with the electric lighting in the City.

Axbridge.—The Guardians have decided to borrow £7,850 for the provision of the new infirmary, cooking plant, heating system, etc.

Reigate.—Major Norton has held an enquiry into the application of the Town Council for sanction to borrow £1,500 for electric lighting works.

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New Showroom.—Mr. G. W. Clarke, electrical consulting engineer and contractor, has opened a showroom at 117, Queen Victoria-street, London, E.C.

Bedford.—We note that Mr. R. W. L. Phillips, A.M.I.E.E., has now taken up his position as chief engineer at the Corporation's electricity works.

Llanelly.—The Harbour Commissioners have again deferred consideration of the engineer's report on the lighting of the dock, recommending electricity.

Nottingham.—The Electricity Committee have prepared a report as to obtaining powers for additional capital for further extensions of the electricity undertaking.

Dublin.—The proposal to add glazed brick lining to the contract for building the electric light station at the Pigeon House, at a cost of £920, has been defeated.

Bexhill.—Mr. C. A. Frost, assistant engineer to the Darlington electricity works, has been appointed assistant electrical engineer to the Urban District Council.

Malton.—The Urban District Council have decided to accept the terms offered by the Postmaster-General for the establishment of a telephone exchange in the town.

Bristol Telephones.—A special committee of the Town Council have obtained leave to go on with their enquiries and to get expert advice upon municipal telephones.

Newark.—The Urban District Council are conferring as to details of a proposed agreement with the Derby and Nottinghamshire Power Company with regard to lighting the district.

Hastings.—The Public Lighting and Electric Light Committee have purchased from the Sheffield Corporation electrical supply department two 36-kw. Brush transformers for the sum of £65.

Shoreham.—The question of a municipal telephone scheme is being discussed, and it is suggested to fall in with the Brighton municipal system, subject to there being an exchange at Shoreham.

Alloa.—The Town Council are at present erecting in the principal streets 19 electric lamp pillars to be in readiness for the electric light, which it is expected will be supplied to the town next month.

Epsom.—The Council are consulting Mr. Hawtayne with regard to a proposal to erect a lift and to instal 200 electric lights at the grand stand; 3,000 yards of new cable will be required, estimated at £1,650.

Wellingborough.—The engineer of the Electrical Power Distribution Company (Mr. Madgen) is making arrangements for the laying down of the mains in connection with the proposed installation of the electric light.

London County Council.—The Council at their last meeting agreed to lend the Poplar Borough Council £7,000 for electric light installation, and the Stepney Borough Council £10,000 for electric lighting purposes.

Electrical Engineers (R.E.) Volunteers.—A detachment of 50 selected non-commissioned officers and men enlisted from the Electrical Engineer Volunteers is about to be accepted for duty as telegraph linesmen in South Africa.

Nairn.—The Town Council have decided to apply to the Board of Trade for a provisional order under the Electrical Lighting Acts, 1882 and 1890, authorising them to supply electricity for public or private purposes within the burgh.

East Grinstead.—At a special meeting of the Urban District Council last week, the motion that the Council should apply for a provisional order authorising the supply of electricity for public and private purposes within the district, was lost.

Middlesbrough.—The Tees Conservancy Commissioners have consented to an agreement with the Postmaster-General and the Commissioner for Woods and Forests for the laying of telegraph and telephone cables across the Tees at Middlesbrough.

Share Market.—During the week a little was doing in manufacturing concerns, British Westinghouse, Electric Construction, and Brush being the principal. Debentures were also in some demand, and the continuance of the fog advanced prices in some lighting companies.

Holyhead.—At a public meeting last week the Urban District Council's scheme for the erection of a refuse destructor to cost about £4,000, and the erection of an electric plant in conjunction with same at a total cost of under £15,000, was discussed, and finally adjourned for a week to enable the ratepayers to fully consider the scheme.

Tottenham.—At a meeting of the Tottenham Ratepayers' Association this week, it was decided not to support an electricity scheme that cost above a certain amount. It was stated that the Tottenham Council had just decided to apply for a provisional order. The association agreed to write the Council applying for full information *re* the scheme.

Banbury.—The Banbury and District Electric Supply Company, Limited (the Electric Power Distribution Company, Limited, Surrey House, Victoria-embankment, W.C.), expect to commence works here in connection with the installation of the electric light about the middle of November. A site for the generating station has been secured on the canal in Lower Cherwell-street.

Electric Lifts.—We are very pleased to hear that Messrs. Easton and Co., of Broad-sanctuary, S.W., have obtained the order for the electric lifts for the Great Northern and City Railway. This firm have had considerable experience in this branch, the lifts of the City and South London Railway, which have now been running since the spring of 1900, having been constructed by them.

St. Andrews.—We learn that since our note in our last issue on this subject, the members of the Electric Lighting Committee have met the manager of Messrs. Crompton and Co., who intimated their intention of applying for a provisional order, and it is understood that at that meeting it was agreed to ask Messrs. Crompton to submit a draft agreement as a basis for future negotiations.

West Hartlepool.—The electrical engineer's last report states that during October 19,707 units had been sold to consumers, and that the number of 8-c.p. lamps, or their equivalent, connected was 18,476. An enquiry has been held into the Council's application for sanction to borrow, *inter alia*, £5,610 for electric lighting.

Northumberland.—An association of Northumberland coalowners has resolved to take up the matter of electrical power for working and lighting the mines as well as tramways in populous districts where the collieries are at a distance from the villages and homes of the workers. The syndicate intend, under the style of the Northumberland Electric Power Company, to apply to Parliament for powers.

Colwyn Bay Electric Light and Power Co.—On behalf of a debenture holder, Mr. Druce on Nov. 1 applied to Mr. Justice Farwell for the appointment of a receiver and manager of the Colwyn Bay Electric Light and Power Company on the ground that the security was in danger. The order was unopposed and was made, the period during which the manager should act being restricted to three months.

Portsmouth.—Mr. F. H. Tulloch held an enquiry yesterday into the Town Council's application for sanction to borrow £23,000 for purposes of electric lighting and £26,000 for the establishment of a municipal telephone system in the borough, in the districts of Fareham, Gosport, and Alverstoke, Havant and Warblington, Cosham, Portchester, and Rowner, the parishes of Bedhampton, Farlington, and Westbourne.

Holyhead.—A ratepayers' meeting last week decided in favour of the proposal of the Urban District Council to acquire a provisional order for lighting Holyhead and its vicinity with electricity. It was stated that a refuse destructor could be constructed and electric light supplied at a cost of £14,575, with a net profit of £396. The Council would require to borrow £16,000 for this purpose, to be repaid in a period of 30 years.

London Gazette.—The partnership existing between H. B. Barlow and L. Barlow (trading as Barlow Bros.), electrical engineers, 237, Shaftesbury-avenue, London, W.C., has been dissolved by mutual consent. A winding-up order was made on Oct. 30 *re* the Telephonic Bell-Push Syndicate, 13, Walbrook, E.C. An order has also been made for the release of the liquidator in the Electric Exploitation Company, 37, Walbrook, E.C.

Broadstairs and St. Peter's.—The Isle of Thanet Electric Tramways Company are about to commence the work of laying distributing cables for the purpose of supplying the electric light in the district, and the Urban District Council have asked the engineer of the company to attend a special meeting of the Council in order to discuss with them the whole question of lighting the streets in the district by means of electricity.

Cromer.—The Urban District Council have decided to accept an offer from Edmundson's Electric Supply Corporation, Limited, proposing that the Council should take up a loan for the purpose of electric lighting, and that the company should take over the order and carry out the work, and pay the principal and sinking fund until after a period of 14 years, when the Council should be at liberty to take over the work and discharge all outstanding liabilities.

Java.—According to a telegram in the *Daily Chronicle*, a resident of Samarang, Java, has applied to the Dutch Government for the definite concession of the application of wireless telegraphy in the Dutch East Indies, with a view to connecting Java with the adjacent coasts. It is also proposed to instal the instruments in the various postal telegraph offices and railway stations of the island, and to provide the different lighthouses round the coast with receivers with a view to taking messages from steamers at sea.

Easthampstead.—We understand that the Marquis of Downshire is having a most complete installation of the electric light fitted in his mansion at Easthampstead Park. The dynamos for generating the light are being driven by oil-engines, and are placed in a specially-designed engine-room some distance from the mansion, so that there can be no annoyance from noise or smell. New farm machinery and sawmills are also being erected. The designs throughout have been prepared by Messrs. Adams and Williams, 60, Queen Victoria-street, E.C., and the work is being carried out under their supervision.

Barnstaple.—The Town Council have received a reply to their application for power to borrow £27,000 for their electric lighting scheme. The Local Government Board considers that at present the scheme should be confined to the compulsory area, and they will be prepared to sanction a loan of £21,600 when the Town Council have furnished a satisfactory plan showing the w.c. and urinal accommodation to be provided at the proposed generating station, and the arrangements for draining the same, and information as to the purpose for which and the authority under which the site of the generating station was acquired.

Uxbridge.—The Uxbridge Electric Light Syndicate are making progress with their generating station, and are hoping within the next few days to proceed with the laying of the mains. At the last meeting of the Council a notice was read from Messrs. Callender's Cable and Construction Company, Limited, stating that they proposed to commence laying electric mains on Oct. 29, 1901, in the undermentioned streets of Uxbridge and district: High-street, Harefield-road, Windsor-street, Vine-street, Cowley-road, Greenway, New Windsor-street, Rockingham-street, Waterloo-road, Cowley Mill-road, Park-road, Hillingdon-road.

Haulbowline.—The contractors' trials of the electric light of the dockyard took place last week, and were entirely successful. While the trials were in progress, the appearance of the yard was greatly changed, the contrast between the new system of lighting and that of the primitive oil lamps being very noticeable. It is not proposed that all the lamps shall be in use under ordinary circumstances, only those

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in the residential part of the yard and in the main roads being used, but when necessary it will be possible to work in the basin and dock almost as well by night as during the day, and this will add materially to the efficiency of the yard.

New Issues.—The directors of the Poole and District Electric Traction Company, Limited, are issuing 2,793 ordinary shares of £10 at £1 per share premium, which is taken by the company. The latter has a capital of £100,000, and was formed in April, 1899, to construct and work tramways in Poole and district, and it has since obtained similar powers for tramways from Christchurch to Bournemouth, making a total length of 8¼ miles. The cost of the tramways from Poole to Bournemouth, which are stated to be complete, is £50,610, of which the company still owes £27,364, and it is in order to discharge this that the present issue is made. The cost of the Bournemouth-to-Christchurch tramways is estimated at £65,500.

Chelmsford.—Enquiries are being made as to the cost of fixing an incandescent lamp on each of the arc lamp-poles, so that the arc lamps could be switched off at midnight and incandescent lamp lights used for the remainder of the night. Marconi's wireless telegraph receiving station was reinstated on Tuesday. The high mast carrying the receiving wire was blown down some months ago, but a new one has been erected, and the first messages transmitted and received in the afternoon. The weather was most unfavourable, and a dense fog completely obscured the top of the mast. Messages were correctly received from Frinton-on-Sea, Sheerness, North Foreland, and from a vessel off the Foreland, and all were duly acknowledged.

Hawick.—Works are now being constructed by the Urban Electric Supply Company at a total cost of about £17,000. It is intended to supply electric power, light, and heat. An engine of 100 h.p. has been put down in Commercial-road to give the necessary power for a temporary installation at the new theatre, to take place within a fortnight. Cables are being laid in the principal streets, and it is expected that the works will be in full operation next spring. Street lamps will be charged at not more than 3d. per unit, and houses and business premises will be supplied at rates varying from 4d. to 7d. per unit. The Corporation have the option of acquiring the works at the end of 10 years at a price equivalent to the amount of capital expended, with 15 per cent. added. Already a large number of applications for electric supply have been received.

Aberdeen.—The new electric station, Dee Village, will probably be opened within a week or two. The demand for current has increased within the past few days so rapidly that the capacity of the works at Cotton-street was being strained to its utmost, and it was obvious that a supply must be got from the works at Dee Village without a day's delay. The staff under Mr. Bell, the electrical engineer, have been laying temporary cables, etc., to meet the demands, and Councillor Kemp, convener of the Gas and Electric Lighting Committee of Aberdeen Town Council, on 4th inst. turned on the first engine to be used at the new station. This is one of 300 h.p., by Willans and Robinson, coupled to a Mavor and Coulson dynamo. It was stated that, owing to the extraordinary increase in demand for energy, it was considered impossible to have undertaken Monday's load without assistance from the new station.

Carnarvon.—At a special meeting of the Town Council last week, the Gas and Electricity Committee recommended that an application be made to the Board of Trade on or before Dec. 21 next for a provisional order to empower the Corporation to supply electric energy for public and private purposes within the borough. Discussion arose whether a clause could be inserted authorising the Corporation to supply electricity to the outside district as well. Sir W. H. Preece, who had been consulted, advised that the question was not one which affected the Board of Trade, but purely a matter for the Local Government Board, who at present were in negotiations with other municipalities on the point, and he hoped it would be settled before the Corporation would need to go to the Local Government Board. Eventually the committee's report was adopted, and instructions were given to the committee to proceed in the matter, and if possible to secure the insertion of the clause referred to.

Sheffield.—The Electric Light Committee are seeking power to include the following provision in any Bill to be promoted by the Corporation—viz.: "Notwithstanding anything contained in the Electric Lighting Acts, 1882 and 1888, a person shall not be entitled to demand from the Corporation a supply of electrical energy to premises having a separate supply, unless such person shall have previously agreed to pay to the Corporation such minimum annual sum as will give to the Corporation a reasonable return on the capital expenditure and other standing charges incurred by the Corporation to meet the possible maximum demand of such person. In case the Corporation and the person demanding such supply of electrical energy shall fail to agree on the amount of such minimum annual sum to be paid by such person, the amount of such minimum annual sum shall be fixed by an electrical engineer to be appointed as arbitrator by the president of the Institution of Civil Engineers."

Manchester Telephones.—The City Council will hold a special meeting on Nov. 13 "to take into consideration and determine upon the expediency of joining with other local authorities in the Manchester telephone exchange area in promotion of a Bill to constitute a Board consisting of representatives of corporations and district councils within the said area, or some of them, for the purpose of providing a system of public telephonic communication in the area; for enabling the Postmaster-General to grant to the Board and the Board to accept licenses for telephonic purposes under the Telegraph Acts, 1863 to 1897, and the Telegraph Act, 1899; and to confer and impose upon the Board and the several constituent authorities all necessary and proper powers and obligations in that behalf; and also (if deemed expedient to promote such Bill) for charging all or some of the expense of promoting such Bill upon the city fund and city rate, or on such other fund or rate as the Council shall deem advisable."

Cape-Australian Cable.—Reuter's Agency is informed that on the occasion of the opening of the Cape-Australian cable last week the following telegram was received by the Eastern Extension Telegraph Company from Lord Tennyson, Governor of South Australia: "Twenty-nine years ago telegraphic communication between Adelaide and London was first established, greatly owing to the courage of Sir Charles Todd and his associates, who joined Port Darwin and Adelaide by overland wire through Central Australia, and to-day we heartily congratulate the Eastern Extension Company for joining Adelaide and South Australia with London by an alternative cable *viâ* South Africa. That would be most important, but it is also a connecting link between several strategic outposts of our Empire and the mother country, every part of which can be under the protection of British ships. Our entire community are grateful to you for this and for your reduced charge of cables, and for the greater facilities thus given to commercial enterprise."

Stockport Telephones.—Mr. W. A. Shaw, of Stockport, has been requested to prepare and submit to a Corporation committee a report upon the following matters: (1) the cost of installing an adequate service of telephones for the area of the extended borough, the wires to be laid underground within a certain radius from the centre of the town; (2) the annual cost of maintenance (including depreciation) and establishment charges for such service; (3) the prospective income reasonably expected to accrue, and the charges at which such service could be provided; (4) the question of including in the area of the municipal service any, and, if so, what outside districts, and the effect of such inclusion on the foregoing matters; (5) the general advisability of establishing a municipal telephone system by the Corporation, having regard to the prospect of such a system being established in the adjoining areas of Manchester and Salford. The town clerk has also been instructed to ascertain from the Postmaster-General the exact extent of the Stockport telephone area.

International Electrical Engineering Co.—We have received from the International Electrical Engineering Company, Clun House, Surrey-street, Strand, London, W.C., copies of bulletins Nos. 1 and 3. Bulletin No. 1 describes a complete electric power installation which has been carried out by their Liège works for the Audun-le-Tiche Blast Furnaces and Mines, Lorraine. The installation comprises two 400-h.p. slow-speed steam dynamos, electric hauling gears, pumps, and electric locomotives, etc. Bulletin No. 3 is a 16-page pamphlet dealing fully with the various types of locomotives made by the Company—viz., mining locomotives for underground work, surface narrow-gauge locomotives, factory or shunting locomotives, tipping or foundry locomotives. There are all made to standard pattern, and as the work is carried out on the Company's premises every part can be guaranteed and quick delivery given. The bulletin contains a table of leading dimensions, horse-powers, weights, etc., also a list of firms to whom locomotives have been supplied. It is well illustrated, and includes a photograph of one of the 100-h.p. gearless motors supplied by the Company to the Belgian State Railways.

Tiverton.—As early as 1888 a company intimated that they intended applying for an order to supply the town with electric light, but the Council themselves obtained a provisional order to carry out the lighting, and according to this order the scheme was to be put into force within five years. The order ran out in 1892, but the Board of Trade done all in their power to assist the town, and allowed the order to go on. Since the commencement of the question the Council have had many reports on the subject by the borough engineer and by experts. The last report, by Mr. W. P. Adams, recommended a water-power scheme, with generating works near the sewage farm, where it was possible to obtain a large fall. He recommended the Washfield Mills site, where a weir existed at the present time. Mr. Adams estimated a profit of £200 on the first year's working, provided there was an installation for 2,500 lamps. The estimate was £11,200, including the purchase of the mills and the site. At their last meeting the Council discussed the matter, and finally it was decided to refer to the experts (Mr. Adams and Mr. Neil) and the borough engineer for some particulars relating to figures submitted during the discussion.

Stock Exchange.—The Stock Exchange Committee have appointed Nov. 12 special settling day for Crompton and Co., Limited, further issue of 31,000 shares of £3 each, fully paid, Nos. 54,001 to 85,000 and Nov. 20 for Willans and Robinson, Limited, further issue of 16,666 ordinary shares of £5 each (issued at £3 premium), £5 paid (of which £3 is capital and £2 premium), Nos. 100,001 to 116,666, and 16,666 6 per cent. cumulative preference shares of £5 each (issued at £1 premium), £4 paid (of which £3 is capital and £1 premium), Nos. 125,001 to 141,666. The committee have also ordered the undermentioned securities to be quoted in the official list: Crompton and Co., Limited, further issue of 31,000 shares of £3 each, fully paid, Nos. 54,001 to 85,000). Applications have been made to the committee to allow the following securities to be quoted in the official list: British Westinghouse Electric and Manufacturing Company's further issue of 50,000 6 per cent. preference shares of £5 each, fully paid: Buenos Ayres Grand National Tramways Company's £87,137 5 per cent. second preference debenture stock, £74,523 5 per cent. income bonds, and a further issue of £9,800 5½ per cent. preference debentures; and Charing Cross and Strand Electricity Supply Corporation's £250,000 4 per cent. debenture stock (redeemable) in lieu of the provisional certificates now quoted.

Colwyn Bay.—Mr. A. A. C. Malet held an enquiry on Nov. 1 into the Urban District Council's application to borrow, *inter alia*, £8,460 for electric light extensions. Mr. G. Bevan, chairman of the Electric Lighting Committee, and Mr. Clirehugh, the engineer, gave evidence. It is proposed to put down new plant and to extend mains. The number of 8-c.p. lamps now connected to the Council's plant is 4,860, and the increased power will enable the supply to be extended to 8,000 lamps. Fifty per cent. of these will probably only be lighted at the

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same time, that being the percentage in Manchester, and there will, therefore, be a reserve or stand-by of power, without which the Council has been working in the past season somewhat riskily, but fortunately without accident. Mr. Clirehugh stated that the revenue for the three-quarters of a year during which the works had been open had been £907. Assuming that the next quarter would produce revenue in proportion, the income for the first year would be £1,250. The estimated working expenses were £742, and the charges for interest on and repayment of loans made a total of £1,242. The works were started in a primitive way, and he thought they held the record of being the only works in the country which had succeeded in paying the whole of the interest and sinking fund on the borrowed capital during the first year of working.

Penarth.—The installation of the electric lighting system has been completed, and the plant and mains having been surveyed by the Board of Trade officials, the approval of the Department was received on Nov. 1. The area of supply includes part of Westbourne-road from the Lower Penarth end to Augusta-road, part of Augusta-road between Westbourne-road and Plymouth-road, part of Alberta-road between Plymouth-road and Marine-parade, Plymouth-road, Marine-parade, Park-road, Bridgman-road, Holmsdale-place, part of Stanwell-road between Victoria-road and Windsor-terrace, Rectory-road, part of Windsor-road between Stanwell-road and Arcot-street, Windsor-terrace, part of Church-road between Beach-road and Beach-lane, and Beach-lane. The installation also provides for street-lighting, the company having erected half a dozen arc lamps. The maximum demand system of charging has been adopted (7d. and 3d.). The power station has been built at Lower Penarth, on a site adjoining the Taff Vale Railway. Here there are two of the Brush Company's 50-kw. Universal engines, with direct-driven dynamos capable of supplying 3,500 8-c.p. lamps. It is a continuous-current system, with a voltage of 230, and is the one which Cardiff will change over to from the present alternating current as soon as the heavy winter load is passed. A battery of accumulators has been erected, so that the station may be shut down at night. The work has been carried out under the direction of Mr. G. S. Leach, the electrical manager of the Electric Power Distribution Company. The order has been transferred to the Electric Power Distribution Company, who have now carried out the installation to completion, Messrs Lewis and Feltcher remaining as consulting engineers to the undertaking.

Heckmondwike.—At Monday's meeting of the District Council the Electric Lighting Committee reported that Messrs. Henleys, Limited, had been instructed to lay a cable down Croft-street. It had also been agreed to connect the engineer's office with the National Telephone Company's system. Messrs. J. H. Taylor and Co.'s tender for installing the electric light in the public baths and fire brigade station and fixing the electric bells, has been accepted. The chairman of the Council drew attention to certain remarks made by the president of the Tradesmen's Association (Mr. J. Cliffe, jun.) at a meeting of that body recently relative to the electric light. He (Mr. Redfearn) remarked that just and fair criticism was healthy, and he took no objection to such because it did good. The president of the Tradesmen's Association started out, however, by giving a wrong impression. He stated that he understood the electric light and the baths were to cost only from £13,000 to £14,000, but how Mr. Cliffe could get that impression was a mystery to him. The only report recommended to the meeting at the Forster Hall for adoption was Mr. Hawtayne's, which estimated that the electric light alone would cost, in round figures, £13,300. When a man began criticising, and got so far across to begin with, he (the chairman) did not know what to expect, nor what would follow. Another point Mr. Cliffe made was that the electric light was going to be a very serious affair for the ratepayers of Heckmondwike. He quite agreed that if they were to take the Tradesmen's Association as a criterion of the demand for the light, it would be a serious affair for the ratepayers of Heckmondwike. The plant was put down more especially at the request of the Tradesmen's Association than of any other body in the town. At any rate, the Council had already over 4,000 lights applied for out of the 6,000 that the plant would supply, and that being so, perhaps after all they might do without the criticism of the Tradesmen's Association if that was all they were going to do for the town.

South Africa.—We are indebted to the *British and South African Export Gazette* for the following items: The Corporation of Cape Town recently obtained powers to expend a further £100,000 in extensions of electric lighting main plant and station accommodation. The works have been actively pushed on for some time past, a new generating station having been put up in the Dock-road; but owing to the delay in the receipt of the plant ordered, its equipment is only proceeding slowly. Finality in plans devised has, also, not yet been reached, and the city electrical engineer recently arrived in this country with the object of acquiring additional plant in order that the Council may be able to cope with the ever-increasing demand for electric energy. The immediate importation of a further supply of electric meters has also been decided upon. The projected disbursement of £150,000 on extensions of Maritzburg's lighting scheme has not escaped the ordeal which all public undertakings seem to have to undergo in the rather censorious atmosphere of the Natal capital, and in order to dispose of the criticisms, the obtaining of an eminent expert's opinion on the Council's plans was called for. For the sanction of the necessary disbursement of £1,000 or £1,500 for this purpose a poll of the ratepayers was recently taken, with the result that an expert will have to be brought from England to inspect the plans before they can be proceeded with. A concession to light Umtali and Massikessi by electricity, power being obtained from the Massikessi Falls, has been granted by the Mozambique Company to Mr. Van Riet, and a syndicate is in course of formation to carry out the scheme, which will doubtless result in some excellent orders for the necessary equipment. Large orders for additional material will probably result if the scheme for the purchase of the Durban Telephone Company's business by the Town Council be carried through. The additional plant ordered before the war for the Bulawayo electric lighting system has now nearly all arrived, and is in course of erection. The Johannesburg Town Council are considering the placing of an order for additional electric plant to the extent of 250 kw., for future extensions of the electric lighting system. An electric lighting installation for a large flour-milling factory in South Africa is on order with Messrs. Thomas Robinson and Son, Limited. Orders have been placed, through the London agents, for 100 electric meters of various sizes for the Cape Town Town Council.

Greenwich Tunnel.—The Bridges Committee submitted the following report at the last meeting of the London County Council: "It will be within the recollection of the Council that the parliamentary estimate for the construction of Greenwich footway tunnel, as revised by the General Powers Act, 1898, is as follows: £120,000 for engineering works, and £35,000 for compensation purposes and for the acquisition of property. Provision for the payment of compensation was rendered necessary by the action of Parliament in inserting certain clauses in the Greenwich Tunnel Bill when it was before them. On Jan. 24, 1899, the Council accepted a tender of Messrs. Cochrane and Sons for £109,500, and up to the present time has sanctioned an expenditure of a not less sum than £115,500 in connection with the construction of the tunnel itself. For compensation purposes and for the acquisition of property the Council has in addition voted £11,000. Of the total amount voted by the Council for works, £6,000 was for the construction of lifts in the shafts of the tunnel, in accordance with the scheme adopted on May 14 last. In previous reports we have intimated our intention of lighting the tunnel with electricity and of using it for other purposes, and in connection therewith have stated that the cost of a special installation and the upkeep of electric plant was beyond that which we should feel justified in advising the Council to incur. For a similar reason the idea of obtaining the required current from the Council's generating station at Blackwall Tunnel had to be abandoned. Accordingly, upon our recommendation, the Council in April last accepted the offer of the metropolitan borough of Poplar to supply electricity at 1·8d. per unit, upon an estimated minimum quantity of 100,000 units per annum. In inviting tenders for the electric lifts and pumps, in respect of which the Council voted the £6,000 referred to above, it was thought desirable to provide for the ventilation and for the lighting of the tunnel in one and the same contract. This addition necessarily resulted in the tenders (opened by the Council and referred to us on Oct. 8 last) exceeding the amount which we were authorised to expend. The following were the tenders received: Messrs. Easton and Co., £9,158. 2s.; Messrs. Easton and Co. (alternative), £8,588. 2s.; Messrs. J. Richmond and Co., Limited, £11,375. 3s. 9d.; Messrs. Scott and Mountain (informal). In considering Messrs. Easton and Co.'s tender, which was the lowest, our attention was called to the price quoted by them for pumps—viz., £1,254—the engineer's estimate being £120. We accordingly communicated with them upon this matter, and have received a reply to the effect that there was a doubt as to the size of the pumps required, and that they, therefore, would be pleased to withdraw the sum of £1,254, and to carry out the rest of the work for £7,334. 2s., which sum is only £100 above the engineer's estimate for the same work. The usual enquiries having proved satisfactory, we are prepared to advise the Council to vote an additional £1,535 with a view to the acceptance of Messrs. Easton's tender, to cover the cost of the pumps, and to meet any other expenditure which it may be found necessary to incur. In this connection, we think it is desirable to inform the Council that, whilst Messrs. Cochrane and Sons' contract for the tunnel works is £109,500, £7,340 is provision money for extras, and little of this has, as yet, been expended. Allowing for some outlay in the future, we have great hope that the whole cost of their work will not exceed £104,000, and, therefore, the additional sum of £1,535, which we now ask for, will be more than covered by the saving effected on Messrs. Cochrane's contract. We recommend that the supplemental estimate of £1,535 submitted by the Finance Committee in respect of electric lifts, fans, pumps, wiring, lamps, and fittings at Greenwich Tunnel be approved; that the amended tender of Messrs. Easton and Co., amounting to £7,334. 2s., be accepted"

RECONSTRUCTION OF THE SOUTH LONDON TRAMWAYS.

The Highways Committee reported at the last London County Council meeting that they had considered the tenders for the supply of the track rails and fastenings, the slot rails, conductor tees, and fastenings, and the execution of the roadwork and platelaying in connection with the reconstruction of the Council's tramways south of the Thames. The tenders for the track rails and the slot rails were so intimately connected with each that they had found it necessary to consider them together. For the supply of the track rails and fastenings four tenders were received—namely:

British Westinghouse Electric and Manufacturing Company...	£33,524
Barrow Hematite Steel Company	29,341
W. Scott, Limited (Leeds Steelworks)	25,442
Bolckow, Vaughan, and Co.	23,876

For the supply of the slot rails, conductor tees, and fastenings there were only two complete tenders:

British Westinghouse Electric and Manufacturing Company...	£29,254
W. Scott, Limited (Leeds Steelworks)	25,334

The committee state: "As regarded the specification (*a*), Messrs Askham Bros. tendered for bolts and nuts only at £640; while as

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regarded the specification (*b*) the Barrow Hematite Steel Company tendered for slot rails and fishplates only at £15,065, and gave no price for the conductor rails, bolts, or any other part of the work. The tender of Messrs. Walter Scott, Limited, for the slot rails and fishplates is £14,650; and Messrs. Askham Bros.' tender for the bars and nuts only at £2,498. Messrs. J. G. White and Co. tender for the bars and connections, which will be required if their alternative tender for roadwork be accepted at £5,150. It will be seen from the list that the lowest tender for (*a*), the track rails, is that of Messrs. Bolckow, Vaughan, and Co., and the next lowest that of Messrs. Walter Scott, Limited. The first-named firm does not, however, tender on the specification (*b*) for slot rails; and Messrs. Walter Scott's tender is not only the lowest for that specification, but they accompany their tender for (*a*) by a statement that they cannot undertake (*b*) unless (*a*) is also entrusted to them. In the circumstances, Dr. Kennedy considers, and we agree with him, that it is advisable that, subject to the result of the usual enquiries proving satisfactory, the tenders of Messrs. Walter Scott should be accepted for both (*a*) and (*b*). Messrs. Scott state that they can deliver the first 500 tons of track rails within 12 weeks from the date of order, and that they will afterwards deliver from 100 to 150 tons per week, which, in the opinion of Dr. Kennedy, will be as much as the roadwork contractors will be able to deal with as the work progresses. As regards the specification (*a*) Messrs. Scott propose as their sub-contractors for bolts and nuts the Helicoid Lock-Nut Company, of Acton; and also to employ the Coghlan Steel Company, of Hunslet, to roll the fishplates and other small work for which Messrs. Scott will themselves manufacture the metal. Under specification (*b*) they propose the same sub-contractors for bolts and nuts as under (*a*), with the addition of another sub-contractor for the tiebars. We recommend (*a*) that, subject to the result of the usual enquiries proving satisfactory, the tenders of Messrs. Walter Scott, Limited, be accepted for the supply (A) for the sum of £25,442 of the track rails and fastenings; and (B) for the sum of £25,334 of the slot rails, conductor tees, and fastenings required in connection with the reconstruction for electrical traction of the London County Council tramways between (*a*) Westminster Bridge and Tooting, (*b*) Blackfriars-road and Kennington, and (*c*) Waterloo-road and St. George's-circus. (*b*) That Messrs Walter Scott, Limited, be allowed to sublet to the Helicoid Lock-Nut Company, of Acton, the supply of the bolts and nuts under contracts (A) and (B); and to another sub-contractor, to be approved by the engineer (Dr. Kennedy), the supply of the tiebars under contract (B); and also, under contract (A), to employ the Coghlan Steel Company, of Hunslet, to roll the fishplates and other small work, for which Messrs. Scott will themselves manufacture the metal. For the execution of the roadwork and platelaying, tenders were received from six firms—namely:

British Westinghouse Electric and Manufacturing Company	£230,932
British Insulated Wire Company	194,168
Dick, Kerr, and Co., Limited	189,013
E. Nuttall (first tender)	185,870
E. Nuttall (alternative tender)	183,870
W. Griffiths and Co.	183,631
J. G. White and Co., several tenders ranging from £165,384 to	183,131

The tenders of Messrs. J. G. White and Co. are the lowest throughout, and consist of different combinations of three sections of the work—namely (*a*) roadwork; (*b*) hydrants and water supply; and (*c*) special work—and, according as these three sections are combined in different ways, the tenders vary in amount from £183,131 to £165,384. The lowest combinations are those in which the speeial work is proposed to be manufactured by Messrs. Askham Bros., of Sheffield. On investigation, however, it has been found that Messrs. Askham's works, though well equipped for turning out excellent material, are not so arranged as to conveniently produce the really heavy castings which will be required, and Messrs. White and Co. have in the circumstances withdrawn these tenders. For the roadwork proper, exactly to specification, Messrs. White and Co.'s tender is £140,849, and to an alternative specification of their own is £146,847. This alternative allows for yokes spaced 3ft. 9in. apart instead of 5ft., and for other modifications; and if the alternative were accepted certain other items would have to be added, making a total for the alternative of £149,313. Dr. Kennedy has endeavoured to combine the best features of his specified scheme and of the alternative proposed by Messrs. White and Co.; and having gone through these in detail, he finds that the corresponding price for the roadwork section would be £145,850. As regards the special work—namely, points and crossings—Messrs. White and Co. originally tendered both for the Lorain Company's work and that of Messrs. Askham Bros., but the latter has, as above stated, been withdrawn. Messrs. White included two tenders for Lorain work, the one at £24,161, and the other at £30,873, the latter being for what is known as 'guarantee work' throughout, a number of the parts being so made as to be renewable. Dr. Kennedy does not think it desirable that the higher price should be accepted, but that Lorain 'guarantee work' should be selected for crossings where the wear will be greatest, and this would add £1,134 to the lower offer, making the amount £25,295. Of the different tenders sent in by Messrs. White and Co., Dr. Kennedy suggests, and we agree with him, the acceptance of the combination under which the roadwork would cost £145,850 and the special work £25,295, making a total of £171,145. The modifications proposed will affect to a small extent (perhaps an addition of £250) Messrs. Scott's contract price under (B), but this is a very small matter, which can be adjusted hereafter. We are informed by Dr. Kennedy that the firm of Messrs. White and Co. is the English branch of a very well-known American firm under the same name, which has in America done a great deal of work of an important character, and that Messrs. White and Co. possess as their chief engineer a gentleman who has carried out a great deal of electrical conduit system work in the United States and on the Continent of Europe, including the conduit work in Paris. They undertake to commence the work in the roads within 13 weeks after receiving notice to do so, and to complete it within 30 weeks from commencement, provided that they will be a lowed to work in six lengths of 440 yards each at the same time. We anticipate that no difficulty will be raised by the road authorities concerned, who will naturally be as anxious as the Council that the work shall be completed within the shortest possible time, to the arrangement proposed. Messrs. White and Co. propose as sub-contractors for the roadwork Messrs. W. Griffiths and Co., and for the special work, as will be gathered from the above particulars, the Lorain Steel Company, of Ohio, U.S.A., and to these arrangements we see no objection. They have not yet indicated to whom they propose to sublet the castings of the yokes and other similar ironwork. We recommend: (*a*) that, subject to the result of the usual enquiries proving satisfactory, the tender of Messrs. J. G. White and Co. be accepted for the execution, for the sum of £171,145, of the roadwork and platelaying required in connection with the reconstruction for electrical traction of the London County Council tramways between (*a*) Westminster Bridge and Tooting, (*b*) Blackfriars-road and Kennington, and (*c*) Waterloo-road and St. George's-circus; (*b*) that Messrs. J. G. White and Co. be allowed to sublet to Messrs. W. Griffiths and Co. the roadwork, and to the Lorain Steel Company, of Ohio, U.S.A., the special work—namely, points and crossings."

PROVISIONAL PATENTS, 1901.

Oct. 28.

21567. Improvements in electric locomotives. Bertram Hopkinson, 26, Victoria-street, London.

21571. Improvements in brush-holders for electric generators, motors, and the like. John Henry Holmes, Portland-road Works, Newcastle-on-Tyne.

21598. Improvements in mouthpieces for telephones and analogous instruments. Adam Bergman, 15, Took's-court, Cursitor-street, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 17, 1901, being date of application in United States.)

21600. Improvements in electric time reminder clocks. Benjamin Dubinski, 15, Took's-court, Cursitor-street, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 1, 1901, being date of application in United States.)

21601. Generating of electric currents by conductors cutting a magnetic field by a new device. Felipe Gomez Humaran, 28, Wharton-street, Lloyd-square, London.

21602. Improvements in polarised electromagnets. Luigi Cerebotani and Carl Moradelli, 111, Hatton-garden, London. (Complete specification.)

21608. Improvements in and relating to arc lamps. Walter Rowbotham and Kate Amelia Rowbotham, 307, Gillott-road, Edgbaston, Birmingham.

21646. Improvements relating to carbons for arc lights. H[s] Viertel and C. Pueschel (of the firm of Gebrueder Siemens und Co.), 27, Chancery-lane, London.

21649. Improvements in and in connection with accumulator plates. Louis Roselle, 36, Chancery-lane, London.

Oct. 29.

21665. Improvements in the construction and production of the terminals of electric glow-lamp sockets and in their fitting to and insulation from the casing of the said sockets. Charles Yeomans Hopkins, 11, Burlington-chambers, New-street, Birmingham.

21686. New or improved controlling apparatus for the trolley poles of electrically-propelled vehicles. Archibald Coke, 8, Lombard-chambers, Bixteth-street, Liverpool.

21701. Improvements in and connected with ships' compasses, ships' telegraph, and the like. Herman Oppenheimer, 55, Redcross-street, Barbican, London. (Actien-Gesellschaft Mix und Genest, Germany.)

21703. Improvements in electric motor controllers. Joseph Gershom Childs, 145, Farringdon-road, London.

21715. Improvements in electricity meters and other electrical instruments of precision. Roger Sherman White, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21721. Improvements in frogs or switches for overhead electric traction. Philip Dawson and Frederick William Fawdrey, 47, Lincoln's-inn-fields, London.

21744. Improvements in apparatus for the wireless transmission of electric oscillations. Archie Frederick Collins, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21750. Improvements in method of and means for tandem connecting asynchronous alternating electric current motors or generators. Ernst Danielsen, 322, High Holborn, London. (Complete specification.)

21767. Improvements in windings for electromagnetic spools or coils. John Allen Heany, Norfolk House, Victoria-embankment, London. (Complete specification.)

21769. Improvements in incandescent electric lamps. Abraham Denby Raine, Norfolk House, Norfolk-street, Strand, London. (Hector Alan Macdonald, France.)

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Oct. 30.

21807. Improvements in electric cable conductors. William Ernst Hitch, 40, Station-road, King's Heath, Warwickshire.

21860. The patent electric light rotary, adjustable telescopic slide. Thomas Ferguson and Bertie Barber, "Fairfield," Slyne, near Lancaster.

21853. Improvements in safety devices for electric tramcars and other motor-driven vehicles. Alexander Rutherford, 6, Lord-street, Liverpool.

21854. Improvements in lifeguards for electric cars and other self-propelled vehicles. Arthur Royle, 6, Lord-street, Liverpool.

21878. Improvements in or connected with electric time switches. Edwin Morgan, Norfolk House, Norfolk-street, Strand, London.

Oct. 31.

21892. Improvements in incandescent electric lamp-holders. The Birmingham Photographic Company, Limited, and Frank Alston, 24, Temple-row, Birmingham.

21915. Improvements in the electro-deposition of metallic copper. Arnold Philip, 67, Waverley-road, Redland, Bristol.

21919. Improvements relating to electric ignition appliances for internal-combustion motors. Harry Lucas and Charles Yeomans Hopkins, 18, Southampton-buildings, Chancery-lane, London.

21935. Improvements in incandescent electric lamps. John McCullough, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 2, 1901, being date of application in United States.) (Complete specification.)

21942. Process for the electrolytic treatment of tin, and an apparatus therefor. Paul Nauhardt, 8, Quality-court, Chancery-lane, London. (Complete specification.)

21974. A new or improved collector for use on electrically-propelled or lighted vehicles. William Griffiths and Benjamin Harry Bedell, 4, South-street, Finsbury, London.

21980. Improvements in and relating to relay operating devices. James Tarbotton Armstrong and Axel Orling, 323, High Holborn, London.

21981. Improvements in and connected with galvanoscopes and means of actuating one or more relays thereby. James Tarbotton Armstrong and Axel Orling, 323, High Holborn, London.

21984. Improvements in or relating to electric coils for oscillatory discharge. Arthur Radiguet and Georges Massiot, 111, Hatton-garden, London.

Nov. 1.

22002. Improvements in and in tools for use in producing sheet metal cases for electricity meters. S. J. and E. Fellows, Limited, and Walter Henry Corker, Prince's-chambers, Wolverhampton.

22012. Improvements in fittings for conduit systems of electric wiring. Léon Harvey Lander and the Simplex Steel Conduit Company, Limited, 34, Castle-street, Liverpool.

22031. An improved system for obtaining variable speeds in direct-current electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (John August Essberger, Germany.) (Complete specification.)

22032. Improvements in alternating electric generators. Henry Metcalf Hobart, Bush-lane House, Cannon-street, London.

22033. Improvements in alternating electric current motors. Henry Metcalf Hobart, Bush-lane House, Cannon-street, London.

22034. Improvements in potential regulators for rotary electric converters. Henry Metcalf Hobart, Bush-lane House, Cannon-street, London.

22035. Improvements in damping devices for rotary electric converters. Henry Metcalf Hobart, Bush-lane House, Cannon-street, London.

22036. Improvements in armature windings for dynamo-electric machines. Henry Metcalf Hobart, Bush-lane House, Cannon-street, London.

22037. Improvements in armature windings for dynamo-electric machines. Henry Hobart Metcalf, Bush-lane House, Cannon-street, London.

22038. Improvement in rotary electric converters. Henry Metcalf Hobart, Bush-lane House, Cannon-street, London.

22041. A new or improved device for use in connection with electrical ignition of explosive engines. Robert Fox, Charles William Higgs, and Alfred Brown, 67, Harrow-road, London.

22044. Improvements in or relating to safety devices for the trolley poles of electric railways and tramways. Joseph Hutchinson Clarke, 6, Lord-street, Liverpool.

22066. Improvements in or connected with insulating troughs or tubes for electrical conductors. Gustav Hevendehl, 37, Essex-street, Strand, London.

22077. Improvements in musical instruments such as piano organs, musical boxes, and the like adapted for use on electric circuits. Harry John Salter and Harry Thorpe, 5, Hatton-garden, London.

Nov. 2.

22083. A method of holding open the exhaust valve of oil and gas motors by utilising the same lever that actuates the advance and retard electric ignition. Ernest de Vismes du Boulay, Belknap, St. John's Park, Ryde, Isle of Wight.

22098. Transmitting electrical energy to tram or railway cars. John Edward Slack and Henry Hutchinson, 94, Market-street, Manchester.

22110. Improvements in or relating to electric motors. Oscar Henry Pieper and Alphonse Ferdinand Pieper, 111, Hatton-garden, London. (Complete specification.)

22146. Improvements in and connected with the covers of inspection elbows, bends, tees, crosses, and junction boxes for electrical wires. Arthur Duffield Robinson, Samuel Withers, and Jabez Griffin, 128, Colmore-row, Birmingham.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 23.

1900.

19383. Electric arc lamps. Boardman.

19386. Electric time switches. Offord and Jevons.

19451. Electrical condensers. Mansbridge.

19766. Overhead trolley poles used in electrical traction. Rowlands.

20177. Commutator or collector for electrical purposes. Batault.

21030. Alternating-current electric railways. British Thomson-Houston Company, Limited. (Potter.)

21100. Electric converters or transformers. Hall.

21804. Manufacture of electrical insulating materials. Claremont.

22287. Synchronising apparatus for electric alternators. British Thomson-Houston Company, Limited. (Dow.)

22372. Method of and apparatus for discharging or neutralising electricity developed or collected in wool or other fibres during the process of manufacture. J. G. White and Co., Limited, and White.

22379. Apparatus for the manufacture of electrical insulating materials. Claremont.

22731. Means for increasing the efficiency of high-tension electric influence machines. Tudsbury.

22747. Electromagnetic brakes for railway and tramway vehicles. Clark. (Date applied for under International Convention, May 14, 1900.)

22748. Electromagnetic brakes for railway and tramway vehicles. Clark. (Date applied for under International Convention, May 14, 1900.)

22910. Means for tilting the shades and lamps of electric lighting pendants. Belcher.

23592. Method of and apparatus for actuating devices on public electric supply distribution systems. Wright and Reason Manufacturing Company, Limited.

23774. Apparatus for producing interchangeable numerals, letters, words, and the like by means of electrical lamps. Johnson and Makin.

1901.

157. Electric motor. Perret.

2854. Apparatus for starting and regulating or controlling electromotors. Wetter. (Elektrizitäts-Actiengesellschaft vorm. Schuckert und Co.

11076. Means for extinguishing electric arcs applicable to lightning arresters, switches, and the like. Lamm

11293. Utilisation of electromagnetic, light, or other like radiations, effects, or disturbances transmitted through the natural media and to apparatus therefor. Lake. (Tesla.)

12400. Trolleys for electric cars. Liddle. (Laclede Car Company.)

12974. Apparatus for making secondary battery plates and plates for other purposes. Madden. (Date applied for under International Convention, March 19, 1901.)

14411. Manufacture of filaments and other conductive bodies for incandescent electric lamps and heaters. Sander.

15671. Dynamo-electric generators and motors. Churchward.

15680. Dynamo-electric generators and motors. Churchward.

15686. Commutator brushes for dynamo-electric generators and motors. Churchward.

15826. Armatures for dynamo-electric machines or motors. Blood.

18437. Incandescent electric lamps. Forster.

18795. Electric lighting by low-frequency currents. British Thomson-Houston Company, Limited. (Fish.)

18879. Collectors for electric tramways and the like. Connett.

19057. Casings for electric arc lamps. Lake. (Lea Electric Manufacturing Company.)

19225. Incandescent electric lamps. British Thomson-Houston Company, Limited. (Howell.)

19393. Electric motors. Fomm, Fomm, and Fomm.

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TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Nov. 2	658	622	+ 36	18,165	16,344
Birmingham Tramways	,, 2	4,794	4,563	+ 231	199,375	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 2	514	438	+ 76	22,273	19,788*b*
Blackpool Corporation	Oct. 31	313	266	+ 47	35,448	26,528
Blackpool-Fleetwood Tramways	Nov. 2	248	205	+ 43	19,661	19,087*b*
Bolton Corporation	,, 3	1,471	1,319	+ 152	64,306	52,822*b*
Bradford Corporation	,, 3	1,075	630	+ 444	39,638	19,702
Bristol Tramways Company	,, 1	3,942	2,897	+ 1,045	—	—
British Electric Traction—						
Croydon	,, 1	609	267	+ 342	14,033*b*	13,171*a*
Devonport	,, 1	377	—	—	7,633*c*	—
Dudley-Stourbridge	,, 1	700	541	+ 159	29,141*b*	13,690
Gateshead	,, 1	603	—	—	14,987*i*	—
Greenock-Port Glasgow	,, 1	167	—	—	764*e*	—
Hartlepool	,, 1	222	187	+ 35	10,080*b*	8,803
Kidderminster	,, 1	101	87	+ 14	5,474*b*	4,807
Merthyr	,, 1	205	—	—	7,780*f*	—
Oldham-Ashton	,, 1	500	—	—	22,115*b*	3,225
Poole	,, 1	224	—	—	8,938*f*	—
Potteries	,, 1	1,426	1,196	+ 230	61,601*b*	43,021
Southport	,, 1	141	160	- 19	7,572*b*	10,258†
South Staffordshire	,, 1	305	202	+ 83	34,308*b*	31,793*a*
Swansea	,, 1	424	388	+ 36	19,511*b*	15,291
Taunton	,, 1	66	—	—	1,001*g*	—
Tynemouth	,, 1	185	—	—	9,387*h*	—
Wolverhampton District	,, 1	86	54	+ 32	2,855*b*	2,231
Carlisle Tramways Company	,, 2	141	140	+ 1	3,525*b*	3,439
Central London Railway	,, 2	6,629	6,564	+ 65	107,002	—
City and South London Railway	,, 3	2,111	1,936	+ 175	34,665	28,394
Cork E. T. and L. Company	Oct. 31	419	384	+ 35	20,589	18,261*b*
Darwen Corporation	Nov. 1	210	181	+ 29	8,307	6,783
Dover Corporation	,, 5	197	187	+ 10	7,762	7,375*b*
Dublin & Lucan Electric Railway	,, 3	89	77	+ 12	2,279	1,960
Dublin U. T., electric cars	,, 1	3,532	3,422	+ 110	—	—
Dublin S. District, Electric	,, 1	766	686	+ 80	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 2	19,194	9,468	+ 3,726	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 2	1,613	1,384	+ 229	31,835	24,953
Liverpool Corporation	Oct. 26	9,170	8,506	+ 664	387,477	340,303*b*
Liverpool Overhead Railway	Nov. 3	1,445	1,561	+ 116	29,335	30,455
Portsmouth Corporation	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 3	3,626	—	—	—	—
Southampton Corporation	Oct. 31	835	659	+ 176	—	—

a Part. *b* From Jan. 1. *c* From June 21. *d* From April 1 *e* From Oct. 3. *f* From April 5. *g* From Aug. 21. *h* From March 22. *i* From May 8. * Fortnightly. † Reconstructing.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £316 decrease.
Barcelona Ensanche y Gracia, £23 decrease. Barcelona, £94 increase.
Brisbane, £104 increase.
Buenos Ayres and Belgrano Electric, £207 increase.
Calcutta, £134 increase.
Cape Town (month of Sept.), receipts, £12,467; expenditure, £6,373.
La Capital Traction and Electric, Buenos Ayres (month of Sept.), £5,880 ncrease.
Mexico Electric (month of Sept.), receipts, £17,700.
Perth Electric, £62 increase.
Port Elizabeth (month of Sept.), receipts, £2,934; expenditure, £1,746.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¾-¼
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	7/16-9/16
—— Ordinary, 1-125,000	1 ..	¼-⅜
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-5¾
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4¾-5¼
Brush Electrical Engineering, Ordinary	2 ..	1⅞-1⅞
—— Non. Cum., 6 per cent. Pref.	2 ..	1¾-2⅛
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	16-17 xd
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	3-3½
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	⅛-⅜
—— 5 per cent. Debentures	5 ..	1½-2½
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	22½-23½
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15¼-16½
Telegraph Construction and Maintenance	12 ..	37-41
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10¼-11½
—— 5 per cent. Cum. Pref.	5 ..	5½-6½
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-102
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	7¾-8¼
—— 7 per cent. Preference	5 ..	8¼-8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7¼-8½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	5-6¼
—— 40,501-50,936	5 ..	4¾-5¼
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	8½-9¼
—— 6 per cent. Cumulative Pref.	10 ..	11½-12½
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	104-107
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¼-6
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1¾
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13-14
——4½ per cent. First Mortgage Debenture Stock	100 ..	113-116
——3½ per cent. Mortgage Debenture, Red.	100 ..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15½-16½
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7⅜-8¼
—— £4½ Shares, New	4½ ..	7-7½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2½-3
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	8½-9½
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11-12
Electric Railways.—		
Central London, Ordinary	100 ..	106-109
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	105-108
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	51-54
—— Ordinary	10 ..	5-5½
—— 4 per cent. Debenture Stock	100 ..	113-118
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	3¼-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-128
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¾-3⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5 xd
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6-6½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅜ xd
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14⅛
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11¾-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	121-124
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¾-2⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
—— Prov. Cert., all paid	100 ..	100-103
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅛-2⅛ xd
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	104-106
New General Traction, Ordinary	5 ..	2¾-3½
—— 6 per cent. Cum. Pref.	10 ..	3¼-4¼
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	98-102
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-10¼
—— 4½ per cent. Debenture Stock	100 ..	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8s. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ ,, ,, Debenture Stock	40 p.c. ..	40 p.c.
Telephones.—		
National Telephone, Ordinary	5 ..	4¼-4⅛
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅛-4⅜
—— 4 per cent. Deb. Stock, Red.	100 ..	96-99
—— 3½ per cent. Deb. Stock, Red.	100 ..	97-100
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

Institution of Junior Engineers. — We are informed that the above institution has now taken some new offices at 39, Victoria-street, S.W., from which all business will in future be conducted.

Manchester Section.—The first meeting of the new session of the above section of the Institution of Electrical Engineers will be held in the new physical laboratory, Owens College, Manchester, on Tuesday evening next, when Mr. C. H. Wordingham, M.I.C.E., M.I.E.E., the chairman, will deliver his inaugural address.

Electrical Canal Lift.—With reference to our note in our issue of last week under this heading, our attention is called to the fact that the power station from which the power is obtained to operate the electric lift is equipped with Lahmeyer plant. The Lahmeyer Electrical Company also manufactured and erected the motor and switching gear.

Electrical Development in Korea.—From reports received we learn that on Aug. 17 last the Seoul Electric Company opened its electric lighting plant, which has been put down for the supply of electric arc and incandescent lighting in Korea. Polyphase currents are used, and the new plant is being run in connection with the electric tramway system of the city.

French Electric Railway.—The first electric railway in France, with the exception of a very short length of line of the Compagnie d'Orleans, is now in operation between the new station of the Invalides, Paris, built by the Chemin de Fer de l'Ouest, and the Normandy and Brittany lines of the company. The electric current, which is generated at Issy, is collected from a third rail.

Berlin High-Speed Trials.—News reached London on Tuesday morning that a speed of 105 miles an hour had been attained on the electrical high-speed military railway near Qossen. Running at this speed the air pressure is said to have been equal to a wind force of 12ft. in a second, a force which on the German coast has only been registered once. The trials are being continued with a view to achieving a still higher rate of speed.

Electric Omnibuses Restarted in New York.—We note that a service of electric omnibuses is about to be put on the roads of New York again by the Electric Vehicle Transportation Company. In a week or two's time there will be eight such vehicles running regular stages. The new 'buses will accommodate 12 persons inside and five outside. In addition to these the company is proposing shortly to run a couple of large double-deckers, which will have a seating capacity for 34 persons

Giant Armature Rewound in Five Days.—The Niagara Falls Power Company recently rewound a 5,000-h.p. armature at the Falls power-house in five days, breaking all previous records. In order to attain this object in the required time, a double shift of 10 men was kept working day and night. An interesting feature of the work was the use of a small electric motor to blow the blacksmiths' forge, on which charcoal was burned—a great improvement over the old method of using gasoline soldering pots.

Wireless Telegraphy on Ostend Boats.—According to a Brussels correspondent, all the Belgian mail steamers plying between Ostend and Dover will shortly be fitted with wireless telegraphic apparatus, which will ensure an absolute secrecy as to messages. Judging by the results obtained by some of the Atlantic liners with wireless telegraphy, it is to be expected that the Ostend boats will be in continual communication with the shore throughout the passage, but we should like to see the secrecy established.

Municipal Tramways in South Australia.—We understand that the City Council of Adelaide have determined upon the purchase of the whole of the existing tramways, considering that there will be no difficulty in borrowing the £400,000 required for the purpose. It is intended to invite tenders from all parts of the world for the conversion of the system to electric traction Following the example of some of our corporations at home, the City Council of Adelaide propose to lease the undertaking to a company for a term of years instead of running the concern itself.

Submarine Transit.—It is said that Mr. Goubet, the inventor of a submarine boat, is now occupied in solving the question of the submarine transit of the English Channel. Report states that the inventor has made a perfect model of a passenger boat over 26 yards in length, to run by electricity on a steel cable at a uniform depth of about 15½ yards. The passage between the English and French ports, we are told, would be as easy as a railway with no vibration, and perfect safety would be ensured by an iron weight, which in case of need could be dropped, and the boat would rise to the surface. The estimated speed of the submarine is 20 knots.

Rapid Transit in New York.—New York will soon be in possession of the first four-track electric railway in the world, which will enable express and local trains to be run side by side. The new line is now in course of completion, and will be ready in a few months. It will be operated on the third-rail system, and is a continuation of the present elevated rapid-transit system of New York City, intended to connect the borough of the Bronx with suburbs in the north. The speed at which it is proposed to run trains on the new track is 60 miles an hour, including stops, and this, of course, will necessitate a much higher rate of speed being made at times. Each car will be equipped with four motors capable, under acceleration, of developing 250 h.p. each. The daily schedule will provide for 124 local and 74 express trains.

Gigantic Power-House Equipment.—According to our New York contemporary *Power*, the rapid transit subway in that city will require the largest power plant in the world for its operation. The power-house itself will cover a rectangle 200ft. by 680ft., and contain 12 8,000-h.p. units, consisting of six pairs of compounds attached to one shaft, with horizontal high-pressure and vertical low-pressure cylinders. The boilers will consist of 72 1,200-h.p. units, which will be arranged in a double row upon a single level. The flues and economisers will be above the boilers, reducing the width of the boiler-house and the working grating or floor will be upon the engine-room level. The engine units are intended to be arranged in a single row, with the condensers between them and the boilers, and the electrical apparatus against the wall, avoiding the bringing of cables in among the piping and machinery. The Allis-Chalmers Company will supply the engines, and Messrs. Babcock and Wilcox the boilers. Six large chimneys will be used, each taking care of two of the 12 units.

Seasoning Wood by Electricity.—We hear that in Austria a new method of quickly preparing wood for building and manufacturing purposes by electricity is being tried with considerable success. The process is simple. The green wood is placed in a large wooden trough, whose bottom is covered with a lead plate, which is connected with the positive pole of an electric battery. A second lead

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plate covers the wood to be dried, thus forming the negative pole. The wood is then subjected to a bath in a solution composed of 10 per cent. rosin and 75 per cent. soda, and under the influence of the electric current the sap is drawn out of the wood and rises to the surface, the solution being absorbed by the wood. In about two weeks' time after this the wood is dry and ready for use, or the drying can be done by artificial means in a much shorter time. The actual operation in the trough, however, only occupies from five to eight hours.

London County Council Tramways.—We are pleased to note that the contracts for the electrical equipment of the first sections of the London tramways are now being placed by the London County Council, and that English contracting firms are receiving the orders. For instance, both the continuous-current and three-phase plant required for the first of the lines to be converted has been ordered from Messrs. Dick, Kerr, and Co. in the face of enormous competition. No less than 29 firms tendered for the work, including all the well-known American and Continental manufacturers. There was also in every case a considerable number of alternative tenders sent in by each firm, so that many combinations of part English and part foreign plant were possible. The outcome of it all, however, is that, on the advice of Dr. A. B. W. Kennedy, the Council are accepting the tender which will involve plant made wholly in England. It is pleasing to reflect that in so doing they are accepting advice by which they will get the best value for the money spent.

Comforts for Christmas.—We would call the attention of our readers to the letter which appeared in our correspondence columns last week from Captain A. H. Pott, of the Electrical Engineers Volunteers, in which he announces the starting of a fund to enable "comforts" to be sent out to the second South African contingent for Christmas. We are sure it needs no words of ours to commend this object to all electrical engineers, and doubtless members of the profession will be only too pleased to take advantage of the fund as a small mark of the high appreciation we all feel of the good work which the second contingent of Electrical Engineers are doing in the struggle for supremacy in South Africa. It need hardly be said that our soldiers at the front are suffering the severe privations which are always inseparable from a state of war, and we may be sure that any little comforts which may be sent out to our men will be truly acceptable. We would only remind our readers that intending subscribers must forward their contributions at the very earliest date to ensure the stores reaching the contingent before Christmas.

Exhibitions in Science and Technology.—The Technical Education Board announce that they will be prepared in June, 1902, to award not more than 200 evening exhibitions in science and technology, which are intended to defray the fees and travelling expenses of persons occupied during the day in the ordinary avocations of life and attending evening classes in science or technology in some polytechnic, or technical institute, or some other institution, if approved by the Technical Education Board. Exhibitioners are required to pay their own fees. The exhibitions will be open to persons of either sex. Candidates must be ordinarily resident within the administrative county of London, and exhibitioners must continue to reside therein during the tenure of their exhibitions. The exhibitions will be of the value of £5 per annum, and will be awarded, in the first instance, for one year, but will be renewable at the pleasure of the Board for a second year, and under very exceptional circumstances may be renewed in a few cases for a third year. Further particulars of the competition will be found in the current number of the *London Technical Education Gazette*.

Anti-Automobile Campaign.—News comes from Paris of the formation of an anti-motor league which proposes to take steps which threaten French automobilists with a very serious danger. For instance, such obstacles as barbed wire placed here and there on the principal roads and cast-iron knobs garnished with nails are talked of as the chief instruments of war to be used by the anti-motorists in their campaign against the reckless and furious driving of autocars. In view of the bellicose intentions of the anti-motorists, it is reassuring to find that the membership of the league, which already holds the names of over 1,200 persons, must be increased by a few thousands before action is taken. The league, however, would not appear to be in want of funds, which is fortunate seeing the dire destruction it means to carry on among the motorcars. The anti-motorists, it is said, are working with the greatest secrecy, and are determined to make reprisals for the accidents caused on French roads by the reckless driving of automobilists. For an example of what would result from the use of barbed wire, nails, etc., we are referred to the bicyclists, who, it is said, already know something of obstacles of this character, and have frequently come to grief over them on lonely roads.

Rival Wireless Telegraphists.—The vital importance of securing non-interference in wireless telegraphy was clearly demonstrated at the recent yacht races for the America Cup. It appears that on the first day there were three different systems in use off Sandy Hook for communication with the shore, but it was soon discovered that nothing intelligible was reaching the receiving stations from any one except the others were out of operation. It thereupon became necessary for the three rivals to come to some arrangement, and a time schedule was accordingly agreed upon for the succeeding racing days. The arrangement made was that the Marconi apparatus should send for five minutes, and then the De Forest-Freeman-Smythe apparatus, which was one of the three in use, for five minutes, and so on at alternate intervals. Even with this arrangement, however, only a partial success was achieved, for the second party does not seem to have been persuaded into a similar agreement. From particulars we have seen the transmission speed of the Marconi system was about 12 words a minute, and the longest distance covered 12 miles. The De Forest apparatus would not appear to have attained this speed even, although at one time signals were transmitted over a distance of 22 miles.

Rise of Electric Power Distribution in the States.—Mr. Alton D. Adams, writing in the *Electrical World* of New York, gives some reliable figures showing the rise of electric power distribution in America. An inspection of the tables furnished by the author makes it clear that the great struggle for supremacy in the field of power distribution from lighting stations has been and is between the incandescent and the purely power circuits. In this contest the incandescent circuits have the advantage of an earlier occupancy of the richest portions of the territory, and of the support of the lighting business. In the city of Boston alone last year the horse-power of stationary motors supplied from electric lighting stations for all purposes totalled to 14,959. There were 2,467 motors on incandescent circuits, 1,042 on power circuits and only five on arc circuits. In the whole of the State of Massachusetts the total horse-power of all motors supplied from electric lighting stations was 27,133. The motors on incandescent circuits numbered 3,735; on power circuits, 2,572; and on arc circuits, 11. The average horse-power of electric motors at the end of 1900 was 4·3. The total power

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increase during the last decade was 896 per cent. of the capacity in 1890, or an average of 89·6 per cent. yearly For the year of 1900, the increase was 161 per cent. of the power in 1890.

Chinese Guttapercha Tree.—Messrs. Dybowski and Frow have just concluded some preliminary experiments to ascertain the yield and quality of the guttapercha obtained from a peculiar Chinese plant known as "Tu-Chung," live specimens of which are at present growing in several botanic gardens in Paris and at Kew in this country. The elastic gum produced by the plant is said to be of the nature of guttapercha rather than caoutchouc, which is a kind of Indian rubber; and the vessels containing it are much more similar to the cells which yield true guttapercha than to the laticiferous vessels of the common rubber-yielding trees. The plant which Messrs. Dybowski and Frow had at their disposal was only very young, and although the bark was found to be full of laticiferous vessels, it was not considered advisable to remove any branches for examination. The dried leaves yielded 2·25 per cent. of substance soluble in toluene, which, considering that the fresh leaves contained 70 per cent. of moisture, is not a high return. The fruits, however, gave a much better result, as when undried, containing 7·4 per cent. of moisture, they yielded over 27 per cent. of substance soluble in toluene. The product obtained was of brown colour, and behaved exactly like guttapercha. When immersed in hot water it softened, and could then be stretched out into thin sheets, like gold-beater's skin, or moulded, while on cooling it again became quite hard. As guttapercha it was stated by experts to be of good quality.

Lightning Conductors.—A good deal is made by authorities of lightning conductors and the need for having a good low resistance in the conductors themselves, We even know of one authority who asserted that the danger in having bends in lightning conductors was that there was apt to be corrosion of the metal at the corners. and, in consequence, the conductivity of the metal would be lowered. While we believe that in every case an attempt should be made to give a good conducting path for the lightning, it seems obvious that it is not so absolutely necessary as one would think, or, at any rate, it is not so important as having a path which contains next to no induction. It is by increase in the induction that damage is likely to be done, as it is apt to cause a lightning discharge to leave the conductor and to flash across to gas, water pipes, etc., in the vicinity. We notice that Mr. K. R. Koch, writing in the *Phys. Zeitschrift*, has made some experiments on this subject. His conclusions are that, although electrical conductors may have become imperfect through corrosion or otherwise, they are still able to act in an efficient way in a thunderstorm. We gather from the article that the author thinks the conductors would still act even if there were a break in them only connected by oxides of iron. He holds that the oxides are rendered conducting by means of a coherer action, in consequence of the oscillatory character of the lightning discharges. The same expert is attempting to prove that all lightning is oscillatory by means of photographs, but up to the present he has not succeeded in getting the negatives he requires.

Electric Traction for Mountain Lines.—We understand from the *Scientific American* that the Great Northern Railway of America is proposing to convert a section of the line 66 miles long through the Cascade Mountains from steam to electricity. It is stated, however, that if the electric traction proves as successful as anticipated, it will ultimately be extended so as to include the whole of the mountain district from Everett on Puget Sound to Wenatchee, a distance of 141 miles. At the present time the 66-mile section of the road referred to is the most difficult and expensive portion to operate on the entire system, owing to the wild and rugged nature of the country through which it passes and the very heavy gradients The principal objection to steam traction on this part of the railway is that there is no local coal supply; in fact, in the matter of cheap fuel the Great Northern is being operated at a great disadvantage as compared with its rivals. While, for instance, the Northern Pacific Railway gets its coal at a cost not exceeding 4s. to 13s. a ton, the fuel used by the Great Northern costs at least 11s. a ton for the ordinary coal. For the Crow's Nest Pass coal, however, which is used on all trains through the tunnel, the cost is much greater. The coal consumption for about 30 miles of the mountain climb is described as something enormous, amounting to upwards of 2,500 tons a day, or nearly a million tons a year. It has therefore been forced upon the company to find a more economical system of traction, particularly for the mountain lines, and we understand that active work toward the installation of the electric power will be commenced next spring. As the water for the generation of electricity to operate the trains will be taken from one or more of the numerous rivers heading in the Cascade Mountains near the Great Northern lines, the innovation contemplated will reduce the coal bills of the division affected practically to a minimum.

An Ideal Six-Volt Installation.—The following note by "H. B. L." is of interest to all young electrical engineers: "In a suburban house—detached by an alley-way of some 3ft. in width from each of its neighbours—it was discovered that the larder was generally too dark for the comfortable conduct of matters domestic. A wax candle was installed, but this, with its attendant blowings out and strikings and blowings out of matches, seemed to take away the appetites of the fastidious. What was to be done? We were far from all mains, save those of gas and water. After concentrated thought a battery lamp and accumulators were installed, but this arrangement was not satisfactory. The cells were always run down too quickly (and too far), while the nearest central station, some two miles distant, rather turned up its aristocratic nose at six-volt business. Yet we would not give in. Four 'Obach' dry cells were attached to the 'mains.' These mains, by the way, measured some 8ft. in all—that is, lead plus return. All went well on the new arrangement for nearly an entire week, but the light was failing, failing fast. At first the reason was by no means obvious. We had carefully put a bell door contact in series, so that the light should only be on when the door was open, but hitherto this had not availed us much. And now the 'generating plant' had to be scrapped again. The sum of 8s. for one week's illumination of the larder seemed excessive. A switch was insinuated next, and a responsible domestic was instructed to put it 'off' when Nature's light penetrated. This was quite useless for the conservation of our energy, because everybody put that switch on if they found it off, and it was invariably left on. Still, we refused to give in. Why should fish, flesh, and fowl be served up with the taint of half-snuffed wick, or smouldering match? Observation—keen observation—was brought to bear. As a result it was ascertained that the matter was not 'understanded of the people.' A vague notion seemed to possess them that the light once out would remain out always. That larder door had been consistently left open for hours together. How could dry cells live in such circumstances? Well, the division of a mind more or less swift produced a very practical conclusion. 'Let a strong spring be fixed upon that door.' There are no more match ends to be found in the soup, and candle snuffings

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no longer flavour the curries. As regards cost, on the present system, is 6d. a week too much of a charge for absolute cleanliness in this otherwise benighted larder?"

Improving the Nernst Lamp.—Several patents have lately been granted in the States relating to improvements in various parts of the Nernst lamp. The first three of these have been issued to a Mr. Potter for a terminal, a heater, and a heater cut-out respectively. The *Western Electrician* furnishes some particulars of the patents, from which it seems that the terminal of the first is made by applying to the glower ends thin coatings of a platinum compound, and then changing the coatings to metallic platinum by subjecting them to heat. Terminal wires are then fastened to the coated ends, and a coating of the same material as first used is applied to the body of the glower. The heater is described as being a thin tubular body of talcite, which is an insulating heat-resisting material, with a heating conductor spirally wound upon it. Terminal wires are secured to the ends of the talcite body, and the ends of the heating conductor, which is wound around the body, are attached to the terminals. The patent also provides for a number of these heating conductors wound upon the talcite body and connected in parallel. In describing the heater cut-out, the patent states that a vacuum chamber contains a carbon spring, which tends to bring and hold contact terminals in engagement when the glower circuit is inactive. A thermostatic device serves to separate the terminals when the circuit is active. A fourth patent is for another form of terminal, the construction of which consists in attaching terminal wires to the ends of an electric lamp glower; while the last two, issued to a Mr. Hanks, relate to glowers for electric incandescent lamps. The first of these describes a glower which is a conductor of electricity only when hot and a non-conductor when cold. The glower is provided with one or more longitudinal grooves, the bottom or bottoms of which are curved. The cross-section of the glower is of approximately uniform thickness, and the edges formed by the groove are rounded. The glower is provided with enlarged spherical ends of the same material as that composing the body of the glower. The glower described in Mr. Hanks's second patent is composed of one or more rare earths, and consists of a main body which is adapted to become luminous under proper conditions. The terminals are enlarged ends of the body, and are of a porous, suitably baked material of different composition from the main body. These terminals, to which leading wires are secured, are non-conductors when cold, but their conductivity increases with heat.

Asylum Lighting.—A very handsomely illustrated souvenir of the official opening of the Chadwell Heath Asylum last August has been prepared and issued by the county borough of West Ham. Passing over the general description of the buildings, which provide accommodation for 800 patients, with the necessary staff, we find some particulars given of the electrical installation of the asylum, which, including the wiring of the buildings and the telephones, has been carried out under the superintendence of Mr. J. K. Bock, the West Ham borough electrical engineer. The Thames Ironworks and Shipbuilding Company supplied the generating plant, which consists of three continuous-current compound-wound dynamos, coupled direct to engines of the high-speed enclosed vertical type made by Messrs. Reavell and Co., of Ipswich. Each set is capable of developing 84 kw. with a steam pressure of 120lb. under ordinary circumstances. The equipment also includes a surface condenser, and the circulating water is cooled by means of a cooling tower erected by the Wheeler Condenser Company. To provide against a failure in the supply of electricity, and in order that a supply may always be available, a Hart battery capable of discharging at the rate of 100 amperes for eight hours has been installed. The buildings have been wired for over 3,000 lamps, the work being carried out by the Corporation's own workmen. From the main switchboard in the engine-room a separate concentric, lead-covered, paper-insulated cable is run to a distribution board in each block of the asylum, and also a distribution board in each detached building. The branch circuits to supply the lamps are taken from these boards, the wires being drawn into steel tubing, so arranged with joint-boxes, pulling-in boxes, etc., that in the event of any failure in the circuit the wires can easily be replaced without disturbing any plaster or woodwork. To ensure against accidents, the arrangements are such that the rooms and corridors are not dependent for their supply on one circuit only, so that the failure of one circuit will not seriously interfere with the supply. As regards the asylum itself, some idea of its magnitude may be gathered from the fact that the buildings cover an area of about 10 acres, and have a width of a quarter of a mile from east to west, and one-eighth of a mile from north to south, the main corridors being about a mile in length. The site is one of the healthiest in the locality, and was acquired by the Committee of Visitors for £8,835. It is estimated that the total cost of the asylum when quite completed will be £300,000.

Improvements in Aluminium Manufacture.—An account of some improved methods in aluminium manufacture, for which patents have recently been taken out, and which are said to overcome some of the difficulties inherent in the processes now in use, is given in the current number of the *Imperial Institute Journal*. The first of these was granted to Mr. A. H. Cowles, and relates to the manufacture of sodium, aluminium, aluminium carbide, and aluminium alloys. A mixture of sodium aluminate and powdered carbon in certain proportions is heated electrically in a furnace of special construction, the chief feature of the latter being the possession of a porous wall. The sodium is reduced and vaporised, the vapour passing through the porous side of the furnace and being condensed by a suitable receiver outside. The aluminium formed during the operation melts and combines with the excess of carbon, forming aluminium carbide. If there be added to the original mixture a non-volatile metal, an alloy of the latter with aluminium is formed. On treatment with water aluminium carbide yields marsh-gas, but, so far as is known, no practical application, either of the carbide or of this product, has been made. This patent is the property of the British Aluminium Company. Two others have been granted in this country to Mr. C. M. Hall, of Niagara Falls, the first of which deals with the partial reduction of the naturally occurring bauxite by means of a small amount of carbon. The novel feature here is the addition of a quantity of aluminium powder to the mixture, which combines with various impurities, such as iron, silica, and titanium, occurring in the metal, leaving a residue of pure bauxite, which can then be reduced in the ordinary manner The advantage of this method of purifying the bauxite is that no sodium compounds are used, so that the presence of sodium in the aluminium eventually obtained is entirely avoided. The other patent taken out by Mr. Hall relates to the preparation of aluminium oxide for reduction by the ordinary process. Calcined crude bauxite is digested with sodium carbonate and quicklime, steam at 140lb. pressure being at the same time forced into the digester, which is continuously agitated for several hours: by this means a solution of sodium aluminate is produced, from which

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alumina is obtained by forcing a stream of carbon dioxide through the liquid. The advantage claimed for this procedure is that sodium hydroxide is generated *in situ*, and the expense of buying it is not incurred, while the sodium carbonate is re-obtained in a suitable form for further use. It is also stated that the lime forms insoluble compounds with the various foreign constituents of bauxite, such as ferric oxide, silica and titanic acid, so that a very pure alumina is obtained.

Longest Electric Cable Span.—One of the most remarkable engineering feats of recent years is the erection of a 4,427ft. single span in the electric power transmission line for the Bay Counties Power Company, of San Francisco, across the Straits of Carquinez. We find some interesting details of the performance in the *Scientific American*, from which it seems that the difficulties of the case were further enhanced by the restriction that there must be a clear headroom of at least 200ft. for the vessels passing along the Straits. The cables are supported in the giant span by two steel towers, 225ft. and 64ft. high respectively, but the latter is located so high on the hillside that its top is fully 80ft. higher than the other, and thus the lowest point of sag in the span is thrown off the lineal centre between the two towers. In order to bring the cables down to anchorages, only 1,700ft. back of the main tower, there was constructed a third structure known as the "leaning" tower. Steel and iron have been used almost exclusively in the construction of all these towers. Estimating the maximum wind pressure at 40lb. a square foot, each of the four corner posts of the main tower is subject to a maximum compressive strain of 132,510lb. The main tower is supported by 12 concrete piers, with the corner ones arranged in a quadrangle measuring 69ft. by 89ft. between the pier centres. Each of the corner piers is a cube of concrete having 8ft. sides. The piers are in reality designed more to give weight as anchorages than to serve as foundations. Each one of the cables which has been erected on these towers exerts a pull of 12 tons on its anchorages. The insulators, which weigh about 50lb each, were subjected previous to installation to long-continued tests of 120,000 volts. There is an extreme variation in temperature of 60deg. at Carquinez, so that there may be a difference during the year of 5ft. in the sag of the cables, a difference which will cause a travel of fully 2in. to occur in the cables running over the sheaves of the main tower. There is an independent housing for each anchorage, and the cable enters by way of a circular hole 6in. in diameter cut through the centre of the plate glass which forms the front of the enclosure. The cables are "dead-ended" at the anchorages, power being delivered to or taken from them by means of tappings. Only three cables are ever in use at one time, the fourth invariably being held in reserve. They are of plough steel wires, with solid steel core. In the twisted strand are 19 wires, including the core, and the strand has a diameter of ⅞in. The erection of the cables comprised a highly interesting feature of the work of construction. Some idea of the power required to pull up the cables may be gained from the fact that when the sag of a cable was such that it touched the surface of the water, its length was 4,535ft. and the strain was 9,000lb.; when 120ft. above the surface, the length of span was 4,482ft. and the strain 12,750lb.; and when in final position the length was 4,448ft. and the strain 22,500lb. The electrical power which is transmitted *viâ* the Carquinez span is derived from the Yuba River. The initial electric pressure for distribution is 40,000 volts, but this is to be increased to 50,000 and ultimately to 60,000 or 70,000 volts, in order to minimise the losses incurred in transmitting the power for long distances.

Electric Power Distribution in Naval Yards.—An excellent example is furnished by the United States Navy yard at Brooklyn, which has recently changed the motive power in its shops from steam to electric motor drives. We gather from an article in the *Electrical World* that in most cases each tool or group of tools is equipped with its own electric motor, and thus the necessity for shafting is eliminated. The most extensive portion of the installation is placed in a large carpenters' shop, which comprises the following equipment: two band saws, 15 h.p. each; one jig saw, 2 h.p.; one emery wheel, 2 h.p.; one plug cutter, 5 h.p.; one circular saw, 5 h.p.; one circular saw, 15 h.p.; one band saw, 15 h.p.; shafting carrying several grindstones, 5 h.p.; one log shifter, 25 h.p.; one surface planer, 5 h.p.; one surface planer, 15 h.p.; one surface planer, 20 h.p.; one surface planer, 25 h.p.; one four-sided planer, 50 h.p.; and one large log saw, 100 h.p. This plant has displaced about 210ft. of jack shafting and a quarter-turn mule, together with a 12 by 12 engine and boiler equipment. Beside doing away with the maintenance and the annoyance of these devices, the comparative coal economy, figuring electric power on the basis of 5lb. of coal per horse-power hour, is 4·3 to 12—that is to say, the plant is now operated on about one-third the coal that was previously used. The 100-h.p. motor is controlled by a series of switches. The first gives the motor full field, and closes the armature circuit through all the resistance, and the succeeding switches cut the resistance out point by point. A system of latches is provided, so that it is impossible to throw on one switch until its predecessor is closed, unless by deliberate intent. The main contacts are made through a laminated spring jaw pressing upon two rectangular blocks set in the surface of the board. The auxiliary contacts which take the arc are heavy carbon blocks set between magnetic poles, which effectively extinguish the arc. The circuit breaker opens quite widely, thereby making the arc very attenuated, and the strong magnetic field cutting across it renders its rupture certain. The auxiliary contacts are shielded from the main contacts by appropriate plates of insulating material. The latch of the breaker has a roller contact, which acts on the time limit principle. The tripping coil has quite a number of turns and does not carry the full series current, but only the portion that is deflected around the shunt. The time element, therefore, enters on account of the period that must elapse before the temperature of the shunt rises and increases its resistance sufficiently to put a potential difference on the tripping coil adequate to actuate it. The lower switch, which cuts off everything, is also interesting, inasmuch as it exhibits a departure from the ordinary jack-knife plan, and favours the laminated contact method, the laminations being held in place by a latch, which is tripped by a slight pull on the handle, which also serves to close the switch. From the table of figures which accompanies the article, we see that the motors are of sufficiently high efficiency. For instance, a 5-h.p. motor has an efficiency of 89 per cent.; a 20-h.p. motor 91·3 per cent.; and a 100-h.p. motor an efficiency of 92·4 per cent. The temperature rise is also good. The highest rise is given as 63deg. F. in the case of the 5-h.p. motors, but the mean rise may be taken at as nearly as possible 50. The present example of the application of electricity in the Brooklyn navy yard it seems is likely to lead to the supersession of the auxiliary steam-engines on board warships by electric motors. Our contemporary points out that at present the figures of steam consumption of auxiliary shipboard engines are very formidable; 140lb. to 150lb. of water per horse-power hour are not uncommon figures for pumps and hoists, as has been repeatedly found by engineering tests.

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THE DESIGN OF A 5-KW. DYNAMO.

The following design has been got out on the understanding that the machine is to be constructed with the ordinary tools and appliances to be found in every engineering workshop, but without any of the special facilities which would naturally be introduced into a large electrical works intended for turning out the machines in quantity. On this account the simplest construction, and the one requiring least special skilled labour, has been chosen throughout.

The output of the machine will be taken as 110 volts 45 amperes at 1,500 revolutions per minute, and the type chosen has a two-polar field magnet of cast iron, cast in one with the bedplate, and compound wound, and a smooth-cored drum armature with the wire wound on, turn by turn, by hand, and fixed to the core by means of driving horns and binding bands.

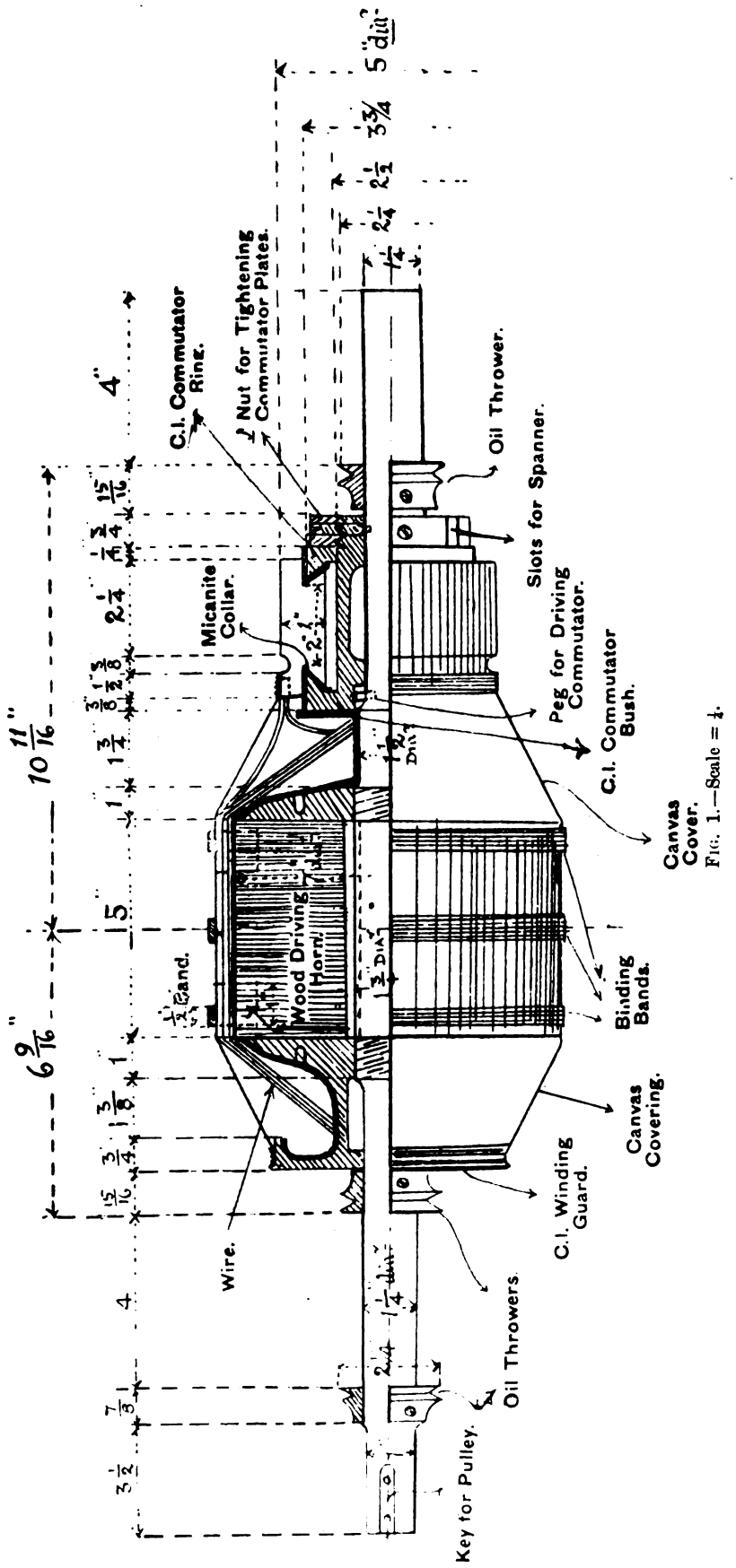

FIG. 1.—Scale = 4.

The first point to decide is the size of the armature core

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and this can be obtained quite satisfactorily by Kapp's approximate rule for small drum armatures:

$$\left\{\left(\begin{matrix}\text{Diameter in}\\ \text{inches}\end{matrix}\right)^2 \times \begin{matrix}\text{Length of core}\\ \text{in inches}\end{matrix}\right\} = \frac{\text{KW.} \times 7{\cdot}7 \times 10^4}{\text{revs. per min.}}$$

$$= \frac{5 \times 7{\cdot}7 \times 10^4}{1{,}500} = 258;$$

which, with a core diameter of 7in., corresponds to a core length of $258/(7)^2 = 5{\cdot}2$in. We will therefore take the core as 7in. diameter and 5in. long, dimensions which give a good and usual proportion of length to diameter. The core will be built up on and keyed to the spindle (as shown in Fig. 1), and will be clamped tightly between the two cast-iron end nuts. It should consist of thin sheet iron or steel discs not more than ·025in. thick, each insulated on one side by a thin coat of copal or shellac varnish. After varnishing and before building up, all the discs should be thoroughly dried in an oven. When built up, the core may require a light cut to be turned off the surface to make it smooth, but, if possible, this should be avoided, and in any case the cut must be very light and made with a sharp tool in order to prevent the risk of eddy currents through the burring over of the surface from disc to disc. A few slots should also be cut lengthwise in the surface of the core to hold the wooden driving teeth or horns. Eight of these slots will be sufficient in this case, and they should be about $\frac{1}{16}$in. to $\frac{1}{8}$in. wide and $\frac{3}{8}$in. deep, and can be cut either with a saw or a slotting machine. The insulation of the core can next be carried out, the ends being covered by successive discs of varnished canvas or similar material, and the periphery being covered with layers of the same material or being wound over with five or six layers of thin cotton tape, each layer being copal varnished before the next layer is put on. The insulation should be at least $\frac{1}{16}$in. thick everywhere, and special care should be taken to get the peripheral insulation to overlap the end insulation at the edges. The insulation of the cast-iron winding support at the pulley end and of the bare piece of spindle immediately behind the commutator should be carried out at the same time, and should be of the same nature. The driving horns, which should be of hard wood or fibre about 1in. wide by $\frac{1}{8}$in. thick, should next be driven into position through cuts made in the insulation at the two ends of each of the slots previously made.

The core is now ready to receive the winding, and the correct number of conductors is best determined by a consideration of the permissible number of ampere-wires per inch of core periphery, whilst the size of them is decided by the current density.

Experience has shown that a certain amount of latitude in the number of ampere-wires per inch is permissible without seriously affecting the working or cost of a machine, but that it should preferably lie somewhere between 300 on small unventilated machines and 600 or 700 on the largest well-ventilated armatures. We will assume 375 to be allowable in our case. Each conductor will carry half the total current—viz., $22\frac{1}{2}$ amperes (there being two parallel paths from brush to brush in an ordinary drum winding)—and the number of peripheral inches is 7in. $\times \pi = 22$in., so that the total number of wires or conductors on the core should be $\frac{22 \times 375}{22{\cdot}5} = 366$, or, say, 360 in round figures. By assuming a current density of 2,500 amperes per square inch, a usual figure for this size of armature, the area of the wire is found to be $\frac{22{\cdot}5}{2{,}500} = {\cdot}009$ square inch, and the nearest standard size to this is No. 12 S.W.G., ·104in. diameter, having an area of ·0085 square inch. This wire should have an ordinary double cotton covering, ·01in. thick, making its outside diameter ·124in.

Now, the core periphery, as worked above, is 22in., of which about 5in. will be taken up by the driving horns and special insulation between the sections, leaving 22in. − 5in. = 17in. for the winding, giving a maximum possible number of wires per layer of $17 \div {\cdot}124 = 138$; so that in order to get our 360 conductors on it will be necessary to use a three-layer winding with 120 conductors per layer. This winding is a rather easy fit, but the excess of space will reduce the labour of winding, and is, therefore, no disadvantage.

A little consideration will show that in order to get a truly symmetrical winding—*i.e.*, all sections at the same angle to their commutator plates—the number of turns per commutator section must be a multiple of the number of layers—*i.e.*, three, six, nine, etc.—so that the number of commutator parts must be either 60, 30, or 20, and for this size of machine the former is not excessive, whilst 30 is rather too low for good and sparkless running, and the commutator will therefore be given 60 plates, and there will be three turns, or six conductors, per section. Each section will be wound independently by hand, almost, but not quite, across a diameter, the two sides of a section being placed at points which are one wire short of being diametrically opposite. For the sake of clearness we will consider the commutator as already in position, though it would not actually be mounted on the spindle until the whole of the wire was wound, when all the connections would be soldered up together. Starting from commutator plate No. 1 (Fig. 2) conductor *a* is wound. The relative positions of 1 and *a* we determine by the required usual position of the brushes on the commutator, and in order to bring these on to a horizontal line the commutator plate and its conductor should be separated by about 90deg., as shown. From *a* the wire is carried across the back of the core to conductor *b*, as shown by the dotted line, then across the front (full lines) to conductor *c*, immediately over *a*, then across the back once more to conductor *d*, over *b*, then across the front to *e*, and finally across the back to *f*, the end of the section being then carried across the front of the core to commutator plate (No. 2) next door to the commutator plate (No. 1) from which the section started. The second section starts from commutator plate No. 2 and passes successively to conductors J, K, L, M, N, and O, and ends at commutator plate No. 3. It will be noticed that the second section is not wound directly against the first, but is separated from it by spaces equal to the width of a wire. These spaces are formed by inserting temporary wooden distance pieces, which are afterwards withdrawn when the space is required for the wires U, V, W, X, Y, and Z of the section connected to the diametrically opposite commutator plate. These distance pieces, as well as the driving horns, will be found useful supports for tieing the wire to during the process of winding, as it will be somewhat difficult to make the different wires retain their positions, three deep, until the whole of the winding is in position, when, of course, all the sections will act as mutual supports.

The three wires forming one side of each section, such as *a c e* or *b d f*, should be insulated from the neighbouring sections by a thin trough of presspahn, varnished canvas, or similar material (as shown at T, Fig. 2), as the full voltage of the machine (110 volts) exists between every two adjacent sections twice in each revolution, and special precautions have therefore to be taken against breakdowns there. Care must also be taken of the insulation on the ends by inserting strips of varnished canvas freely wherever wires cross one another. In order to make the armature ends uniform and symmetrical, it is best to wind sections situated at different points of the periphery consecutively, instead of passing steadily from section to section all round the armature, as this latter method leads to an accumulation of wire and the formation of a lump at one particular point on each end of the armature.

When the whole of the wire has been put on the armature, packing pieces of equal thickness of presspahn or wood should be inserted between all sections so as to make the winding a tight fit on the core. The winding should then be bound in position by means of three binding bands. Each band should be about $\frac{1}{2}$in. wide, consisting of about 20 turns of No. 24 S.W.G. steel or phosphor-bronze wire. The bands should be insulated from the winding by a strip of presspahn or thick canvas placed under them, and the wires composing each band should be soldered together, not only at the start and finish, but also at intervals all round, though not continuously. The bands should be put on under a high tension whilst the armature is turned slowly round in a lathe. The winding being securely held, the

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commutator and the connections of the winding to the commutator plates can next be dealt with. A section of the commutator is shown in Fig. 1. It consists of 60 plates of tapered section of either cast copper, or, preferably, hard-drawn copper. Each plate should be 3¼in. long, 1in. deep, ·24in. thick at the top, and ·137in. for the commutator end nut. Having mounted the commutator, it is next necessary to connect the ends of the sections to it. The two ends of one of the sections should be picked out from the mass of ends projecting from the core by means of an indicator or bell circuit, and should be placed in the slots of two adjacent commutator plates

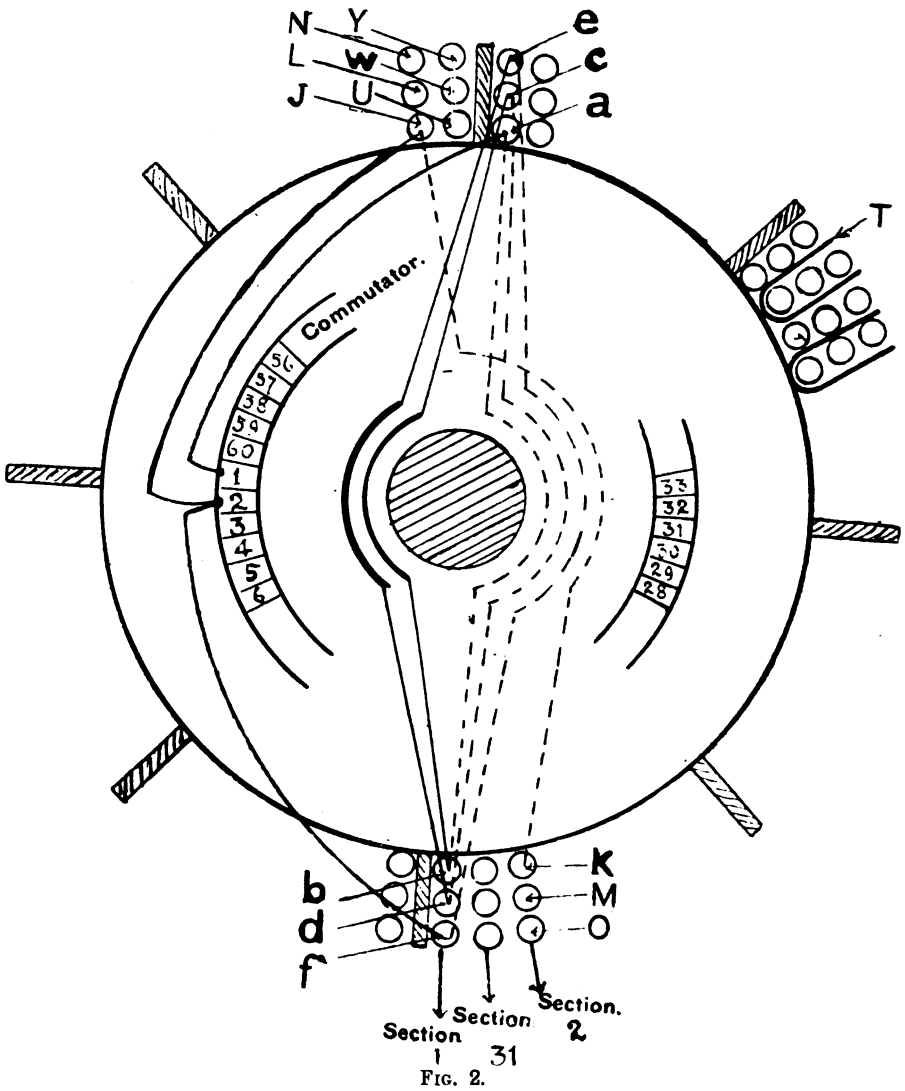

Fig. 2.

at the bottom, and should have a small slot ⅛in. wide and ¼in. deep cut at one end to take the wires. If hard drawn, the plates can be obtained to the exact dimensions required, but if cast they will require to be cast rather large, and milled or planed to the correct size. The plates are then grouped together, every plate being separated from the next by a sheet of pure mica ·02in. thick to form a ring with an outside diameter of 5in. and an inside diameter of 3in. This ring of plates must be clamped in some form of chuck, as in Fig. 3, and the inside face and the conical recesses, shown in Fig. 1, must be turned out in a lathe to exact dimensions. The angle of the cones should be about 40deg. The commutator must next be removed from the lathe and clamped up finally in its own cast-iron bush (shown in section in Fig. 1), with two conical sectioned rings of micanite, about ⅛in. thick, insulating the plates from the bush. These micanite rings had better be purchased ready formed from one of the recognised makers of the material, as special dies and heating arrangements are required in their manufacture to ensure a safe material of uniform thickness, and one not liable to shrink or soften. The plates should be clamped as tightly as possible in the bush by screwing up the end nut with a long-handled special spanner fitted into the slots shown in Fig. 1. Having formed the commutator, it can be fixed to the spindle as shown in Fig. 1, partly by means of a small peg let into the spindle and engaging with a slot in the inside of the bush, and partly by means of one or two long screws tapped right through the commutator end, nut, and bush, and a little way into the spindle. These screws serve also conveniently as lock nuts at a point at an angular distance of about 90deg. from the section itself. The starting end of section No. 2—separated from section No. 1 by section No. 31 (see Fig. 2)—must next be picked out and placed in the same commutator plate as the end of section No. 1, the other end of section No. 2 being placed in the

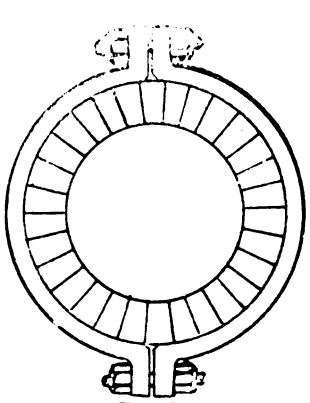

Fig. 3.

adjacent unoccupied plate, and so on all round, care being taken to pick out the ends of section after section in the right order by means of the circuit indicator. Having fitted all the ends into their proper slots, they must be carefully soldered in position. In order to give a neat finish to the armature, it will be necessary to fix a tightly-stretched varnished canvas cover over the mass of winding at each end. One edge of each of these covers should be

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placed under one of the end binding bands, whilst the other edge of one should be held under a neat string band over the commutator joints, and that of the other under a band wound on the projecting cast-iron rim of the winding support at the pulley end of the armature. The armature is now completed, but before dealing with the field magnets it will be best to determine the probable heating of the armature as follows, this being the only safe check on the dimensions of core, size of wire, etc., chosen above. This heating (rise in temperature after a continuous run of several hours at full load) depends on the $C^2 R$ watts lost in the winding, on the hysteresis and eddy-current losses in the core iron, on the cooling surface, and on the peripheral speed of the armature. These quantities are fairly satisfactorily connected by Kapp's formula:

Rise in temperature in degrees F. =

$$\frac{153 \times \text{total watts per square inch of cooling surface}}{1 + (\cdot 0005 \times \text{peripheral speed in feet per minute})}$$

The various losses are found as follows: The mean length of a turn of armature winding is approximately (core length + $1\frac{1}{2}$ × core diameter) 2 = 31in., and the resistance of the armature winding from brush to brush when warm is

$$\frac{\cdot 00000078 \times \text{mean length of turn} \times \text{number of turns}}{\text{Area of wire} \times \text{twice the number of parallel paths from brush to brush}}$$

$$= \frac{\cdot 00000078 \times 31 \times 180}{\cdot 0085 \times 4} = \cdot 128 \text{ ohm},$$

and the $C^2 R$ loss at a current of 47·5 amperes (which is the output current + the shunt current) is

$$(47 \cdot 5)^2 \times \cdot 128 = 287.$$

The voltage lost in armature resistance is $47 \cdot 5 \times \cdot 128 = 6 \cdot 1$, and allowing 1·4 for the loss in the series winding of the magnets, the total lost volts are $7\frac{1}{2}$, and the internal voltage required in the armature is 117·5. The total magnetic flux through the armature is given by the formula—

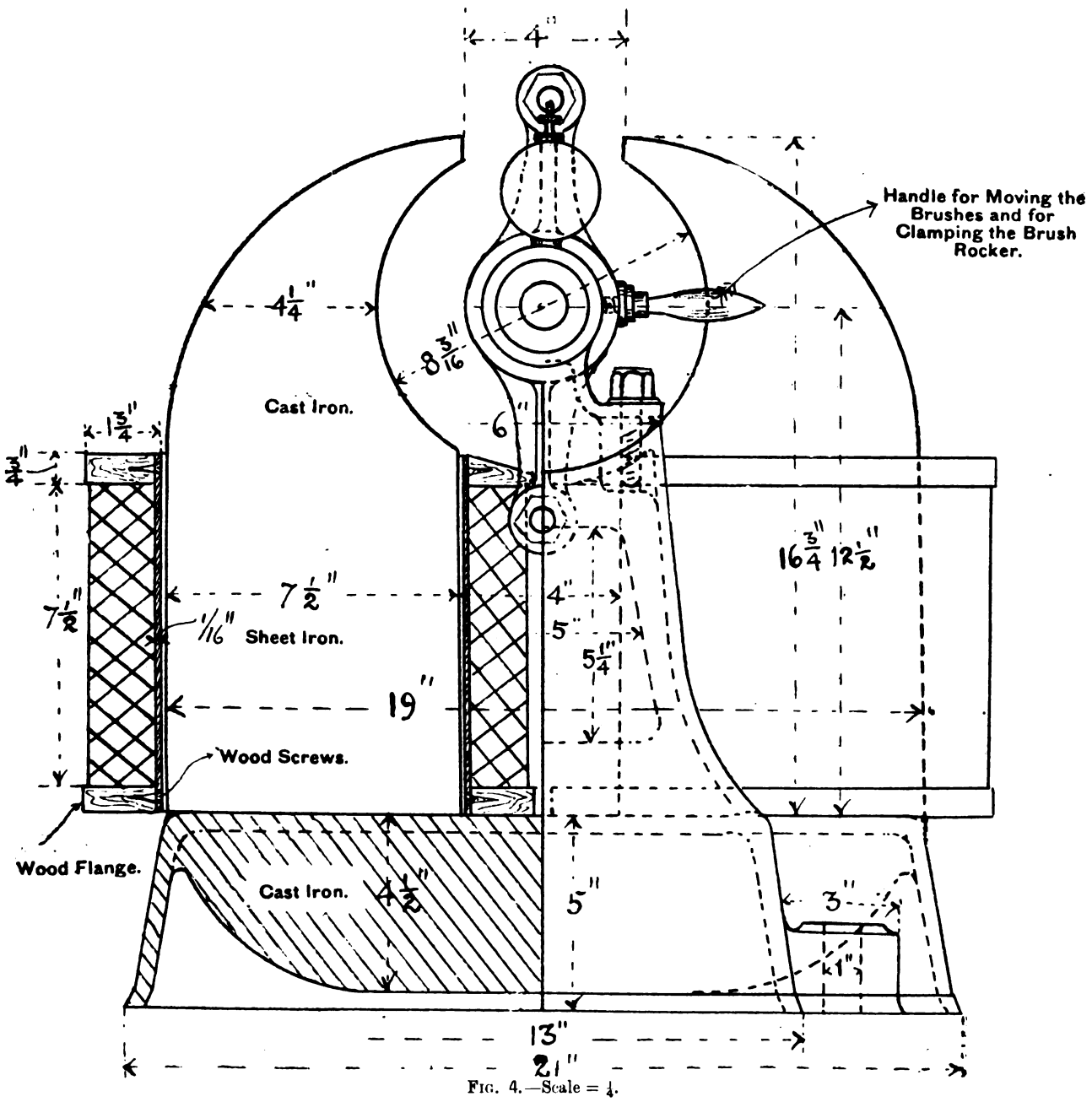

FIG. 4.—Scale = ¼.

$$\text{Flux} = \frac{\text{Internal voltage} \times 60 \times 10^8}{\text{Number of conductors} \times \text{revolutions per minute}}$$

$$= \frac{117 \cdot 5 \times 60 \times 10^8}{360 \times 1{,}500} = 1{,}310{,}000 \text{ C.G.S. lines.}$$

The net section of core iron (allowing for a $1\frac{3}{4}$in. diameter hole in the centre for the spindle, and 5 per cent. for the space occupied by varnish between the discs) is $(7 - 1\frac{3}{4}) \times 5 \times \cdot 95 = 24 \cdot 9$ square inches, and the volume of core iron is $\frac{24 \cdot 9}{2} \times 4\frac{3}{8} \times \pi = 172$ cubic inches.

The induction density in the core iron is therefore

$$\frac{1{,}310{,}000}{24 \cdot 9} = 52{,}500 \text{ C.G.S. lines per square inch.}$$

Using Steinmetz's constant for average iron, the hysteresis loss is given by

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Hysteresis watts

$$= \frac{2{\cdot}8}{10^{10}} \times \sim\sim \times \text{Volume in cubic inches} \times \left(\text{Density in C.G.S. lines per square inch}\right)^{1{\cdot}6}$$

$$= \frac{2{\cdot}8}{10^{10}} \times \frac{1{,}500}{60} \times 172 \times (52{,}500)^{1{\cdot}6}$$

$$= 43 \text{ watts.}$$

The eddy-current loss in the core discs is given by the formula (Kapp):

$$\text{Eddy-current watts} = \left(\text{Flux density in C.G.S. lines per square inch} \times \sim\sim \times \text{Thickness of each core disc in inches}\right)^2 \times \left\{\text{Core volume in cubic inches}\right\} \times \frac{3{\cdot}75}{10^{11}}$$

$$= \left(52{,}500 \times \frac{1{,}500}{60} \times {\cdot}02\right)^2 \times 172 \times \frac{3{\cdot}75}{10^{11}}$$

$$= 4{\cdot}7,$$

showing that eddy currents in this particular case are practically negligible.

The cooling surface of the armature, assuming that the ends are of hemispherical shape, is

$$(8\text{in.} \times \pi \times 5\text{in.}) + (8^2 \times \pi) = 325 \text{ square inches.}$$

The total watts per square inch are, therefore,

$$\frac{287 + 43 + 4{\cdot}7}{325} = 1{\cdot}03.$$

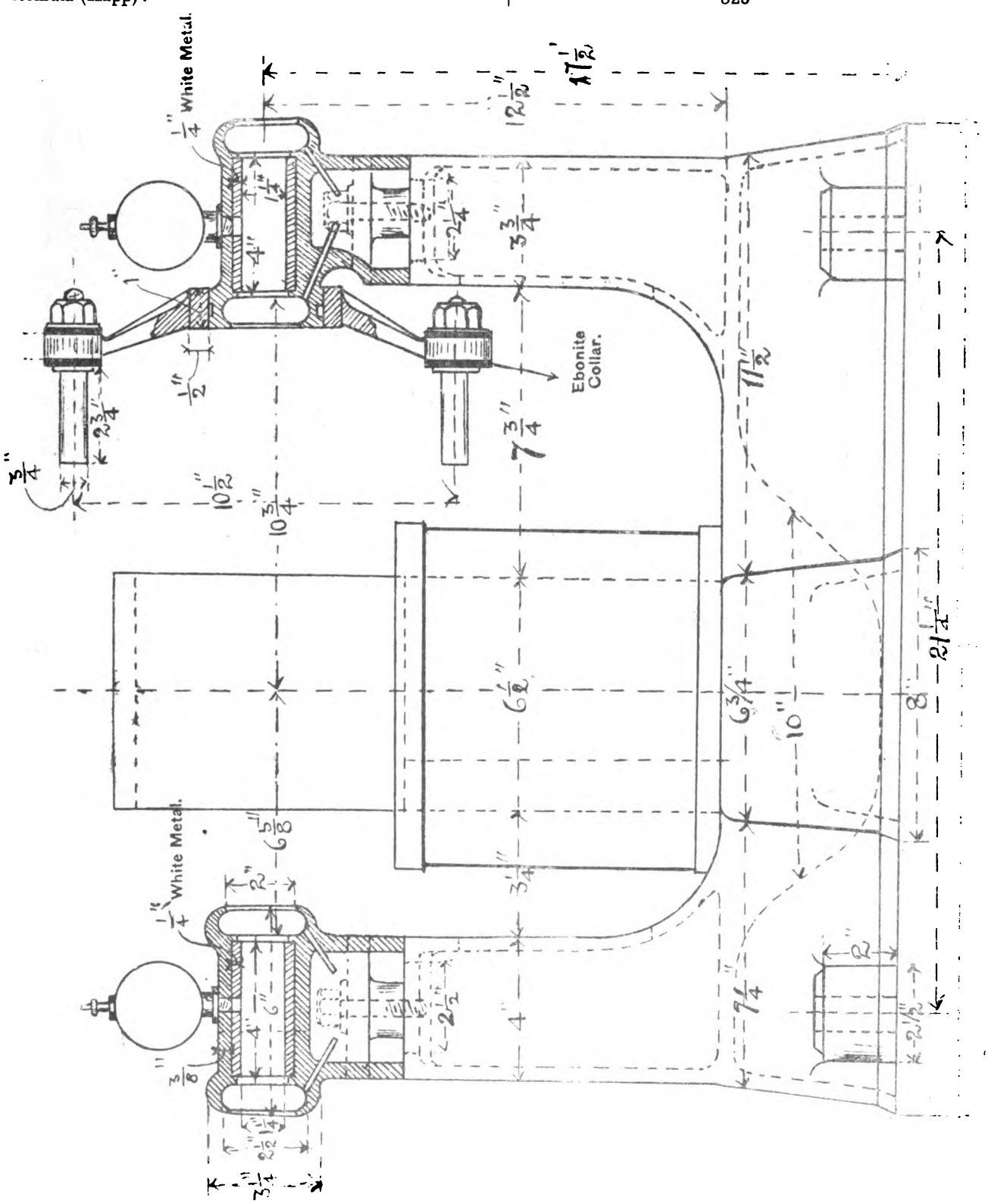

FIG. 5. Scale = 4.

The peripheral speed at the outer surface of the winding is $\frac{8 \times \pi \times 1{,}500}{12} = 3{,}140$ft. per minute, so that the temperature rise according to the formula given above should be $\frac{153 \times 1{\cdot}03}{1 + ({\cdot}0005 \times 3{,}140)} = 61$deg. F., which is a very satisfactory figure.

The particulars of the magnets and magnet windings must next be determined.

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The full load armature flux is, as given above, 1,310,000, whilst the no load flux is $\frac{110 \times 60 \times 10^8}{360 \times 1{,}500} = 1{,}220{,}000$.

Assuming a leakage coefficient for the magnets of 1·5, we find that in order to get a usual flux density for cast iron of about 40,000 C.G.S. lines per square inch, the sectional area of the magnet iron should be

$$\frac{1{,}310{,}000 \times 1{\cdot}5}{40{,}000} = 49 \text{ square inches.}$$

As the armature core is 5in. wide, the magnet cores can be safely made 6½in. wide, which will make the thickness of the magnet cores = 49/6½ = 7½in. A block of metal of about this same section (49 square inches) must also be cast underneath the bedplate (as shown in part section in Fig. 4 and dotted in Fig. 5) in order to satisfactorily connect the two magnet limbs together.

The necessary bore of the magnet tunnel to take the armature is found as follows:

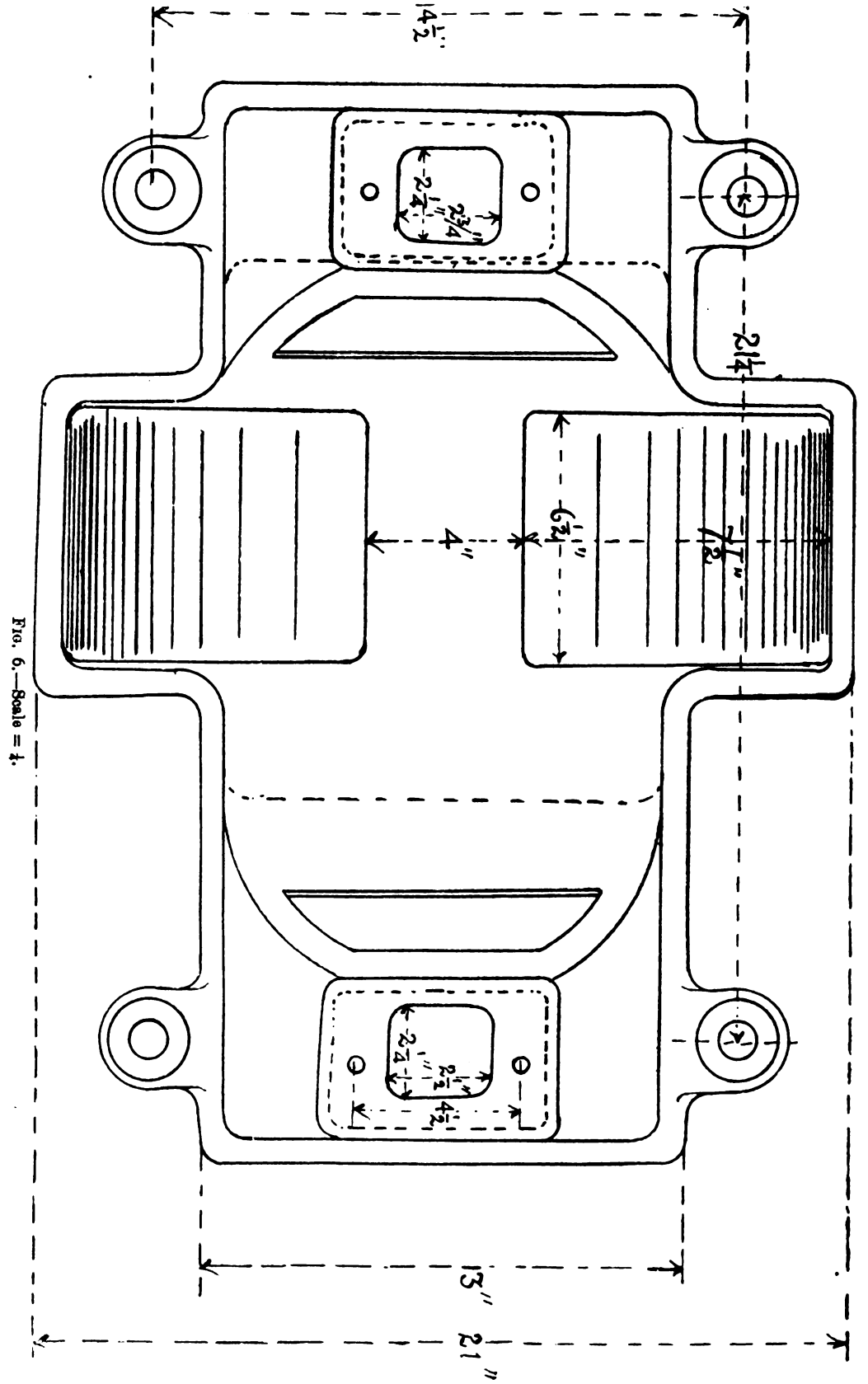

FIG. 6.—Scale = ¼.

Armature core diameter	7in.
Insulation on core (1/16in. thick)	0⅛in.
Six wires ·124in. diameter each	0¾in.
Insulating troughs (1/32in. thick)	0 1/16in.
Binding bands (1/16in. thick)	0⅛in.
Clearance (1/16in. a side)	0⅛in.
Bore of magnets	8 3/16in.

In order to allow a usual depth of winding on the field

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coils of 1½in. to 2in., it will be necessary to leave a space of 4in. between the two magnet limbs, and this practically determines the length of each polar arc as

$$\frac{(8\frac{3}{16}\text{in.} \times \pi) - 8\text{in.}}{2} = 8{\cdot}85\text{in.}$$

Adding to this an amount equal to 80 per cent. of the double air-gap from armature to magnet iron ($\cdot 8 \times 1\frac{3}{16}$in. = ·95in.) in accordance with Prof. Hopkinson's rule for fringing of the magnetic field at the pole-tips, we get 8·85 + ·95 = 9·8in. as the effective length of polar arc. The width of the polar arc parallel to the shaft may be taken as 6in. including the fringe, for, though the magnets are 6½in. wide, the armature core is only 5in. We are now in a position to calculate the number of exciting ampere-turns required at no load and full load, and so determine the amount of shunt and series winding.

The total number of ampere-turns required at no load (shunt winding) is made up of those required in the air-gap and those required in the iron path to produce the no-load induction. At full load (shunt and series windings acting together) the amount is made up of three quantities: those required for the air-gap and iron paths at the full-load induction, and an allowance to compensate for armature reaction and distortion. This latter is a point of some doubt, but a sufficiently close allowance for it can be made by adding an amount equal to one-quarter of the total armature ampere-turns to the excitation.

The whole calculation can be stated as follows:

Air-gap, ampere-turns = $\frac{\cdot 313 \times \text{length of gap} \times \text{induction}}{\text{area of pole-face}}$	$\frac{\cdot 313 \times 1\frac{3}{16}\text{in.} \times 1{,}220{,}000}{9{\cdot}8 \times 6} = 7{,}700$ at no load.	$\frac{\cdot 313 \times 1\frac{3}{16}\text{in.} \times 1{,}310{,}000}{9{\cdot}8 \times 6} = 8{,}250$ at full load.
Induction density in magnet cast iron	No load. = 37,400	Full load. 40,000
Mean length of magnet iron path	= 37in.	37in.
Ampere-turns per 1in. length of path in cast iron at above density, about	40	50
Ampere-turns for magnet iron...	= 37 × 40 = 1,480	37 × 50 = 1,850
Induction density in armature iron	= 49,000	52,500
Mean length of armature iron path	= 6in.	6in.
Ampere turns per 1in. length of path in wrought iron at above density	9	10
Ampere-turns for armature iron ...	= 6 × 9 = 54	6 × 10 = 60
Total armature ampere-turns at full load	$= \frac{47{\cdot}5 \times 360}{4}$ = 4,300	
Allowance for armature reaction and distortion	—	4,300/4 = 1,075
Total ampere-turns required on the field	9,934	11,235

The shunt should, therefore, be wound for 9,234 ampere-turns, and the series winding for 11,235 – 9,234 = 2,000; but, in order to allow a small margin for contingencies and possible differences in the quality of iron, we will wind the shunt for about 9,600 ampere-turns (4,800 on each limb) at 110 volts and the series winding for 2,400 (1,200 per limb) at 45 amperes. For a total number of ampere-turns of 6,000 a length of winding space of about 7½in. would be usual, and the total depth would be about 1¼in., of which the shunt would occupy about 1¼in. The spools for holding the field winding should consist of a sheet-iron body (see Fig. 4) fitting close to the magnet limbs, and having wooden end flanges screwed on. The body should be insulated all over to a depth of about ⅛in. by alternate layers of varnished canvas and tape, and especial care should be taken to put plenty of insulation at the corners, where the flanges join the body, so as to prevent any wires getting down on to the iron. The shunt should be wound first, and then should be covered by a layer of insulation about $\frac{1}{16}$in. thick before the series winding is added.

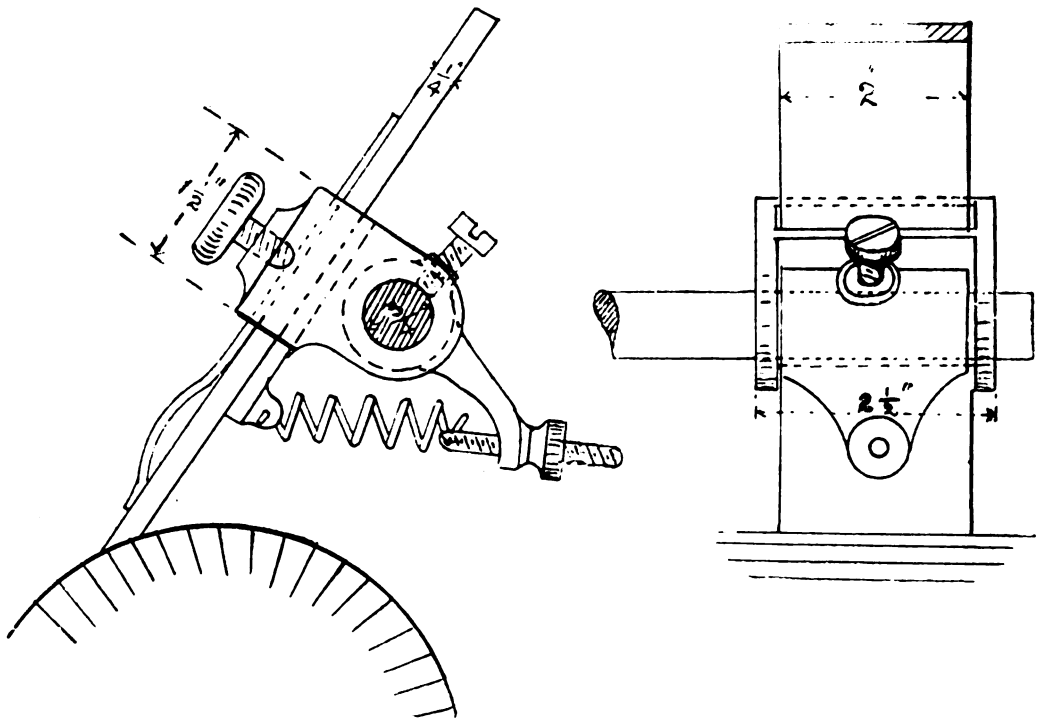

FIG. 7.—Scale = ½.

Shunt Winding.—The correct sectional area of the shunt wire is given by the formula

$$\text{Area of shunt wire} = \frac{\cdot 00000078 \times \text{Shunt ampere-turns per limb} \times \text{Mean length of a shunt turn in inches}}{\text{Volts across one limb}}$$

The mean length of a shunt turn is

$$\text{Periphery of magnet limb} + \text{an allowance of about 2in. for spool and insulation} + (\pi \times \text{depth of shunt winding})$$
$$= 28 + 2 + (\pi \times 1\tfrac{1}{2}) = 33{\cdot}9\text{in., about.}$$

$$\text{The area of shunt wire if the two limbs are coupled in series is therefore} = \frac{\cdot 00000078 \times 4{,}800 \times 33{\cdot}9}{55}$$
$$= \cdot 0023 \text{ square inch,}$$

and the nearest standard sizes to this are No. 18 and No. 17 S.W.G., having areas of ·00181 and ·00245 square inch respectively. The bare diameters of these wires are ·048in. and ·056in., and the double cotton-covered diameters ·063in. and ·071in. respectively. In order to get the required ampere-turns, about three-quarters of the depth of shunt should be of No. 17, and the remaining one-quarter of No. 18.

We will, therefore, wind on each limb, No. 17 S.W.G., 15 layers of 105 turns per layer, giving 1,580 total turns, occupying a depth of 1·07in. and having a mean

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length of $28 + 2 + (\pi \times 1{\cdot}07) = 33{\cdot}35$, and a resistance when warm of

$$\frac{{\cdot}00000078 \times 33{\cdot}35 \times 1{,}580}{{\cdot}00245} = 16{\cdot}75.$$

Also, in series with the above, No. 18 S.W.G., three layers of 119 turns per layer, giving 357 total turns, occupying a depth of ·19in., and having a mean length of $33{\cdot}35 + (\pi \times 1{\cdot}07) + (\pi \times {\cdot}19) = 37{\cdot}3$in., and a resistance when warm of

$$\frac{{\cdot}00000078 \times 37{\cdot}3 \times 357}{{\cdot}00181} = 5{\cdot}75\ \omega.$$

The whole resistance of the two limbs in series is therefore $(16{\cdot}75 + 5{\cdot}75)\ 2 = 45$ ohms. The shunt current is $110/45 = 2{\cdot}45$ amperes, and the ampere-turns on each limb are $2{\cdot}45 \times 1{,}937 = 4{,}750$. The total shunt watts are $2{\cdot}45 \times 110 = 270$.

Series Winding.—The number of turns required on each limb is $1{,}200/45 = 26{\cdot}5$. Say 26 turns. The sectional area of the wire should be chosen so as to give a current density of about 1,000 amperes per square inch, and so should be about $45/1{,}000 = {\cdot}045$ square inch. We will select a wire of rectangular section ·23in. wide × ·19in. deep, giving a section of ·0437 square inch, and double cotton-covered to about ·26in. by ·22in. The 26 turns will occupy a length of about 6¾in.—*i.e.*, part of a single layer—and a depth of ·22in., and will have a mean length of about 39in. The resistance of the two limbs in series (52 turns) when warm will be

$$\frac{{\cdot}00000078 \times 52 \times 39}{{\cdot}0437} = {\cdot}036\ \text{ohm}.$$

The watts lost in the series winding will, therefore, be $(45)^2 \times {\cdot}036 = 73$.

The outer periphery of the series winding is $39 + (\pi \times {\cdot}22) = 39{\cdot}7$, and the outside cooling surface of the two coils is, therefore, $39{\cdot}7 \times 7\frac{1}{2} \times 2 = 595$ square inch. The total watts per square inch at full load $= \frac{270 + 73}{595} = {\cdot}575$, and this, according to Kapp's rule for field coils, corresponds to a temperature rise of $83{\cdot}5 \times {\cdot}575 = 48$deg. F., or, according to Esson's rule, of $100 \times {\cdot}575 = 57{\cdot}5$deg. F., either of which temperature is quite low enough to agree with good practice.

The essential parts of the machine have now been determined, and it only remains to consider one or two details of construction. Fig. 7 shows a simple form of brush-holder suitable for the machine. One of these holders, containing a copper gauze brush 2in. × ¼in. × about 6in. or 7in. long, is sufficient to collect the current on each side of the commutator. The brushes should be set at an angle of about 50deg. to the commutator face, and will then cover about 1½ plates.

In order to simplify the construction as far as possible, the bearings shown in Figs. 3 and 4 are of the lubricator glass type instead of the more usual self-oiling ring type. They consist of a simple cast-iron casting with a white-metal bush—the casting being partly filled with white metal in a molten state, and afterwards bored out to suit the spindle. The circular seatings for the bearings on the pedestals are bored of the same diameter, and, in fact, with the same tool as the bore of the magnets. The bearings themselves are turned on the under side, and bolted to the seatings by two ½in. bolts. The lower parts of the bearing pedestals (which are cast in one with the bedplate and magnets) are occupied by cans to receive the oil drippings as they leave the bearings by the short tubes shown in Fig. 5.

The details of the mechanical design of the different parts can, however, be readily varied to suit individual taste without affecting the working of the machine.

The weights of active material used in the construction of the machine will be approximately as follows:

Armature copper			16lb.
Commutator copper			11lb.
Armature core discs			48lb.
Magnet copper	No. 17 S.W.G.	90lb.	136lb.
	No. 18 S.W.G.	17lb.	
	Series wire	29lb.	
Magnet cast iron (not including the bedplate)			530lb.

The commercial efficiency that may be expected for the machine is about 83½ per cent., which is obtained as below

Output of dynamo	5,000	watts.
C^2R loss in armature winding	287	,,
Hysteresis loss in armature core	43	,,
Eddy-current loss in armature core	4·7	,,
C^2R loss in shunt winding	270	,,
C^2R loss in series winding	73	,,
Allowance for bearing friction, brush friction, and windage, say	300	,,
Required input	5,977·7	,,

$$\text{Commercial efficiency} = \frac{5{,}000}{5{,}977{\cdot}7} \times 100 = 83{\cdot}6 \text{ per cent.}$$

SOME TESTS ON SMALL STEAM DYNAMOS.

BY F. J. WARDEN-STEVENS.

Difficulty has been experienced in ascertaining the results to be expected from small steam dynamo sets, and the following results obtained by tests on 20-kw. and 40-kw. sets carried out under the supervision of the writer at the maker's works in connection with a contract for the Poplar Union may be of interest:

1. A 50-kw. Thames Ironworks multipolar dynamo, direct coupled to a Reavell engine; governing automatic expansion, with throttling at light loads; speed, 500 revolutions per minute; steam pressure, 120lb. per square inch.

2. A 20-kw. De Laval steain turbine, direct connected through helical gearing to a twin-armature dynamo; governing throttling throughout; speed, 22,000 revolutions per minute turbine, 2,200 revolutions per minute dynamo; steam pressure, 120lb. per square inch.

Results—Condensing, Vacuum 24·5in. Mercury.

Description.	Load. Kilowatts.	Pounds of steam per B.T.U.
Reavell engine	50	29·3
,, ,,	37·5	30
,, ,,	25	34·8
De Laval turbine	20	38·16
,, ,,	15	37·63
,, ,,	10	40·5

Results—Non-Condensing.

Reavell engine	50	37·3
,, ,,	37·5	38·6
,, ,,	25	45
De Laval turbine	20	61·1
,, ,,	15	59·62
,, ,,	10	84

In each case the weight of water condensed with or without vacuum in a surface condenser was carefully measured. With the De Laval turbine it is to be noticed that both condensing and non-condensing the results are better at three-quarter than at full load. This is explained by the fact that the steam nozzles are arranged for a higher than the nominal full load, whereas at three-quarter load one nozzle shut down allowed the turbine to deal with the load with little throttling. The steam-chest pressures were, at full load 95lb., and at three-quarter load 119lb., so the greater throttling at full load (nominal) explains the loss of economy. If full load had been taken as 25 kw., the result would, of course, have been better at full than three-quarter load. I would say that with regard to the actual results those above given are better than the guarantee, and the guarantees were at least as good as any offered by makers of all the well-known high-speed engines and other makes of turbines. In neither case was superheating allowed, and the boilers were working at approximately the proper pressures, so there was no possibility of superheating by throttling. These figures may, therefore, be taken as representative of what may be expected from small sets of plant by first-class makers of high-speed engines and of small steam-turbines. I do not propose to go into figures per indicated horse-power, etc. They are not of much interest to electrical engineers. The figures expressed in pounds per Board of Trade unit appear formidable, but as the dynamos are in both cases as good as can reasonably be expected, I think it is well to express steam consumption in pounds per unit, as it is units of electricity that are required

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ELECTRIC TRACTION ON THE "UNDERGROUND."

(Continued from page 675.)

MONDAY'S PROCEEDINGS.

The enquiry into the dispute between the Metropolitan District and the Metropolitan Railway Companies as to the system of electric traction to be employed on the "Inner Circle" was continued before the arbitrator, the Hon. Alfred Lyttleton, K.C., M.P., assisted by Mr. H. F. Parshall and Mr. T. Parker, in the Lord Chief Justice's Court at the Law Courts.

Mr. O. T. Blathy, in answer to questions from Mr. W. R. Wallace, K.C., said he considered that the safety devices proposed for the Ganz system would with ordinary supervision be quite reliable. He had again looked through his figures, and was sure that he could maintain a 50 minutes' service round the Inner Circle for 70·6 watt-hours per ton-mile. He had also looked into the cost of the equipment of the sub-stations which would be required with the direct-current system. He found that seven sub-stations would be wanted for the full service, instead of the four mentioned in the British Thomson-Houston Company's tender. At their cost of £20,000 per sub-station this meant an excess expense over the Ganz system of £140,000. There would also be a large saving in the cost of the equipment for the lines outside London if the Ganz system were adopted. On behalf of his firm he was prepared to guarantee that the total consumption of energy per ton-mile, including all accessories, such as the lighting of the train, the working of the air-pumps, the signalling, etc, would not come to more than 95 watt-hours. He found from the British Thomson-Houston tender that they required 109 watt-hours per ton-mile. Finally, he thought that with the Ganz system a more regular service as regards freedom from interruption would be maintained, because there were fewer elements to get out of order. Also a short-circuit on the system would not do so much damage with an alternating current as with a direct current.

Mr. Blathy, cross-examined by Mr. Fletcher Moulton, K.C., said that his firm had agreed to pay a certain proportion of the costs of the present arbitration. The cross-examination was then continued, with a view of showing how much the Ganz system for the Inner Circle had been altered since their original tender of a year ago. Mr. Blathy admitted that in this tender he had described an acceleration of 1·5ft. per second per second as the maximum which could be used without causing discomfort to the passengers. He now held that acceleration of 2·6 was quite feasible if it is not applied too suddenly. He instanced the Westinghouse brake in action as producing a negative acceleration of from 3ft. to 5ft. per second. Mr. Moulton then read from Messrs. Preece and Parker's report, which attributed to the low frequency employed the great success of the Ganz motors. Mr. Blathy admitted that they had raised the frequency from 15 to 25 in order to use geared motors, but this latter frequency was not chosen because it was the American standard for transmission work. The motors in the original tender were rated at 150 h.p. and weighed 8,000lb. They were wholly spring-borne. The motors now proposed were partly spring-borne, and weighed 5,500lb and developed 300 h.p. This motor had not been made, but a photograph of the working drawings was shown. His firm had used geared locomotives on two or three more lines in connection with mines. These would be from 15 h.p. to 20 h.p., but he saw no difficulty in building motors with 300 h.p. to work at 750 revolutions. In the original tender the stator of the first motor was to be permanently connected to the line. He now proposed to use high-tension switch gear on the car to interrupt this connection. The switches would have to deal with 9·5 amperes at 3,000 volts. The water rheostats for the District Railway had been designed. They differed from those in use on the Valtelina line chiefly in having large cooling surfaces and a system of circulating the liquid. These improvements were not due to the remarks which had been made by the three engineers who had inspected the line on behalf of the District Company. The locomotives on the Valtelina line were controlled by hand, whereas there would be a magnetic control of the air-cock to the liquid rheostats on the District Railway. The hand control cock would, however, leave the driver in full charge of the train. He thought the automatic control would be quite reliable. The armature of the electromagnet would have a range of ¼in., and would regulate the air admission according to the acceleration. In the event of the current being shut off in consequence of an adverse signal when the train was almost at full speed, it would not be necessary when again switching on to wait the interval of time which it took for the controller to get the train up to that speed originally. In other words, the controller would quickly bring up the liquid resistance to the same point as before. He did not agree with Mr. Moulton that because all successful automatic electric controls on trains are up to the present of the positive on or off type, that he could not make his apparatus work successfully on the qualitative system. If the train was running at more than half speed, the driver could switch the one motor directly on. It was true that if he switched on the motors in cascade at more than half speed, they would act as brakes. As regards the braking by means of reversing the motors, this could only be done on the front car. In the original tender it was pointed out that owing to the short time available all details could not be thoroughly gone into, hence it did not include the coal-handling plant and the water-cooling towers, which he would now advise to be used. He held that the boilers proposed with 48,000 square feet of heating surface and 9,000 square feet of superheating surface, would give all the steam required to drive the engines offered, which only required 11lb. of steam per indicated horse-power. The boilers would give 100deg. C. of superheat, or, say, 80deg. at the engine stop valves. As regards the train equipment, after a long cross-examination Mr. Blathy would not admit that the eight motors per train he suggested giving 1,200 h.p. in all would cost more than the six motors of 150 h.p. each offered by the British Thomson-Houston Company. His motors ran faster. The second motor on his cars weighed each 4,180lb. This would mean that with a 2½-minute service on the Inner Circle they would carry round some 300 tons of additional apparatus in order to be able to work in cascade, and to get 2·6ft. per second per second of acceleration when starting up. This weight was small compared with the weight of the rotary converters on the rival system. He adhered to his figure of 70·6 watt-hours per ton-mile, although an expert from the other side had found 87 watt-hours by direct experiment on the Valtelina line.

Re-examined by Mr. Cripps, K.C., Mr. Blathy said that he could get more acceleration with his system than could be got by the direct-current system. In the direct-current system, if the motorman moved his handle too fast he blew his fuses. He held that his system of control was more simple than that on the direct-current system. They had quite enough details obtained from practical work to enable them to design with accuracy the apparatus required for the equipment of the Inner Circle on the Ganz system.

Mr. Kalman de Kando, the vice-manager of Messrs. Ganz and Co., examined by Mr. Cripps, said he had had eight years' experience in designing polyphase motors for his firm. They first began to use such motors for traction work in 1896. They had been experimenting with and using the cascade system for four years. In the first instance he had found that special designs of motors were required in order to obtain successful working in cascade. He was sure he had sufficient data to ensure success of the system on the Inner Circle. He was present when the three engineers of the District Railway inspected the Valtelina equipment, and told Mr. Chapman that they had not for that line attempted to get high acceleration. He considered liquid resistance the ideal form of regulating motors. There was no mechanical difficulty in working with ⅛in. clearance in the motors. As regards the proposed trolleys for the Inner Circle trains, there was nothing in their design which calls for any anxiety in view of the experience they had had.

TUESDAY'S PROCEEDINGS.

Mr. Kalman de Kando, cross-examined by Mr. Gordon, admitted that with regard to the heating of the polyphase motors it was quite possible that there might be differences of opinion between engineers. The heating depended not only on the make of machine, but also on the work it had to do, so that in order to test this point it was necessary to test the motors under the conditions it was proposed to run them. With his present knowledge, he contemplated no difficulty with cascade couplings. The practical power factor for running in cascade was 77 or 78 per cent. This was the power factor of the combined primary and secondary motors. He knew that Mr. Rice was of opinion that it was not good practice to run polyphase motors in cascade, but with his (the witness's) improved motors there was no difficulty whatever in the use of cascade connections. He thought that any first-class electrical firm, if they used the improved motors, would be able to make the polyphase system succeed with cascade working. The reason why his firm had succeeded with cascade connections where others had failed, was that they did not stop at the first bad results, but kept on improving their motors. It was important that the secondary motors should have as high a power factor as possible. The chief importance of this was that it was required to get a very large output through to the secondary motors, but he did not agree that if this were not obtained the system would fail. His experience with polyphase motors in cascade was confined to their trials and Valtelina lines, but he did not admit that the experience gained with stationary motors could not be relied upon in the design of traction motors. Certain features of the stationary and traction motors were common to both. The system of multiple-unit control proposed by Messrs. Ganz had never yet been subjected to experiment to any extent nor to practical working. He admitted that if anything went wrong with this method of control on the Inner Circle it would be a serious matter, but his firm believed that they had shut every door to mistake.

Re-examined by Mr. Wallace, K.C., Mr. Kando said he had sufficient experimental data to determine the power, efficiency, the power factor, and the heating of the polyphase motors it was proposed to supply for the Metropolitan Railway. Experiment was also sufficient to satisfy him of the success of the cascade connections.

Prof. J. A. Ewing, F.R.S., was then called. Examined by Mr. Wallace, he stated his opinion that the most appropriate name for the continuous current was the "mixed system." The Ganz system was polyphase throughout. The very fact that polyphase current was used in the mixed system for the purpose of carrying polyphase power from the central station to the sub-stations, was evidence of the advantage of transmission of energy by polyphase currents. It could not be truthfully said that either system was in an experimental stage. The conversion of polyphase current at the sub-stations was prejudicial to the continuous-current system. In the first place, there was the necessity for the very expensive and elaborate rotary converters in the sub-stations, which also required attendance, and also these machines were a source of loss of power. Beyond this, however, there was this very important consideration—that with the converted current you were necessarily restricted to use motors with a limited pressure. With polyphase current supplied to the motors no such limit of pressure was imposed. The consideration was of enormous importance in electrifying long railways. Again, in the provision of rotary converters for the Inner Circle Railway you must put down a large margin of power. He had special knowledge of the Central London Railway, as he was a member of Lord Rayleigh's Committee on the question of vibration. The voltage used on this line was 500, and this could not be increased with success, as up to the present it had not been found practical to use continuous-current motors with much higher pressures. The effect of having a low voltage was a loss of power in the conductors. Taking the voltage of 550 volts proposed in the British Thomson-Houston tender, he had calculated that the loss of energy in the starting of a

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train between two sub-stations would be 10 volts. This would mean an average loss of 9 per cent., and also would result in very much larger conductors being necessary. A portion of this difficulty could, however, be overcome by using a larger number of feeders or by multiplying the number of sub-stations. He had no doubt that if the British Thomson-Houston Company had to tender for the whole of the Inner Circle instead of only 220 train miles per hour they would have to increase their number of sub-stations, or else use copper feeders to assist the rails in carrying these large currents. In the Ganz system none of these difficulties were experienced. Owing to the very small currents that were used, there would practically be no drop in the line. It was because of the difficulties he had referred to that he believed the cost of the continuous-current system would be prohibitive. He conceded that there was an advantage using a single insulated conductor with the continuous current, but in the case in question all the tenders provided for two insulating conductors. With the large currents proposed it would be impracticable to use a single insulated conductor on the Inner Circle, so that as far complication of conductors was concerned there was nothing to choose between the two systems. With regard to the power which the trains used, there was also no substantial difference between the two. So far as acceleration was concerned, the continuous-current motors had a small advantage. They used rather less energy to produce the same effect on the train. But, on the other hand, the polyphase system had an advantage in restoring part of the energy to the line, which just about neutralised the advantage to the continuous-current. With regard to the sub-stations, he thought the efficiency of the rotary converters would not be more than 92 per cent. Besides the heavy addition to capital cost for these machines, they required continuous attendance, which was a fairly heavy item in working cost. The switchboard in the continuous-current sub-station was also a very expensive item of cost. As regards the central-station plant, the power required for the continuous-current system was more than for the Ganz system, on account of the loss in the process of conversion. On the other hand, with the polyphase system you had to make allowance for the wattless current, so that, practically speaking, the current generators would have to be of the same capacity in both cases, although the boiler capacity would not have to be so large in the polyphase system. The existence of rotary converters required that the current coming from the generating station should be supplied with great uniformity of periodicity. This requirement had to be met in the continuous-current by the use of very heavy flywheels on the generators. There was not the same strict need for such absolute uniformity of periodicity if the use of rotary converters were avoided, and, consequently, the engines and generators from that aspect might be somewhat cheaper in the polyphase system. Questioned as to the comparative flexibility of the two systems, Prof. Ewing expressed the opinion that for the future operation of electric railways it would be the polyphase, and not the continuous, current which would be universally adopted. He thought that the cascade working proposed by Messrs. Ganz was an ingenious and effective invention. Also, the overhead equipment proposed by that firm was a perfectly workable arrangement. In regard to the question of safety, he would like to say that with the precautions which Messrs. Ganz proposed, in his opinion the 3,000-volt working would not only be as safe, but more safe than the 500-volt working as carried out in the ordinary way. He thought that the criticisms offered in evidence on the proposed water rheostats had been based on experience of water rheostats for continuous-current and not for polyphase motors. He considered that the liquid rheostat was an excellent resistance. It made it possible to get rid of the human element by the use of solenoid and of air pressure to actuate the fluid. He agreed with the previous witness that a small air-gap was mechanically perfectly sound if long bearings were used, and these kept well lubricated. Further questioned on the point of acceleration, Prof. Ewing stated that one of his assistants carried out some tests on the Valtelina line. On one journey he obtained an acceleration of 1·6ft. per second per second, and on another an acceleration of 1·5ft.

Cross-examined by Mr. Gordon, the witness admitted that some of the points he had brought up in his evidence-in-chief were simply matters of opinion. His conclusions, however, were based on a consideration of the matters in question. He knew that the original Ganz tender gave an acceleration of 1¼ft. per second per second in the first half and ¾ft. in the second, and that this had now been altered to 2·6ft. and 1·44ft. respectively. Counsel then cross-examined him at great length with a view to showing that the higher acceleration gave the Ganz system an advantage in a comparison of first cost and energy consumption between the two systems. The professor, however, would not admit the proposition, considering that, although the acceleration was an important factor in making such a comparison, it was not necessary to a fair comparison that it should be the same in both cases. With the higher acceleration you required more power for the motors in accelerating, but so far as the total amount of energy was concerned, if you accelerate faster you used rather less energy than otherwise. He agreed that there would be new points to be dealt with in both systems as applied to the Inner Circle.

The **Arbitrator** pointed out here that if the question of cost were left out of consideration, Prof. Ewing had no fault to find with the continuous-current system.

Mr. Cripps said that was the principle on which the Metropolitan Company's case had been conducted throughout.

Under further cross-examination, the **Witness** stated that the fact that extreme uniformity of periodicity in the generators was required, with the use of rotary converters would make the continuous-current generators more costly. The use of cascade connections with polyphase motors was equivalent to the series-parallel control in the continuous-current system. He held that there was exactly the same torque, the same power, and the same capacity in both cases.

Major Cardew, examined by Mr. Cripps, K.C., said that in his capacity as electrical adviser to the Board of Trade a few years ago, he had inspected the City and South London, the Liverpool Overhead, the City and Waterloo, and the Central London Railways systems. He did not consider that the third-rail system could be economically applied to long lines having a large traffic. Commercially, it was out of the question for the Inner Circle; but electrically he did not know any difficulty. Both in cost of equipment and afterwards in cost of working the difference was enormous between the polyphase and the direct-current system. Substantially, the additional cost in the case of the continuous current was in respect of rotary converters and larger conductors. In considering the question of working cost, it must be borne in mind that there was a loss of about 10 per cent. in the continuous-current conductors. Against this, the loss in the polyphase conductors was well inside 4 per cent. Until very recently he did not look with much favour on the polyphase system. His opinion, however, was now changed. He thought tha with the improvements Messrs. Ganz had worked out, the polyphase system would work with even greater efficiency than the continuous-current. Originally, the fault he found with the polyphase system was that it was not sufficiently flexible. On the question of safety, with the 3,000 volts there was no doubt whatever that considerable danger was involved, but if the conductors were properly protected, and arrangements made that in the event of a rupture the current would be immediately cut off, there was absolutely no risk. On the other hand, he thought there was an element of danger with the 500-volt working. With the overhead conductors the element of inaccessibility both to passengers and employés was obtained. Further, he had no doubt that any difficulty from the breaking of the overhead wires could be overcome by the use of an efficient safety device. Questioned as to whether there was any element in the Ganz system which presented a difficulty as regards electrical principle, Major Cardew said he considered that Messrs. Ganz had appreciated better than any other firm what was the correct way of designing and treating these induction motors.

In reply to the Arbitrator, he asserted that if he had the tenders of Messrs. Ganz and the British Thomson-Houston Company before him and nothing else, he would be able to express a confident opinion as to whether the one system would be more costly than the other. He thought the two tenders might very well be compared.

Further examined, he found sufficient in the tenders to justify the conclusion of Messrs. Preece and Parker that the Ganz system was the better and most economical system. Apart from the tenders, he considered that the Ganz system had the advantage all the way through. Questioned as to what the energy consumption would be with the Ganz system on the Inner Circle, he quite agreed with the figures given by Mr. Kapp, who put it at 70·6 watt-hours per ton-mile. In his opinion the results gained from the tests on the Valtelina line justified the figures furnished for the Inner Circle. So far as the polyphase system was concerned, the proposed multiple-unit control was perfectly simple and effective, and he was quite in favour of the use of liquid rheostats. With regard to the reversal of the polyphase motors at triangular junctions on the Inner Circle, he thought the difficulty was an imaginary one. The whole difficulty was based on Mr. Swinburne's assumption that there was only one line in the Inner Circle. There were two lines, and with four conductors overhead no reversal was needed.

In reply to the Arbitrator, Major Cardew admitted that the polyphase system was an experimental system in the sense that before proceeding to equip the whole of the Inner Circle with it, it would be necessary to equip a portion in order that sufficient trials might be made to satisfy the Board of Trade and the officers of the company that the system was going to work safely and satisfactorily.

The **Arbitrator**: Assuming such a test were made, and the experience which was obtained resulted in the rejection of the Ganz system, how soon could you arrive at that result—how long would it take you to put this experiment into operation?

Major Cardew thought that the test itself would probably not occupy more than a fortnight. The rest of the work, such as the construction and equipment of the generating station, etc., would be just the same in both systems, so that practically no delay would occur in the work of converting the Inner Circle to electric traction.

The **Arbitrator** further questioned the witness as to whether he had ever known of a case where the controlling authority had insisted upon a particular system of electrical working which was not approved by the company. He pointed out that in the present case whichever system was ultimately decided upon, it would be opposed to the views of one or other of the two railway companies concerned.

Major Cardew said he had never heard of such a case. His only desire in the matter was that the best system should prevail, and that Messrs. Ganz should have fair play.

The Court adjourned.

Wednesday's Proceedings.

On the reopening of the enquiry, **Major Cardew** was further examined by Mr. R. W. Wallace, but, after argument, it was ruled that he could not give evidence as to whether Mr. Kapp had, in his opinion, made allowances in his calculations for the energy returned to the line. He gave the results of his own calculations from the Sondrio experiment as to what could be expected on the Metropolitan Railway. Making allowance for the reduced speed from 41 to 25 miles per hour, and for the decrease in the length of the run, he calculated that 81 watts per ton-mile would be required. He thought that the difficulty of having two insulating conducting rails for each line would cause more obstruction and be more dangerous than having the 3,000-volt wires suspended overhead.

Cross-examined by Mr. Moulton, Major Cardew said that Sir W. Preece's advocacy of the two rails on the ground level in one of his reports was made before the Ganz system had been considered. It would be difficult to support the heavy conductors for the low-tension

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system overhead. He thought that the Ganz system was the better for the suburban lines.

Mr. Moulton then asked, in view of the fact that the cost of energy for the line was only some 10 per cent. of the whole cost of running, whether he would advise the use of a new and untried system in order to attempt a small saving in that 10 per cent. ?

Major Cardew said that the saving in working was also accompanied by a large saving in first cost, which was most important. As regards overhead wires, in his opinion no crossing wires must be allowed. On the 2½ miles of open cutting in the Inner Circle, it would be necessary to remove telegraph and telephone wires which cross the line of route. On the question of the tenders, it was not fair to consider only the capacity of the boiler plant. His view of the matter was as follows: The British Thomson-Houston Company in their tender said the maximum output which would be required would be 7,400 kw. They proposed to instal three machines of 2,500 kw. and a fourth machine of the same size as spare. These machines were to stand 50 per cent. overload, and under normal conditions the temperature rise was to be under 40deg. C. In the Ganz tender, on the other hand, it was estimated that the maximum output would be 9,300 kw., and the average output 4,800 kw. The firm proposed to supply three generators, of which one would be spare. The normal efficient load of each engine would be 3,600 h.p., or 2,700 kw., but the machines would give 100 per cent. overload, and the temperature rise under ordinary conditions was to be 35deg. C. In answer to Mr. Moulton, he did not agree that Sir W. Preece and Mr. Parker should have reported that the plant offered by the Ganz Company had a capacity of 8,100 kw., and not 14,000 kw. He thought that the latter figure was somewhat too high. The Ganz tender offered less boiler power, but not less engine power.

In reply to Mr. Parker, Major Cardew said that the unit offered by the Ganz Company, being larger, was more suitable in view of coming extensions.

Mr. Parshall then pointed out that the outputs of the machines in question offered by the two firms were as 25 to 27.

Further-cross-examined by Mr. Moulton, **Major Cardew** was taken through the question of the control, and concluded that he did not look upon the Ganz system as a purely experimental one. There were details to be worked out, but it was only on these points that experiments were wanted. These experiments would be required to satisfy the Board of Trade.

Re-examined by Mr. Cripps, K.C., Major Cardew said that experience had proved the difficulty of using two insulated conductors on the track level.

With respect to the Central London experience, **Mr. Parshall** interpolated the explanation that only one line—*i.e.*, that to the locomotive sheds—was first equipped with two conductors on the ground level. This was in regular use. For the other sidings overhead conductors had been put up, but the staff of the company were not in favour of their use. They had accordingly employed steam locomotives for shunting the carriages.

Major Cardew said that even with the direct-current system the Inner Circle would hardly be equipped without numerous alterations being required from the plant used on the "Tube" and elsewhere. He apprehended no difficulty from the use of the liquid resistance or from the solenoid control. In the event of a hitch occurring in the latter, the driver could still retain control of the train.

Mr. E. Talbot, examined by Mr. Cripps, gave his experience of the use of overhead wires in Leeds. The conductors there had stood a regular four minutes' service since 1897 without being replaced. With the exception of one small difficulty in connection with the ears, which had been overcome, they had had no trouble with the overhead equipment. The G.E. 58 motors used at Leeds had a clearance of $\frac{5}{32}$in. at the bottom of the armature and ⅛in. at the top. He found that with these they could run 45,000 miles before the bearings required new white metal. This represented 18 months' work.

Under cross-examination, Mr. Talbot said that he had no experience with phosphor-bronze wire; they used hard-drawn copper wire at Leeds.

Prof. S. P. Thompson, examined by Mr. Cripps, said he was conversant with three-phase working; and preferred it for all cases for which high voltages were required for the distribution of electrical energy. The two rival systems were the same until the sub-station was reached, and he thought that the rotary converters of the direct-current system might be dispensed with. He calculated that with seven or eight sub-stations on the direct system there would be an average loss of 8 per cent. in the conductors, with a maximum loss of from 12 to 13 per cent. He based his calculation on 40 trains, with a consumption of energy of 7,800 kw. They would also lose from 7 to 8 per cent. in the converters, and from ½ to 1 per cent. on the commutators of the motors. He made the total loss 16 per cent., which, allowing 3 per cent. for the Ganz system for transformer and line losses, still left 13 per cent. in favour of that system. Comparing motors for the two systems with equal size of revolving part, equal speed, and equal efficiency, the motors would give equal torque. The polyphase motors had the advantage that (A) the stator was lighter, (B) it could work with smaller clearance, (C) it required less attention, owing to the absence of a commutator, and (D) it was more simply controlled. He considered the Central London controllers exceedingly complicated, but they worked well. The cascade coupling was, in his opinion, an advance over the series-parallel control, as it gave higher acceleration in the first portion of the run. He had always been adverse to overhead wires, but considered that on railways they were the only possible solution. Alternating currents were more easily insulated than direct currents, because leakage did not result in chemical action. He had seen a number of polyphase motors on railways in Switzerland working with the same clearance as proposed by the Ganz Company. He considered that the use of an exciter on the shaft of each generator was the most modern practice, as separate exciters had given trouble in the City of London Electric Lighting Company's stations.

Mr. Parshall asked Prof. Thompson if he did not know that it was grouping the exciters together on to one omnibus bar which had caused the breakdown he had referred to, and that separate steam-driven exciters were now always used?

Prof. Thompson said that he was not aware of it.

Cross-examined by Mr. Moulton, **Prof. Thompson** said that his calculation as to the average loss on the rails on the direct-current system was made on the assumption of 7,800 kw. being used. If only 1,600 kw. were required, his calculations would require to be remade. He had not ascertained how much the rotary converters on the Central London Railway wasted. A long extract read from Prof. Thompson's book on "Polyphase Electric Currents and Alternate-Current Motors," dated 1900, was to the effect that for lines in towns in which there were frequent stops required, the direct current was the best, and that if the load was a heavy one, it should be distributed by polyphase currents and converted into direct currents by rotary converters. Prof. Thompson said that the advice given was correct at the time it was written. The small clearances in alternate-current motors were a necessity in order to get good results. The rest of the cross-examination consisted in a battle over the excitation question, and as to the Ganz details of controlling the motors. On the last subject no more definite information was forthcoming.

Re-examined by Mr. R. W. Wallace, Prof. Thompson said that the book was written before cascade working had been tried. He objected to overhead wires being used in any position where they could fall on to the public or any other wires could fall on to them. A stray question from Mr. Moulton elicited that cascade working was actually mentioned in the book. This concluded the evidence.

Mr. Cripps, K.C., then opened his reply on behalf of the Metropolitan Railway. He urged that the arbitrator should not be prejudiced by the statement of the District Company, that they were going to equip in any case their suburban lines on the direct-current system. Such a course was outside the present arbitration, and the company had no right to expect the arbitrator to vary the decision accordingly. In view of the financial state of the District Company, as well as in the interest of the shareholders of the Metropolitan Company, economy in the first cost of equipment was of the utmost importance. He claimed that no attempt had been made by Mr. Moulton in cross-examination to show that Mr. Blathy's estimate of the saving of £140,000 in the Inner Circle equipment, and £3,000 per mile on the outside lines by the use of the Ganz system, was not correct. As regards safety, no attempt had been made to prove that they could not place the 3,000-volt conductors in inaccessible positions. It was absurd to suppose that in the present state of electrical knowledge these conductors could not be rendered harmless in the case of a fracture occurring. The railway companies, as freeholders, had the power to enforce the removal of any telegraph or telephone wires which crossed over their lines. He claimed that his friend's case, that the necessary acceleration could not be obtained by the polyphase system, had utterly broken down. The evidence that accelerations of 2·6ft. and 1·4ft. per second per second had been obtained on the Valtelina line had not been shaken in cross-examination. Again, the bogey raised by Mr. Swinburne as to the trouble at triangular crossings had been shown to be quite fallacious by Major Cardew, and to be based only on the assumption that there was only one running line. He considered he had proved his case as regards cost, safety, and efficiency. Mr. Moulton then had to fall back on the argument that the Ganz was not a proved system. This argument was always urged against new practice, and, if allowed, would stop all progress. He claimed that all the essentials required had been proved to be satisfactory on the Swiss and Italian lines, and that the remaining details were to be easily solved in the present state of electrical knowledge. He confidently awaited the arbitrator's decision, and thanked them for the courteous hearing he had received.

The enquiry then adjourned till two o'clock to-day, when Mr. Fletcher Moulton will make his reply.

PHYSICAL SOCIETY.

At the ordinary meeting held Nov. 8, Mr. T. H. Blakesley, vice-president, in the chair, a paper on **"A Voltameter for Small Currents"** was read by **Dr. R. A. Lehfeldt.** The instrument consists of a capillary tube about 25cm. long completely filled with mercury, with the exception of a bubble of mercurous nitrate solution about 1cm. long placed near the middle of the tube. Connection with the two mercury columns is made by means of platinum wires passing through the side of the tube. To use the instrument, it is placed in a vertical position, the anode being at the top, and the quantity of electricity which passes through is measured by the change in volume of either electrode. In a test experiment the change in volume was measured by means of a micrometer, and agreed within 0·6 per cent. with the amount deduced from the known value of the current. It is necessary that the currents should be small, so as to avoid complications due to polarisation.

The **Chairman** pointed out that the presence of air in the tube would render the readings inaccurate, and asked if it was necessary to apply any temperature correction.

Dr. Lehfeldt said that it was quite easy to seal the tube without admitting air, and the temperature correction was negligible.

A note on a paper by Prof. Fleming and Mr. Ashton, entitled **"On a Model which Imitates the Behaviour of Dielectrics,"** by **Dr. J. Buchanan**, was read by the Secretary. The action of this model depends on the viscosity of a liquid, and the diagrams derived from it show by their form that the motion of the pencil which traced them approximated closely to what may be expressed by the term, "motion

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of a viscous fluid by diffusion." In other words, the displacement curves obtained from the model, and their derived velocity curves, are of the same form as the graphs of certain solutions of Fourier's well-known equation $\frac{dv}{dt} = K\frac{d^2v}{dx^2}$. Lord Kelvin has shown that the potential and the current at any point in the wire of a cable can be expressed by appropriate solutions of this equation, and in the same manner by the use of solutions of this equation the diffusion of electricity into or out of the dielectric of a condenser can be treated. It appears, therefore, that the motion of the model, and the diffusion of electricity in a dielectric, are subject to one and the same mathematical law. The author suggests that the inventors should obtain hysteresis diagrams by cyclical loading of the springs.

Prof. J. A. Fleming said he was glad that Dr. Buchanan had drawn attention again to the model, because there were points about it which might be amplified with advantage. After giving a short description of the apparatus, he said that Dr. Buchanan had shown that, mathematically, the theory of the model was the same as that of diffusion in a cable, and he suggested that there might be something more than mathematical analogy. Prof. Fleming referred to the discussion on the original paper, in which Prof. Ayrton asked in what respect the model served its purpose better than a twisted wire. A twisted wire cannot represent the properties of a dieletric because, if twisted beyond the elastic limits, there is a permanent set. There is no permanent set in the present model. He should like to know if a dielectric has a true conductivity, and suggested that experiments should be made by subjecting a dielectric to constant electric pressure, at constant temperature, for years if necessary, and observing whether the curve of current becomes asymptotic to the zero line or to a line parallel to it. The model could be made to represent a conduction as well as a displacement current, by so arranging the bottom piston that it could descend but not return. The fact that the movements of the model were similar to the diffusion of current in a cable, suggested that the process of conduction in a metal was similar to that of displacement in a dielectric.

Mr. J. Macfarlane Gray read a **"Note on the Numerical Value of the Characteristic of Water."** The author referred to a paper on thermodynamics which he published 20 years ago, and in which he supported the theory of a granular ether under enormous pressure. This theory easily explains the properties of bodies. There is a numerical characteristic for every substance in the state of vapour. This characteristic can be deduced from an analytical expression involving certain physical data, which must be experimentally determined. His original number for water was 25·30693, but later experiments by Lord Rayleigh on the weight of hydrogen have altered this number to 25·33776. The author's original value for the absolute specific heat of water was 124,960 "mms. lift at Paris," but recent experiments of Callendar give 126,230. According to the author's theory, water commences to freeze at 95deg. F., and the variation of the specific heat of water at low temperatures is due to the latent heat of ice. The formation of ice particles also explains the peculiar changes in volume of water as it cools to the freezing point.

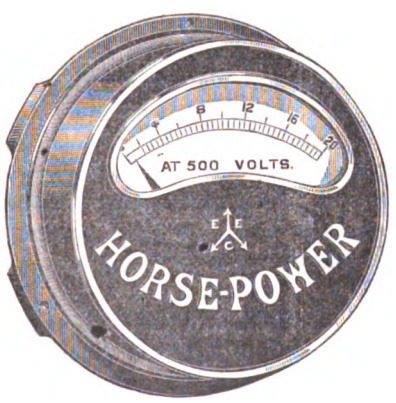
The **Chairman** asked if this theory could explain the fact that water can remain liquid below 32deg. F.

Mr. Macfarlane Gray said it could.

The society then adjourned until Nov. 22.

HORSE-POWER METERS.

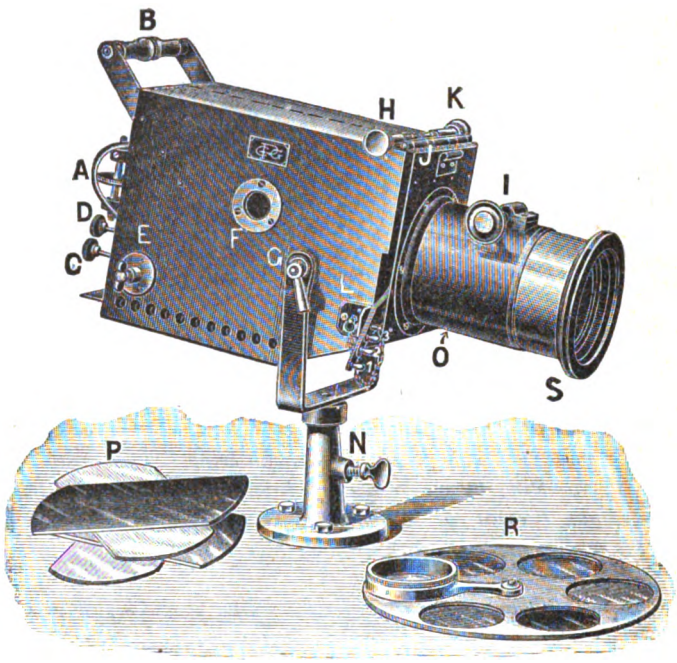
We have received from Messrs. Everett, Edgcumbe, and Co., electrical and mechanical engineers, 22, Charterhouse-square, a description of the new type of wattmeter which they are introducing for factory motor work. It is designed on the same lines as the ammeters and voltmeters made by the same firm, and recently described by us, being of the dead-beat type to avoid large fluctuations due to sudden changes of load. The makers claim that it has the advantage of being



graduated directly in horse-power. We think, however, that such a graduation is hardly necessary, as the workmen soon get used to reading the indications on the existing types of wattmeters, and reading in watts are more handy to the power station staff. In the same way an ammeter will show, like this horse-power meter, when a tool requires grinding. For this purpose the instrument before us has a good field, and its dead-beat qualities will recommend it for workshop use.

NEW ELECTRIC STAGE PROJECTOR.

The stage projector herewith illustrated is the invention of Messrs. Clément and Gilmour, Paris, who have supplied them to many of the London theatres, where they are giving great satisfaction. One of the principal features of the projector is a new adjustable and powerful combined condensing and projecting system for the production of truly achromatic discs of varying sizes, controlled by means of a series of swinging diaphragms, which are easily manipulated in the dark. The front combination of the optical system is hinged to the top of the lamp body, and swings from its horizontal position, thus discovering the back combination when required for flood lighting. The hand-feed arc lamp can be centered by mechanical adjustments in all directions, and will work under all intensities up to 30 amperes with perfect insulation. It is fitted to comply on all points with the rules of London County Council regulations. The lamp body is a strong double-walled case of Russian iron, with perfect ventilation enamelled white inside. The electric connections are made from the exterior. The entire projector is mounted on an iron stand, and the operator can guide it in every direction by means of the porcelain-mounted handle at the back. A set of five light tinted toughened glasses is supplied with the apparatus.



New Electric Stage Projector.

They are slipped alternately in the slot of the hood of the front lens; or, in place of these loose glasses, a rotary disc is made to screw to the front after the removal of the slotted brass hood. The key letters to the illustration are: (I) rack focussing optical system; (L) set of swinging diaphragms; (S) slot for tinting glasses; (O) catch-pin to release front combination; (J) hinge of front; (K) locking spindle; (A) feeding screw of lamp; (D) vertical adjustment; (E) electrical connections; (F) sight holes; (H) lamp body; (B) porcelain-mounted handle; (N) iron stand; (G) clamp screw handle; (Pl) set of tinting glasses; (R) rotary disc.

NEW COMPANIES REGISTERED.

The following new companies have been registered since our las issue:

London and North-Western Electric Tramways, Limited.—Capital, £100. Objects: to construct maintain, and work tramways, light railways, electric and other railways, and accessories.

London Warming and Ventilating Company, Limited.—Capital, £10,000. Object: to adopt an agreement between a company of the same name and H. P. Archer, its liquidator, of the one part, and A. P. Florence of the other part, for the acquisition of the assets of the said old company, and to carry on the business of manufacturers of and dealers in electric and other heating, lighting, and ventilating apparatus.

Direct Action Engine Syndicate, Limited.—Capital, £14.000. Objects: to adopt an agreement with C. Tuckfield and D. Weston for the acquisition of certain property and rights, and to carry on business as manufacturers of steam, electric traction, and other engines, electrical and general, iron, brass and steel founders, wire drawers, motor-propelled cycles, etc.

Petersen-Stephens Engineering Company, Limited.—Capital, £5,000. Objects: to acquire the business of consulting and general engineers now carried on at Newcastle-on-Tyne as the Petersen-Stephens Engineering Company, and to carry on the business of hydraulic, electrical, mechanical and general engineers, etc.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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SUBWAYS.

It is not often we are in accord with the proceedings of the London County Council, and probably in 90 per cent. of its proposed legislative action we shall be in opposition; but in its proposal to create a subway for gas and water pipes, electrical mains, etc., from the Embankment to Southampton-row, *viâ* the new street Strand to Holborn, we emphatically agree. If the London County Council would turn its attention to improvements such as this and similar ones under its nose, which if carried out would increase the convenience and comfort of thousands, if not millions, of citizens, it would be carrying out work it was created to do. However, when it goes further and proposes the construction of a shallow subway for tramways, a scheme which has in view not so much the benefit of London as the linking of tramway systems, we "agree to differ." Voltaire's words about the civilisation of mankind are not far wrong even now: "In general, mankind is not above two or three degrees more civilised than the Kamschatkans. The multitude of brute beasts called men compared with the little number of *those who think* [the italics give the pith of the argument] is at least in the proportion of a hundred to one in many nations." The London County Council seem to be guided by emotional fanaticism—a fashionable craze among the unimaginative, selfish, and thoughtless—which leads it to attempt mostly the things it should not, and mostly to leave those severely alone it ought in the first instance to attempt. We are not among those who charge the London County Council with the chaos of London streets. Its control of the Embankment is enough to stultify its practical capacity to all thinking men. It cannot organise the maintenance of one street, much more honestly administrate a gigantic tramway monopoly which must seemingly come into its hands. If this tramway subway is allowed, the link from the south side over one or more bridges to the Embankment terminus must be allowed. The greater metropolis is a hugely populous place, but we venture to prophesy that this municipal trading business of the London County Council is unsound. This authority is going—and do not forget it—to control *all* tramways within its jurisdiction, and a necessary corollary is that it control all tramways coming to the borders of the area it controls. It is going in for powers greater than those of Parliament, for Parliament can no more stop this ultimate control than it can dam Niagara with a wheat straw. Business men are giving away their birthright, and not only that, they are financing a corporation whose entrance into such a sphere of operations means putting a brake into the wheel of progress. Municipal control of tramways *may* under certain conditions be vested with a municipal authority, but the London County Council in this differs from all other municipalities—it is a kingdom in itself. Once its system is stereotyped no progress can be made or improvements introduced, except at a cost that will effectually keep things "as they are." The London County Council tramway business, if it proceeds, is not going to cost a million or twenty millions—it may cost a hundred millions or more. Are we so certain of the position as to say this expenditure is warranted? Are the railways asleep? Are the powers that be going to stamp out locomobilism as it was stamped out seventy years ago? Granted that motor 'buses and motor cabs have so far not met with success, can any man who thinks honestly say he believes motor vehicles have not come to stay? If they have come to develop into efficient convenient means of travel, will they not be deadly antagonists to much tramway traction if for nothing more than flexibility of system? Every auto-

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mobilist knows why the existing types of motor 'buses and cabs have failed. He also knows that a vastly different type could easily be supplied of a kind that would satisfy most people as regards noiselessness, non-stinking powers, comfort, and time saving. A policy may be expedient at Liverpool or Glasgow and inexpedient at London. One of the most important duties of a municipal authority is to see that the citizens have the best possible carriageway surface obtainable. In an old town many of the streets are too narrow to allow of more than a single track, and if, as in many cases within the metropolitan area, there is a single paved track with macadamised sideways, the carriageway is seldom passable and never approaching good. Heroic methods for dealing with London traffic are unnecessary. Have subways by all means for dealing with those things which otherwise constantly interfere with the area of street surface in use. If private individuals or combinations believe in the paying properties of tramway or railway subways, by all means let them have the chance of construction, but to use public money in risky enterprises to serve a portion only, and not the whole of the community, ought to be made impossible.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRICAL ENGINEERS (R.E.) VOLUNTEERS SECOND SOUTH AFRICAN CONTINGENT.

SIR,—I see by your last week's issue that Captain Pott is asking for subscriptions to a fund for providing comforts for the men of the second detachment E.E. (R.E.) now at the front. I trust that Captain Pott will take some measure to ensure the comforts reaching the *men*, as, from my personal experience, I regret to say that, of the comforts sent to the first detachment, not a single man of the rank and file received any.

I am anxious to say that it is not my desire to cast any reflection on Captain Pott, as he was struck down with fever before the various large cases of provisions arrived from home, but no doubt any of the other officers could supply some clue should anybody feel a desire to trace them.—Yours, etc., ONE OF THE MEN.

LIGHTNING CONDUCTORS.

SIR,—The only cause for surprise in the letter by Mr. Hands is, that after the bouncing introduction he gives for his vast experience, he should undermine his great reputation by maintaining so decidedly that the bad earth did not cause, and a good earth would not have averted, the side flash at All Saints', Nottingham, in 1868.

He scouts the idea of inductance, but dwells on the close proximity of the gas-pipe as being the sole cause. He ignores the part that the damp masonry may have played in forming a better path than the bad earth, and that from the damp wall the current probably found a still better path on the gas-pipe; and then where to—earth, or where? If to earth, would it not have been better accommodated by meeting with a good earth connection at the foot of the conductor instead of rambling through a thick wall to find earth. Moreover, as your correspondent states, it was not the result of bad earth, and that inductance need not be taken into account. It may be asked, What is his term of expression for the action of the current in the case in point?

Mr. Hands also makes a boast of the extent to which he could criticise the theories respecting bends in conductors. What a pity he did not venture to trespass on your space with just a few concise remarks—it would possibly have been beneficial to the community. He might have given the similitude of a branching tree, to have fallen in with his concluding remarks respecting the four conductors being less serviceable than one. That one conductor would, I presume, terminate above the surface of the ground, just near enough to a gas-pipe to admit of 4ft. 6in. air-space, as a sure connection thereto.—Yours, etc.,

W. DALBY.

187, Ombersley-road, Birmingham, Nov. 11, 1901.

SIR,—Mr. Hand's letter in last week's *Electrical Engineer* certainly is a surprise. Are we to understand that as one with practical experience he considers that the question of whether the earth connection of a lightning conductor is good or bad makes no difference in the result? Surely a good "earth" is a necessity, or are there cases on record in which conductors with bad earths have answered?

The opinion that inductance need not be taken into account seems strange. I believe that Prof. Lodge insisted that self-induction was the sole cause of side flash. How else would Mr. Hands explain the experiment quoted by "J. C. R." in his reply published in your issue of Sept. 18?

I, for one, very much regret that he did not risk trespassing on your valuable space by criticising the answers, as further light on this subject, especially the views of those with practical experience, would be of great benefit to others who are studying this complicated question.—Yours, etc., J. W. F.

FORTHCOMING EVENTS.

FRIDAY, NOV. 15.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Paper: "The Balancing of Locomotives," by Pro. W. E. Dalby.

Electro-Harmonic Society.—At 8 p.m., ladies' night. Concert at St. James's Restaurant.

Institution of Electrical Engineers (Students' Section).—At 3 p.m., visit to the Electrical Power Storage Company's works, Millwall. Train from Fenchurch-street Station, 2.25 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., Newcastle-on-Tyne, general meeting. Paper: "The Speed of Machine-Shop Tools," by Mr. J. W. E. Littledale.

SATURDAY, NOV. 16.

Institution of Junior Engineers.—At 3 p.m., visit to the Standardising Laboratory of the Board of Trade Standards Department, Westminster.

MONDAY, NOV. 18.

Institution of Electrical Engineers (Newcastle Section).—Ordinary meeting. Inaugural address of Mr. John F. C. Snell.

TUESDAY, NOV. 19.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "The Discharge of Sewage into a Tidal Estuary," by Messrs. W. Kaye Parry, M.A., and W. E. Adeney, D.Sc. Time permitting the following paper will be read: "The Treatment of Trades' Waste Bacterially," by Mr. Wm. Naylor.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., ordinary meeting. Inaugural address by Mr. C. H. Wordingham, M.I.C.E., M.I.E.E. (Glasgow Section).—At 8 p.m., ordinary meeting. Inaugural address by Prof. Magnus Maclean. "Some Experiments in High-Frequency Currents," by Mr. W. Jamieson.

WEDNESDAY, NOV. 20.

Society of Arts.—At 8 p.m., ordinary meeting. Opening address of the one hundred and forty-eighth session by Sir Wm. H. Preece, K.C.B., F.R.S.

Institution of Electrical Engineers (Students' Section).—In the Library of the Institution. Paper: "Design and Tests of Small Transformers," by Mr. E. Fawssett.

Royal Meteorological Society.—At 7.30 p.m., ordinary meeting at the Institution of Civil Engineers.

THURSDAY, NOV. 21.

Institution of Electrical Engineers.—At 8 p.m., opening meeting of the session. Presidential address of Mr. W. E. Langdon and presentation of premiums.

FRIDAY, NOV. 22.

Physical Society.—At 5 p.m., special general meeting. Science meeting follows for the discussion of following papers: "Multiple Transmission Fixed-Arm Spectroscopes," and "On the Measurement of Young's Modulus," by Prof. W. Cassie; and "Notes on Gas Thermometry" (Part II.), by Dr. P. Chappuis.

SATURDAY, NOV. 23.

Manchester Association of Engineers.—At 7 p.m., ordinary meeting. Paper: "Electric Welding," by Mr. T. T. Heaton.

Willesden.—The District Council have accepted tenders amounting to £48,000 for electric lighting works.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

429. What is the "selector" system of switching sub-chamber transformers in and out to suit the load? This system is being used at Croydon and, I believe, several other places, but information as to the working of it is very difficult to obtain.—F. A. G.

430. Explain why the polarity of a shunt-wound dynamo is liable to be reversed when temporarily short-circuited.—C. D. G.

ANSWERS.

Question No. 423.—How would you set about to prepare a specification for a country house electric lighting plant, comprising oil-engine, dynamo, accumulators, and the wiring?

Best Answer to No. 423 (*awarded* 10*s.*).—The requirements for house-lighting are totally different to those for, say, factory lighting. In the latter case the generating plant is usually installed of such capacity as to be capable of supplying the full number of lights, and the accumulators, if any are included, need only be sufficient to light a few pilot lights to enable the hands to get in and out of the factory when the main engine is stopped, and to supply also the office lights for three or four hours for any overtime which may be worked. Now, in a private house the conditions are altogether different: the light is supplied as a rule from the battery, and not direct, and the full number of lamps burning is seldom, if ever, anything like the full number installed. For the sake of clearness, let us take the case of a typical private house, and, in order to save any unnecessary complications, we will assume that only 16-c.p. lamps are used: Reception rooms, lights—dining-room 10, drawing-room 10, billiard-room 12, breakfast-room 3, boudoir 3, library 4; bedrooms—No. 1 bedroom 3, No. 2 bedroom 3, No. 3 bedroom 2, No. 4 bedroom 2; day nursery, 4; night nursery, 2; servants' bedrooms, 4; staircases, landings, and passages, 12; kitchen, 3; scullery, 1; pantry, 2; wash-house, 2; cellars, 4; dynamo-house, etc., 3. This makes a total of 89 lamps, but it must not be then assumed that accumulators must be put down to last 12 hours before recharging is necessary when all these lamps are lighted. Except at such periods as when there are a large number of guests, it will be unusual to have more than 15 lights in use in the reception rooms at one time, with, say, five bedroom lights and five other lights. If then the battery will supply 30 lights for 12 hours or 40 lamps for eight hours, it will be of sufficient capacity; taking 100-volt lamps, the dynamo must then be capable of maintaining 135 volts 25 amperes, which will be driven by an oil-engine capable of developing 5½ b.h.p. In case of any large entertainments being given, this will admit of the dynamo being brought to the assistance of the battery so as to supply the whole number of lights.

The size of the engine, dynamo, and accumulators being settled, the position of the plant is the next important point. This should be at some little distance from the house in order to avoid any smell or noise being discernible. From the main switchboard a pair of underground mains of the lead-covered and armoured class should be run to a main distribution board, having four ways—viz., (1) reception rooms; (2) bedrooms; (3) servants' bedrooms; (4) offices. Each of these circuits should be protected by a double-pole switch and fuse. The board should also be mounted with a voltmeter, and perhaps a recording ammeter or wattmeter. The four circuits just mentioned should end in sub-distribution boards having single-pole switches and double-pole fuses. All cables and wires should be of the best quality, and run either in hardwood casing or Simplex tubing. The branch switches should be placed in easily accessible places, and it should be remembered that all three-light electroliers should be controlled by two switches, one for two lights and one for one light; all five-light electroliers should have two switches, one for three lights and one for two lights.

If the owner is afraid of burglars, it might be advisable to adopt the following system which came under the writer's observance some time ago. Two pairs of leads were led from the dynamo-house, one to the main distribution board, the other to a special double-pole switch in the owner's bedroom. Each lamp in the house was doubly wired, first in the ordinary way, and, secondly, to a pair of leads between the lamps and switch, which ended at the double-pole switch in the bedroom. The result was that in case of hearing burglars at night, the owner could immediately light every lamp in the house from his bedroom, never mind what position the switches had been left in. The writer tested the arrangement, but although it had been up for some years, he had not yet heard that it had ever been put to actual use as a burglar scarer.—M.

Answer to No. 423 (*awarded* 5*s.*).—Before a specification for a plant of this kind can be prepared, it is, of course, necessary to fix first the number and candle-power of the lamps, and the voltage and system of supply. The capacity of the accumulators should also be decided upon, and whether the wiring is to be run in steel conduit or wood casing. The total watts required by the lamps, together with an allowance of, say, 10 per cent. for loss in mains and another allowance of, say, 25 per cent. for future extensions, will give the maximum output required for the dynamo, and this will, of course, decide the power of the engine. Supposing, as will most likely be the case, that the contractors will be required to supply and erect the plant complete, including foundations and all accessories, the specification may be drawn out somewhat after this manner:

Specification of Complete Electric Lighting Plant, comprising Oil-Engine, Dynamo, Set of Accumulators, Wiring, and all Accessories.

Oil-Engine.—The contractors to provide, bed, and erect on a suitable foundation to be provided by them one —— h.p. horizontal oil-engine of approved make and best workmanship and finish. The engine to be provided with extra heavy flywheel, pump, pulley, efficient lubricating gear, and complete set of tools; also with water vessel, silencer and all necessary pipes, bends and connections. The pipes from the silencer to be fixed outside building, and to be carried up —— ft. The exhaust pit for containing the silencer to be constructed by the contractors. Consumption of oil at full load not to exceed —— pint per brake horse-power per hour.

Dynamo.—The contractors to provide, bed, and erect on a suitable foundation to be provided by them one shunt-wound dynamo, capable of giving a continuous maximum output of —— amperes at —— volts at a speed not exceeding —— revolutions per minute. The dynamo shaft to be provided with an efficient continuous lubricating arrangement of an automatic character. Slide rails to be provided, and tightening screws for taking up slackness in the belt. The dynamo to be provided with an extra bearing and heavy flywheel, to ensure steady running. The armature to be of the drum type, slot wound, and provided with a commutator of large diameter, with carbon brushes.

Belting.—The dynamo to be provided with a suitable belt made of the best English tanned leather, the joint to be properly scarfed and cemented.

Accumulators.—The contractors to supply and connect up a storage battery of —— type, in glass boxes. The battery to have a normal capacity of —— ampere-hours at —— volts, and a maximum discharge at the rate of —— amperes for —— hours, at the same voltage. The battery to be complete with all insulators, trays, connections, acid, and the necessary wood stands, which are to have two coats of shellac varnish.

Switchboard.—A main switchboard to be supplied and

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erected by the contractors in the dynamo-room. The switchboard to contain an automatic cut-out, ammeter, voltmeter, double-pole dynamo switch, as well as the necessary fuses, and switches, and resistances for charging accumulators, for allowing accumulators to supply all load by themselves, or for running accumulators in parallel with dynamo. The instruments to be mounted on a marble or enamelled slate base.

Wiring.— —— main cables to be taken from the main switchboard in dynamo-room to main distribution board in house. These cables to be of —— type, each cable to have an area of —— square inch of copper, and an insulation resistance of not less than —— megohms. The house wiring to be carried out on the —— plan, the wires being run in ——. —— separate circuits are to be taken from main distribution board, each circuit to be protected by suitable double-pole cut-out. The size of conductors to be proportioned to number of lamps to be carried on each circuit (as shown on attached plan). The whole of the wiring to be put in to fire office rules. The contractors to make good all damage to walls, woodwork, paint, paper, or decorations caused by running the wires.

General.—The price of the plant to include delivery at ——, and erection complete to the satisfaction of the purchaser or his consulting engineer. The contractors to run the installation at full power before handing over to the purchaser, and to guarantee the plant for a period of six months, during which period they are to carry out at their own cost any necessary repairs or renewals caused by defects in plant.

A specification similar to the above should be quite sufficient for a small plant for house-lighting, a few modifications being probably necessary for each special case. The specification should be accompanied by a plan of the house, showing number and size of rooms and where the lamps are required: also the size and shape of proposed engine and dynamo house, with distance from dwelling-house. —R. D. S.

Answer to No. 423 (*awarded* 5*s.*).—In preparing a specification for a country house plant, the first item of importance required is a plan of the house, from which we can determine the position and the number of lamps required. After having determined the number of lamps required, we next determine what pressure we require. One hundred volts is the general pressure fixed upon for private installations, and so we fix our pressure at 100 volts. Now a 16-c.p. lamp at 100 volts pressure requires a current of ·7 of an ampere; from this data we can fix upon our maximum current, for maximum current = (·7 × total number of lamps) amperes. Having determined our maximum current, and fixed our pressure at 100 volts, we can now determine the maximum output of our machine in kilowatts; for maximum output in kilowatts

$$= \frac{\text{maximum current} \times \text{pressure in volts}}{1{,}000}.$$

Having determined the output of our dynamo, we can now determine the required horse-power of our oil-engine from the following table:

Output of machine in kilowatts.	Horse-power of engine.
12	20
20	35
46	80

Or by allowing 1·75 h.p. per kilowatt. We now come to the accumulators. Having fixed the current and pressure, we can now determine the number of cells required. If we allow a pressure of two volts for each cell, when fully discharged the number of cells required would be

$$\frac{\text{Pressure of battery}}{\text{Pressure of one cell}} = \frac{100}{2} = 50;$$

∴ number of cells in circuit when battery is fully discharged is 50.

Now consider the battery fully charged, each cell will have a pressure of 2·4 volts,

$$\therefore \text{number of cells in circuit} = \frac{100}{2{\cdot}4} = 42 \text{ approx.};$$

∴ number of regulating cells required = 50 - 42 = 8.

The battery should be arranged so that eight cells could be cut out, one at a time. Our next step is to determine the sizes and number of plates required per cell, which can be obtained from the following table:

Number of plates.	Charging current.	Discharging current.	Capacity in ampere-hours.	Width.	Length.	Height.
	Amperes	Amperes.		Inches.	Inches.	Inches.
7	10 to 13	1 to 13	130	5½	11½	15¾
11	16 ,, 22	1 ,, 22	220	8	11½	15¾
15	25 ,, 30	1 ,, 30	330	9½	11¾	15¾
23	30 ,, 46	1 ,, 46	500	14¼	11¾	15¾

The next step is to determine the sizes of leads, etc. As in most installations of this type the plant is placed in an outhouse, a short distance away from the residence, the main cables from the engine-house to the residence are generally lead covered and steel armoured, and laid direct in the ground, all regulation required being done in the engine-house. The cross-section of these cables can easily be found. As regards the house wiring, the size of the distributing leads can be found by finding the maximum current taken by each distributing lead. The rest of the requirements for the wiring can be obtained from the Phœnix Fire Office rules. The remaining parts of the specification are of a general order, such as "fair wage clause," date of completion, etc., which are practically the same for all specifications.—L. B. H.

Answer to No. 423 (*awarded* 5*s.*).—The first thing to be decided upon before the generator is selected is the voltage of supply. This need not be excessively high if there are no lengthy cables to absorb power, but if the power station is to be situated at some distance from the point of consumption, then it will be more economical to use a higher voltage—from 100 to 200 volts. Therefore, supposing 50 to be the voltage of supply, or the voltage to be maintained at the terminals of each lamp, then the machine must generate at least 55 volts to allow for the drop in the cables. The generator should be a shunt-wound one, and the maximum output in amperes that the machine is required to give must be calculated as follows: First, ascertain the maximum number of lamps required (say 30 16-c.p.). Now these would take approximately 1,800 watts (for one 8-c.p lamp takes about 30 watts), and this figure that is, the maximum watts absorbed divided by the volts of supply gives the maximum current required.

The next consideration is the method of running the plant: (1) by charging the battery during the day or on light load, and then discharging it when the maximum current is required or when light is required; (2) charging the battery while supplying current to the lamps. In the first case the generator need only give the number of amperes required to charge the battery, which, if large enough, will only require charging about twice a week. In case (2) the machine must develop the number of amperes necessary to charge the battery and also that required by the lamps.

Secondary Battery.—This should be divided into two parts, one, the main battery, consisting of a number of cells, arrived at by dividing the pressure of supply by 2·5 volts. The second part consists of such a number of cells as to

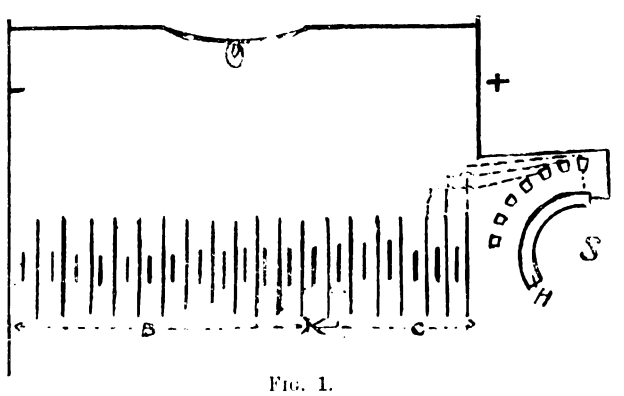

Fig. 1.

make the whole number in the battery equal to the figure obtained by dividing the volts of supply by 1·85. The second part is connected to switches which enable one or

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two regulating cells to be put into circuit as the volts of the other cells drop. Fig. 1 shows this system of regulation. B is the main battery, and C are the regulating cells. Each cell is connected to the regulating switch, and as the potential difference between the mains falls the switch is moved on to another point, which places another cell in circuit, and thus raises the voltage. The capacity of the battery should be calculated by ascertaining the number of hours the current would be required, and this figure multiplied by the maximum current required by the lamps gives the ampere-hours of the battery. It should be capable of discharging the maximum current required according to which system is adopted. If the system as in Fig. 1 is adopted—that is, the battery is required to give the current, the dynamos being only required to charge the battery—then the battery must supply the maximum current for at least one night's supply. But if the system is adopted as in case (2), then it need only supply the maximum current for about two or three hours. When charging a battery in parallel with lamps as shown in Fig. 2, in some cases, more particularly where constant attendance is not provided, an automatic switch is employed, which in the event of the dynamo pressure falling cuts out the machine, and the lamps are fed from the battery alone

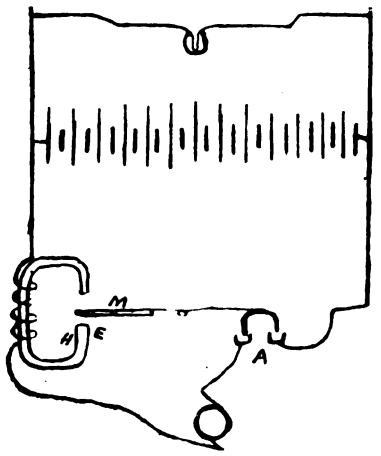

FIG. 2.

The automatic switch consists of an electromagnet, H, between the poles of which a permanent magnet, M, is so placed as to rock horizontally. The magnet is attached to a rod, at the end of which is a fork which dips into mercury-cups, A. The coil surrounding the electromagnet is placed in the main circuit, and the mercury cups are connected as shown in the figure. Should the voltage of the machine fall below that of the battery, the current passes round the coil of the magnet, H, from the battery to the machine, which makes the pole, E, attract the permanent magnet, and thus lifts the fork out of the cups, A. This disconnects the dynamo from the circuit, until a current again passes from the dynamo to the battery or lamps. This switch is exceedingly useful in cases such as the supply of oil being accidentally cut off or a belt breaking.

Wires.—The main leads should be of such sectional area as to offer a negligible resistance, and should be well insulated. The leads which connect each lamp with the mains need not be of the same sectional area, because they are not called upon to carry the same current, but only that required by one lamp. Fuses should be inserted in the circuit, so that no excessive strains should be put upon either the dynamo or battery.—S. M. G. T.

Question No. 424.—Discuss, with sketch, what you consider to be the simplest and best method of ascertaining the brake horse-power of small motors from ½ h.p. to 6 h.p.

Answer to No. 424 (*awarded* 7*s.* 6*d.*).—There are two methods of measuring the brake horse-power of any prime mover—viz., the absorption dynamometer and the transmission dynamometer. For small powers such as the question deals with, the former has many advantages. It can be made in any workshop in a very short space of time, and it is easy to work with. A transmission dynamometer is more often used where large engines and motors require testing, and to absorb all the power from the latter would be a difficult matter without a large amount of preparation.

The best absorption dynamometer for small powers is that called the Prony brake. In Fig. 1, K is the pulley of the motor to be tested; A A wood blocks which are tightened to produce the required amount of horse-power, by the bolts and milled headed nuts, B B. C is the beam fixed to the wooden blocks and connected to a spring balance at the end, which measures the pull at radius, *r*. J is an adjustment made by the milled headed nut and screw; this is provided for the purpose of keeping the pointer, P, on the beam opposite to the fixed pointer, *p*. The position of *p* is obtained by arranging the beam in a horizontal position by means of a spirit level, and fixing it

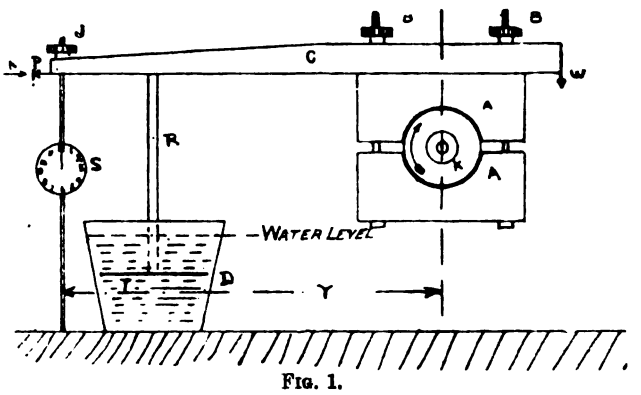

FIG. 1.

opposite to P on the beam. Sometimes a dash-pot arrangement is necessary to keep down the vibration of the beam and allow a steady reading of the balance to be taken. The arrangement of the dash-pot is as follows: R is a light wooden rod fixed to the beam, at the other end is a disc of sheet tin, T—the tin disc is immersed in a pail of water to give the damping effect (the water should cover the disc by at least 3in.); *w* is the balance weight, which is hung on the opposite end of the beam. Although not exactly necessary, it is advisable to have this balance weight, as then you obtain a reading from the balance which requires no correction. It is necessary to calibrate the brake in order to find this weight, as if not found accurately, serious errors will occur in the results.

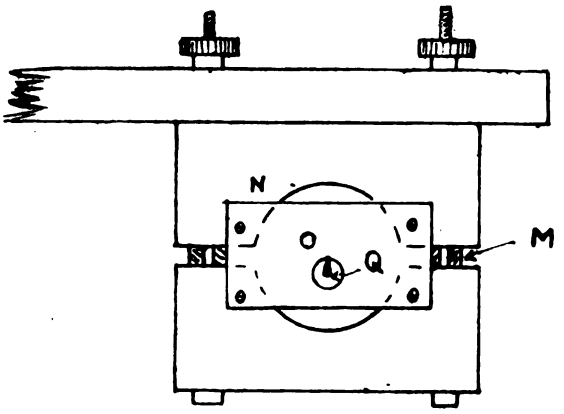

FIG. 2.

On referring to Fig. 2, a method of calibrating the brake is shown. Distance pieces, M M, are placed between the wooden blocks, so that when the nuts, B B, are screwed up tight the brake would fit tight on to the pulley. Pieces of board are then screwed to each side of the wood blocks, and the position of the centre of the pulley marked on each one. This centre is marked O on the diagram. A hole about 2in. in diameter is then cut in the boards vertically below the centre, O, and passing through it at its highest point. The brake is now balanced about O in a wedge-shaped bar, and weights are suspended at *w* until the beam assumes a horizontal position. The brake must be calibrated, as it will be used on the trial with all the fittings in their places, including the dash-pot.

With this sort of brake a mixture of soap and water is kept constantly flowing between the wooden blocks and the surface of the pulley; the soap to make the brake run steady, and the water to carry off the energy which is in the form of heat.

A small funnel is generally placed in the wooden block

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vertically over the centre of the pulley, and a hole is bored through the block to allow the soapy water to run on to the surface of the pulley. A pail of soap and water is suspended above the brake with a tap in the bottom. The formula for this sort of brake is

$$\text{B.H.P.} = \frac{2\pi r n \text{P}}{33{,}000},$$

where r = perpendicular distance of vertical centre line of pulley to centre line of spring balance;
n = revolutions per minute;
P = reading on the balance in pounds.

In the formula r is a constant quantity; n, the revolutions, must be observed as well as P, the reading on the spring balance. There are, therefore, only two readings to be taken as far as the brake is concerned. For small powers this brake has proved most accurate and reliable, especially when a copious flow of soap and water is provided. It is extremely simple to construct, which is also a great advantage in its favour.—W. B.

Answer to No. 424 (*awarded* 7*s.* 6*d.*).—One of the simplest and best methods of obtaining the brake horse-power of small motors is Soames's patent absorption brake method, which is a system specially designed for testing motors. The apparatus consists of a three-legged stand fastened at the top to an iron plate (shown in Fig 1),

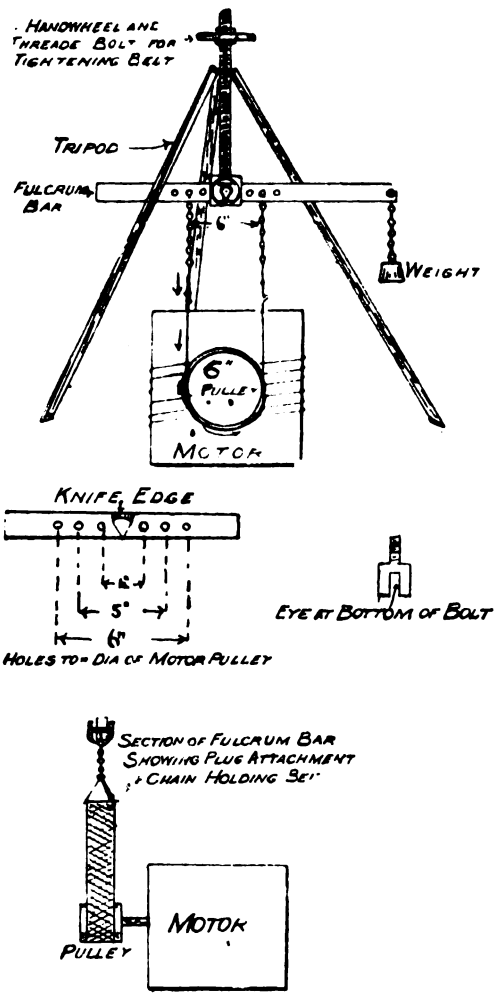


FIG. 1.

through the centre of which is threaded an iron bolt with a hand-wheel attached, as shown in the figure, for adjusting the belt. The lower end of bolt is formed with an eye (shown in detail in figure), on which rest the knife-edge of fulcrum bar. The holes in fulcrum bar are for attaching the belt, so that with knife-edge in the centre the distance between holes = diameter of motor pulley.

The formula for working out results is as follows:

d = distance from knife-edge to chain holding strap;
R = " " to weight;
w = weight;
p = pull in pounds;

$p \times d = \text{R} \times w$;

$$p = \frac{\text{R} \times w}{d};$$

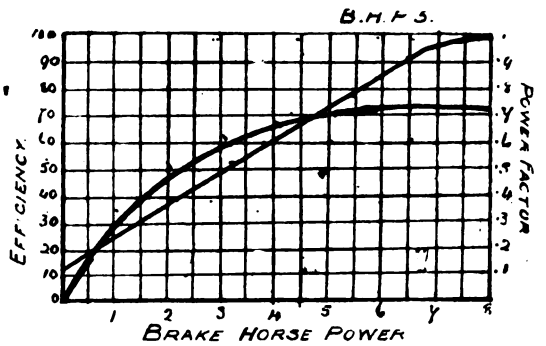
n = revolutions per minute;
D = diameter of pulley;
B.H.P. = $p \times (3\ 1416 \times \text{D feet}) \times n$.

By screwing up on bolt and so tightening belt, keeping fulcrum balanced by adding weights, w, any desired load can be obtained. To obtain the efficiency and power factor, a suitable voltmeter and ammeter in circuit will give the apparent watts, with a Siemens dynamometer connected up as a wattmeter or other direct-reading wattmeter for the true watts.

$$\text{Efficiency} = \frac{745 \times 100 \times \text{B.H.P.}}{\text{Volts} \times \text{amperes}};$$

$$\text{Power factor} = \frac{\text{True watts}}{\text{Apparent watts}}.$$

The following curve and table are taken from a paper by Messrs. J. R. P. Lunn and P. S. Thompson, published in



the *Proceedings* of the Municipal Electrical Association, 1899, and are the results obtained by them from the above method:

Load.	Volts.	Apparent watts.	True watts.	E.H.P.	B.H.P.	Efficiency.	Power factor.	Speed.
Starting ...	100	12,792	5,142	6·89	0	—	·40	—
Light	100	9,675	1,450	1·95	0	—	·15	1,560
	100	9,275	2,318	3·10	1·07	35	·25	1,550
	99	8,235	3,135	4·20	2·14	51	·38	1,558
	99	7,601	3,880	5·21	3·23	62	·51	1,560
	101	7,351	4,710	6·31	4·28	68	·64	1,550
Full	101	7,025	5,615	7·52	5·34	71	·80	1,550
	100	7,380	6,724	9·02	6·49	72	·91	1,556
	99	7,620	7,453	10·1	7·36	73	·98	1,556
	99	8,450	8,430	11·3	8·02	71	1·00	1,560

W. C. T.

Answer to No. 424 (*awarded* 5*s.*).—The methods of measuring the brake horse-power or efficiency of motors occurring in practice are very numerous, some involving only electrical measurements and others both electrical and mechanical ones. One of the simplest, and one giving quite sufficiently close results with such small motors as those mentioned, belongs to the first class. It involves simply measuring the no-load loss—*i.e.*, the input current of the motor when it is running round unloaded at its correct speed and voltage and the resistance of the armature winding. Then the output in brake horse-power for any given input is

$$\text{Input watts} - \left\{ \begin{array}{c} \text{No-load loss, including shunt watts} \\ + \text{armature winding at the given input amperes} \\ + \text{series winding (if any)} \end{array} \right\} \frac{\text{C}^2\text{ R watts in}}{\text{C}^2\text{ R watts in}}$$

$$\overline{\qquad\qquad 746 \qquad\qquad}$$

The only valid objection to this method is one which only becomes of real importance in the case of large motors having a great armature reaction, and is the fact that the hysteresis and eddy-current losses in the armature core and in the pole-faces are always somewhat higher at full load than when running light, on account of armature distortion and eddy currents induced in the pole-faces by the currents in the armature wires. Another electrical

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method, and one giving a very high degree of accuracy, is the Hopkinson efficiency test as described in most text-books, but this method is usually found inconvenient, as it necessitates the use of a second machine of the same size and winding as the one to be tested.

The methods found in most general use in manufacturing

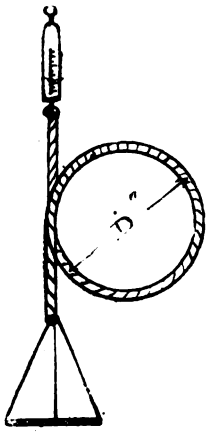

Fig. 1.

works where small motors are turned out in quantity are some form of modification of the Prony brake. For very small motors, up to, say, 2 b.h.p., it is only necessary to fit a small pulley of 5in. or 6in. diameter to the end of the motor spindle and loop a piece of cord or rope once or twice round it. To one end of the rope a scale pan is attached, and the other end is connected to a spring balance (see Fig. 1). The motor is run up and the weight in the scale pan is then increased, thus increasing the friction of the rope on the pulley, until the required input current is reached. Then if D is the diameter of the pulley, measured to the centre of the rope, in feet, the brake horse-power output of the motor is

$$\pi \times D \times \frac{\text{Revs. per minute}}{} \times \left\{ \begin{array}{l} \text{lbs. read on spring balance} \\ - \text{lbs. in scale pan} \end{array} \right\} \times \frac{1}{33{,}000}$$

For outputs much in excess of 2 b.h.p. the rope gives trouble through heating and wear, unless special cooling arrangements are provided, and so is usually replaced by a wooden clamp fitted with a projecting lever to which a spring balance is attached (Fig. 2). Increased friction is

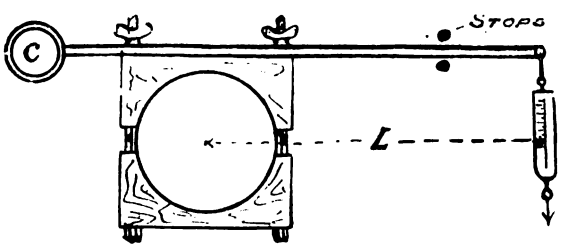

Fig. 2.

produced, when required, by screwing up the thumb screws shown. The counterweight, c, is arranged to just counterbalance the weight of the lever, and the brake horse-power of the motor is given by

$$\pi \times L \times \frac{\text{Revolutions per minute}}{} \times \frac{\text{lbs. read on the spring balance}}{} \times \frac{1}{33{,}000},$$

L being the distance in feet between the spring balance and the centre of the spindle.

In those cases in which large numbers of small motors have to be tested for brake horse-power it would usually be worth while to provide an eddy-current brake. Though rather expensive, these are quite the most handy instruments for the purpose, and are gradually coming more and more into use, as they combine quickness with steadiness and accuracy in the measurements. They usually consist of some form of electromagnet supported on knife-edges, so as to be free to turn through a small angle, and a copper or other metal disc directly coupled to and revolved round by the motor under test. The disc is so situated relatively to the magnet poles, that when it rotates eddy currents are at once generated in it and cause it to act as a brake. The magnet system is provided with a lever and scale pan, or a spring balance, as in the ordinary Prony brake, and the load on the motor is very readily and quickly adjusted to the required amount by varying the exciting current of the electromagnet. The expression for the brake horse-power is exactly like the

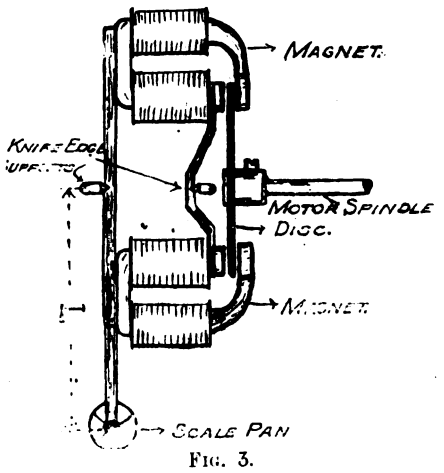

Fig. 3.

one last given. Such a brake is shown diagrammatically in Fig. 3.—Q.

Answer to No. 424 (*awarded* 5s.).—For motors varying from ½ h.p. to 6 h.p. the ordinary friction Prony brake cannot be applied to them all, for that brake arrangement that would be suitable for the 6 h.p. would be much too heavy to be of use in determining the power of the small motor. The best form for this purpose is the arrangement illustrated in the accompanying sketch, which is a very slight modification of Prof. Jenkins's, consisting of two pulleys of equal diameter, the pulley

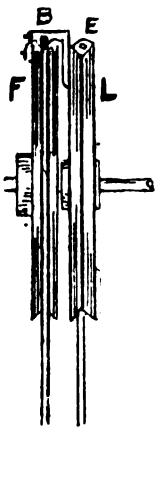

Fig. 1.

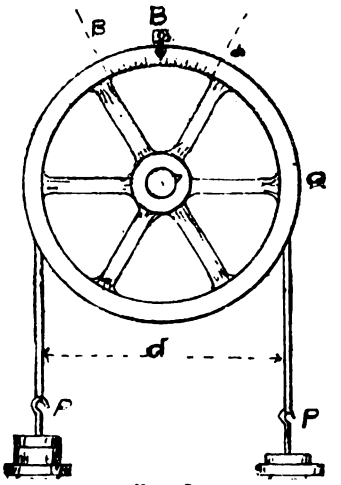

Fig. 2.

shown at L being loose on the motor shaft, whilst the pulley F is fixed to the same shaft by means of a key or an adjustable clutch. The pulley L carries two cords, P p, "which should be of leather." The cord P is held by an eye, E, in the middle of the rim of the loose pulley; the cord p being supported by the bracket shown at B, which is also fixed to the loose pulley, L. When the index attached to the bracket, B, indicates that the bracket stands vertically over the centre of the motor shaft, then each cord will embrace about one quarter of the circumference of its own pulley.

The necessary friction between the cord p and its pulley, F, is obtained by suspending weights on the free ends, as shown in Fig. 2. When the motor is set revolving in the direction of the arrow head, the cord and the weight on p will be pulled downwards, and the bracket, B, will also swing round to a new position, say (a), the frictional surface being thereby diminished. Now, in order to bring B back to its normal position, either the weight attached to p must be decreased or that attached to P must be increased, and whether we increase P or decrease p depends upon the speed at which we desire to run the

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motor. Suppose the weight on P is found to be too great, then the pointer attached to the bracket, B, will be pulled over towards β, the arc of the pulley embraced by the cord p will then be augmented. It is therefore clear that the frictional surface adjusts itself to a very great extent, weights having to be merely added or removed in order to establish equilibrium. If when the bracket, B, is in its normal position the speed is found to be too great, then weights are added to both P and p, proportionately more, however, at P, as the friction between B and Q increases faster than the sum of the added equal weights. Then supposing d represents the distance in feet between the centres of the cords, and if P and p represents the weight in pounds at the ends of these cords, then by applying the following formula the horse-power absorbed by the friction of the cords can be calculated thus:

$$\text{B.H.P.} = \frac{d\,\pi\,(P - p)}{33{,}000},$$

For determining the brake horse-power of small motors such as in question this form of dynamometer will be found very handy, the only lubrication necessary being that to overcome the friction of the motor shaft in the pulley L.—K.

APPOINTMENTS VACANT.

Engine-Driver, Borough of Leigh Tramway and Electricity Department, 35s. per week of 56 hours, Nov. 16. Full particulars in our advertisement columns.

Clerk of Works, Hornsey Urban District Council electricity works, £250 per annum, Dec. 2. Full particulars in our advertisement columns.

Assistant Draughtsman, with office and outdoor experience in the overhead equipment of electric tramways, for borough engineer's office of a large town, £2. 5s. per week, Nov. 26. Full particulars in our advertisement columns.

Editorial.—Electrical engineer required by a firm in Germany to translate technical articles dealing with electrical matters. Full particulars in our advertisement columns.

Draughtsman, used to the manufacture of switches, automatic cut-outs, and measuring instruments. Full particulars in our advertisement columns.

Junior Demonstrator in the Electrical Engineering and Applied Physics Department, Northampton Institute, London, E.C., £80 per annum, Nov. 27. Full particulars in our advertisement columns.

NEW COMMITTEES.

The following new committees have been selected:

ALLOA.—*Lighting*: Bailies Duff, Calder, and Crawford; Messrs. Home-Hay Duncanson and Wilson; Mr. Duncanson, convener.

BLACKPOOL.—*Tramways*: The Mayor (Councillor Howarth), Aldermen T. Bickerstaffe, Brodie, Grime, Heap, Kingsbury, Smith, and Ward; Councillors Ash, Blundell, Broadhead, Challoner, Hill, Holden, Laurie, Pagnam, Revill, Scholes, Smith, Whiteside, and Wilde. *Electric Lighting*: The Mayor; Aldermen T. Bickerstaffe, Brodie, Grime, Heap, Kingsbury, Smith, and Ward; Councillors Ash, Blundell, Broadhead, Challenor, Hill, Holden, Laurie, Pagnam, Revill, Scholes, Smith, Whiteside, and Wilde.

BRISTOL.—*Electrical*: The Lord Mayor; Aldermen Pethick and Pearson (chairman); Councillors Tryon (deputy-chairman), Hughes, Lloyd, Elkins, Billing, Harris, Chandler, Lowe, and Cook. Sub-Committees: *Finance*: The Chairman, Deputy-Chairman, Alderman Pethick, and Messrs. Chandler, Hughes, and Lowe. *Works*: The Chairman, Deputy-Chairman, Dr. Cook, and Messrs. Billing, Elkins, Harris, and Lloyd. *Avonbank Opening*: The Chairman, Deputy-Chairman, Dr. Cook, and Mr. Lloyd. The Chairman will represent this committee on the Finance Committee of the Council.

ECCLES.—*Public Lighting and Electrical Supply*: Alderman Mellor; Councillors Broughton, Hindley, Mort, Nuttall, Oldfield, Pearson, and Smith.

HULL.—*Telephones*: Messrs. Peter Atkinson, J. Beautement, G. J. Bentham, J. Brown, W. H. Cockerline, H. Feldman, George Hall, E. Hanger, W. Holder, F. Larard, G. Latus, W. A. Massey, G. H. Panton, J. Pybus, G. Sipling, and J. Watt. *Electric Lighting*: Messrs. F. Askew, T. B. Atkinson, G. J. Bentham, G. J. Briggs, J. Brown, J. G. Hall, E. Hanger, A. E. Kessen, G. Latus, W. G. Millington, G. H. Panton, J. Pybus, G. Sipling, J. T. Skinner, and H. Toozes.

IPSWICH.—*Electric Supply and Tramways*: Councillors F. Bennett, E. Catchpole, H. J. W. Jervis, J. Pratt, W. T. Pretty, H. W. Raffe, E. P. Ridley, F. Turner, and Owen Turner. *Paving and Lighting*: Councillors T. Alderton, Geo. Butcher, E. Catchpole, Geo. Fenn, R. D. Fraser, W. Grayston, W. C. Page, J. Pratt, and H. W. Raffe.

LEICESTER.—*Gas and Electric Lighting*: Mr. Billings, Mr. Bruce, Mr. Canner, Alderman Coleman, Mr. Edwards, Mr. Flint, Mr. Hancock, Mr. William E. Hincks, Mr. Hurley, Mr. Jackson, Mr. Jennings, Mr. Loseby, Alderman Payne, Mr. Joseph W. Smith, Alderman Thomas Smith, Mr. Spurway, Mr. Thos. W. Walker, Mr. Watts, and Mr. Woolley. *Tramways*: Mr. Banton, Mr. Billings, Mr. Bruce, Mr. Edwards, Mr. Faire, Mr. Flint, Mr. Henderson, Mr. Hubbard, Mr. Hudson, Mr. Jackson, Mr. Mann, Alderman Marshall, Mr. Matts, Mr. McCall, Mr. Shrise, Alderman Thos. Smith, Mr. Tollington, Alderman Vorley, Mr. John E. Walker, Mr. Walters, and Mr. Woolley.

NOTTINGHAM.—*Lighting*: Aldermen Ford; Councillors Baker, Bexon, Byron, Elliott, Fleeman, Hooton, Lovett, Marlow, Skerritt, Ward, and W. White. *Electricity*: Aldermen Brownsword, Lambert, McCraith, Sir John Turney, and Woodward; Councillors A. Ball, Cleaver, Johnstone, and Palmer. *Tramways*: Aldermen Brownsword, Bright, McCraith, Ford, and Sir John Turney; Councillors Baker, Bradley, Billycald, Butler, Houston, Hunter, Johnstone, and Loverseed.

SHEFFIELD.—*Tramways*: Aldermen Clegg, Hobson, Styring, Eaton, and J. Smith; Councillors Fenton, Fisher, Tandy, Wing, H. W. Chambers, J. R. Wheatley, Carr, Fox, Knowles, and Sharman. *Electric Light*: Aldermen Styring, Clegg, Sir C. Skelton, and Roberts; Councillors Bennett, Colver, Nowill, Tandy, Castle, Crowther, Maxfield, and Milnes.

LEGAL INTELLIGENCE.

HAMPSTEAD ELECTRICAL SUPPLY COMPANY.

At the High Courts of Justice last Friday, Mr. Justice Wright heard the petition of Mr. R. Wheelock for the compulsory winding-up of the Hampstead Electrical Supply Company, Limited.

Mr. Eve, K.C., and Mr. Martelli appeared for the petitioner, and Mr. Rufus Isaacs, K.C., and Mr. Cozens-Hardy for the company. Mr. Abrams opposed the petition on behalf of creditors representing £5,000, and Mr. Gilchrist Alexander for creditors representing £6,000.

Mr. Eve stated that the petitioner was the holder of fully-paid shares, and the petition stated that the substratum of the company had gone, and that it was unable to pay its debts. Those allegations were substantiated by the evidence filed in answer to the petition. It was stated in the affidavits, however, that the company could pay its debts if a reconstruction took place and further capital was brought in. His client's contention was that the company had no chance under any reconstruction of paying its debts, and that any chance of its ever being able to do so had been thrown away by a change in the circumstances which had arisen since its formation. The company was formed in July, 1898, the object being to supply certain portions of the district of Hampstead with electric light by wires over the houses, instead of by wires placed under the soil. The business was purchased by the company from a vendor who had certain contracts with builders and others to supply the light, but the company had not obtained a provisional order to supply electricity to their district. On the other hand, the Vestry of Hampstead had obtained a provisional order to supply electric light, and it was sanctioned by a private Act in 1892, which would operate adversely to the company. The learned counsel admitted that a considerable majority of the shareholders were opposed to the petition, but said that a large number were directors of the company or connected with the promoters. He made certain statements as to the nature of the contracts purchased by the company from the vendor, and the issue of four series of debentures, which he submitted required investigation. He contended that the company, as at present constituted, could not go on. It was admitted that there must be a liquidation, and it was proposed that there must be an assessment of 25 per cent. on the existing shareholders. This his client was opposed to, and to any reconstruction on that basis.

Mr. Isaacs said there must be a reconstruction for the purpose of getting more working capital. Shareholders to the amount of £80,000 opposed the petition.

His Lordship thought that Mr. Eve's clients would be protected if the voluntary liquidator were a person approved by the Court. He was anxious to do what was right in the matter. Would Mr. Isaacs give an undertaking that the voluntary liquidator should be subject to the approval of the Court?

Mr. Isaacs: Certainly.

His Lordship said that the proposed reconstruction of the company might at some future time be brought before the Court for review. The petition would be dismissed, but the voluntary liquidator to be appointed must be subject to the approval of the Court. There would be no order as to costs at present. As to future proceedings against directors for misfeasance, etc., he must not be understood to express any opinion. At present he thought sufficient protection had been given. Of course, the dismissal of the petition did not prejudice any further petition that might be presented.

Order accordingly.

ELECTROLYTIC PLATING PATENTS.

In the King's Bench Division last week Mr. Justice Ridley heard the case of the Electrolytic Plating Apparatus Company against Henry Holland and Co., of Salop Works, Birmingham, for an infringement of plaintiffs' patent for an apparatus for the electric deposition of metals.

His Lordship held that the plaintiffs' patent had not been anticipated by either Zincsein or Heathfield and Rawson, two patents which the defendants relied upon. He also decided that the plaintiffs' invention was both novel and useful and proper subject matter for a patent, and that it had not been invalidated by reason of public user. In these circumstances he decided that the plaintiffs were entitled to the decrees asked, and accordingly gave judgment for them for an injunction, delivery up of infringing machines, damages, and costs as between solicitor and client.

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WINDERMERE ELECTRICITY WORKS.

Alleged Nuisance.

Before Mr. Justice Kekewich in the Chancery Division, on the 7th inst., the case of Wrigley *v.* the Windermere and District Electricity Supply Company was heard. The action was brought to restrain the defendant company from conducting its business in such a manner as to cause a nuisance to the plaintiff, whose house is in the vicinity of the defendants' works, by reason of smoke, noise, and vibration. It appeared the case had been before the Court on various occasions, and a gentleman was agreed upon amongst the parties to visit the *locus in quo* and to make a report for the guidance of the Court. That gentleman had reported to the effect that there was a nuisance caused by noise, and the action was ordered to stand over with the view of seeing what remedy could be provided.

Mr. Warrington, K.C. (with him Mr. Gatey), for the plaintiff, said the only question now at issue was whether the plaintiff was entitled to a general injunction on the ground of nuisance. The company desired time to remedy the nuisance, to which he would not raise any objection.

Mr. Lawrence, K.C. (with him Mr. Grant), for the company, said that his clients were spending a great deal of money in order to get rid of the noise, and were adapting their works to suit modern requirements. He asked his Lordship to assist the parties by suggesting that the experts should meet with the view of seeing what could be done in the matter.

After a conference between the parties, an order was agreed to admitting that the plaintiff was entitled to an injunction to restrain the company from carrying on their works so as to occasion a nuisance to the plaintiff, and continuing an undertaking given on July 30, 1901, with liberty to the plaintiff to apply at any time, after the expiration of six months from this order, for an injunction.

Order accordingly.

AUTOMOBILE MANUFACTURING COMPANY.

Winding-up Petition.

In the Winding-up Court, before Mr. Justice Wright on Wednesday, the Clipper Pneumatic Tyre Company, Limited, presented a petition for the compulsory winding-up of the Automobile Manufacturing Company, Limited. Certain debenture holders opposed the petition on the ground that the whole assets were insufficient to pay their debt.

Mr. B. Davis, K.C., said there had been litigation to set aside the alleged sale of the goodwill of the business by Mr. Jordan, the then managing director, for £100. The debentures issued were to the directors, and fraudulent preference was alleged. The debenture holders wanted the business to continue.

His Lordship said he did not see any ground for alleging fraudulent preference. The matter must stand over until the validity of the debentures was ascertained in an action. This and another petition by Messrs. Cordingley and Co. therefore stood over.

COMPANIES' MEETINGS AND REPORTS.

CALLENDER'S CABLE AND CONSTRUCTION.

An extraordinary general meeting of the shareholders of this Company was held at Hamilton House, Victoria-embankment, on Monday, to consider resolutions for increasing the capital to £500,000, Mr. Henry Drake presiding.

The **Chairman,** in proposing the resolutions, pointed out that in a circular letter the directors stated that they proposed to issue 5,000 ordinary shares of £5 each to all ordinary shareholders. In consequence of the increasing business of the Company it was thought desirable at the same time to take powers to increase the capital by 20,000 shares. These would not be issued at present, but if the business of the Company required it they would have them to fall back upon. The business was going on in the most satisfactory way. Another reason why the Company must have more money was that they had the opportunity of buying some land adjacent to the factory, which it was very necessary for them to have. The directors proposed to allot the 5,000 shares referred to at par. This would produce £25,000. It would be remembered that the last time the capital was increased 20,000 additional ordinary shares were created, of which 10,000 were allotted to the holders of the ordinary shares. If the whole 20,000 had been allotted then and there, they would have gone to the ordinary shareholders, but as only half this number were issued, now that they wanted to issue the other they would have to allot them also to the original ordinary shareholders. That was not the intention. The first 20,000 and the subsequent 10,000 ranked *pari passu*, and on the allotment of new shares they must be treated alike. The directors had therefore been advised that the best plan to adopt was to create a fresh lot of shares entirely, and afterwards to annul the creation of the unissued 10,000 shares.

Colonel G. A. Elliot seconded the resolution, which was unanimously adopted after some discussion.

WEST INDIA AND PANAMA TELEGRAPH.

The directors' report for the half-year ended June 30 last shows that the amount to credit of revenue is £29,145, against £27,737 for the corresponding half-year of 1900; the expenses have been £21,277 against £21,731, leaving a balance of £7,868. To this is added £2,342 interest on investments, and £6,670 brought over from the last account, making a total of £16,881. After the final settlement of the terms of the formal judgment given against this Company by the Court of Appeal, in the action brought against it by the Cuba Submarine Telegraph Company, the directors after much deliberation decided to lodge an appeal to the House of Lords, which alone could finally clear up the Company's position. In their last report and at the general meeting of the shareholders the directors stated that they thought it prudent, having regard to the pending litigation, and to all the circumstances, to carry forward the balance then shown of £6,670 to the next half-year's account. The shareholders approved of this policy, and on the present occasion the directors having to deal with the accumulated balance of two half-years—viz., £16,881—recommend the payment in full of the dividend of 6s. per share on the first preference shares for the half-year ended Dec. 31, 1900, amounting to £10,368, and to carry forward the balance of £6,512. This will leave still in arrear the dividend on the first preference shares for the six months ended June 30, and 12 months' arrears to the same date on the second preference shares. In concluding their report, the directors state that there have been certain diminutions in expenditure, and a very small increase in revenue during the half-year under report, but there has practically been no improvement in West India trade, owing to the low price of cane sugar, caused by the system of foreign bounties.

At the ordinary meeting of the shareholders in this Company, held at Winchester House, E.C., on Wednesday, **Mr. W. S. Andrews,** who presided, said the accounts showed that the receipts had slightly risen from the low point to which they fell a year ago. The practical result of the working of the six months ended June 30 last was a credit to revenue of £29,145, less expenses of £21,277, plus interest on investments of £2,342, and £6,670 brought forward, making a total of £16,881. The Board recommended the payment in full of the dividend of 6s. per share on the first preference shares for the six months ended Dec. 31, 1900, amounting to £10,368, leaving £6,512 to be carried forward. This would leave still in arrears the dividend on the first preference shares for the past six months and 12 months arrears to the same date on the second preference shares. In the action brought by the Cuba Submarine Telegraph Company the directors decided to lodge an appeal to the House of Lords, by which means alone the Company's position under the the agreement could be cleared up beyond any further disputation. This Company, as the shareholders were only too painfully aware, was struggling on, contending not alone with the disastrous unfair and anti-free trade operation of the sugar bounty system, but with the unusual competition of the direct West India cable, equally contrary both to free trade and to fair trade, because it was subsidised by our own Government to work at unremunerative rates. It was, therefore, only kept alive at the expense of the public, which thus unwittingly paid one British enterprise to compete with and pauperise another purely British enterprise. He concluded by moving the adoption of the report.

Mr. Henry Holmes seconded, and the motion was carried.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH.

In their report for the half-year ended June 30 last, the directors state that the gross receipts have amounted during the period under review to £346,336, against £313,227 for the corresponding half-year of 1900. The working expenses, including £28,338 for maintenance of cables, absorb £115,781, against £108,660 for the corresponding period of 1900, leaving a balance of £230,555. From this is deducted £6,908 for income tax, £6,400 for interest on debenture stock, £2,048 for expenses in connection with the new issue of shares, and £175 for subscription to the national memorial to the late Queen Victoria, leaving £215,023 as the net profit for the half-year. Two quarterly interim dividends of 1¼ per cent. each, amounting to £75,000, have been paid for the half-year, leaving an available balance of £140,023, from which £125,000 has been transferred to the general reserve fund and £15,023 carried forward. During the half-year under review the Company, in conjunction with the Great Northern Telegraph Company, duplicated the Taku-Chefoo section of the international cables which they established to the north of Shanghai in the autumn of last year. Partial renewals of the cables between Singapore, Malacca, and Java were also carried out during the half-year, and the cost, amounting to £7,810, has been charged against the general reserve fund. The contract entered into with the Netherlands Indian Government for supplying and laying, on account of that Government, a cable between Java and Borneo, has been satisfactorily completed. The directors have the pleasure to announce the completion and opening for traffic on the 1st inst. of the Cape-Australian cable as far as Perth (Western Australia). The manufacture of the remaining section, to be laid between Perth and Adelaide, is progressing satisfactorily, and the whole line is expected to be in working order before the end of February next. The Company's expenditure on account of the Cape-Australian cable up to June 30 amounted to £583,241, of which £125,137 was debited to the general reserve fund last year, and the balance of £458,104 is charged against the fund in the accounts. Substantial reductions of tariff were brought into force on the 1st inst. for local telegrams exchanged between South Africa and Australasia. By arrangement with the American authorities in the Philippines the tariff for telegrams exchanged between Europe and the island of Luzon will be reduced on the 15th inst. from 8s. 7d. to 5s. 9d. per word, the rate to the other islands being at the same time reduced to 6s. 2d. per word. Considerable reductions will also be made from the same date in the tariffs for local international messages transmitted to and from the Philippines. With a view to meeting the Company's requirements in connection with the maintenance of the Cape-Australian cable, and to strengthen their fleet in the Far East, the directors have entered into contracts for the construction of two repairing steamers of the most modern and approved type.

On Wednesday the half-yearly meeting of this Company was held at Winchester House, Sir John Wolfe-Barry in the chair.

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The **Chairman,** in moving the adoption of the report, which has appeared in a previous issue of this journal, said that the strength of the Company lay, as the shareholders were very well aware, in keeping up a large reserve, and nothing had shown this more conspicuously than the fact that they had been able to undertake large extensions, involving enormous outlay, while they had only to raise £500,000 of new capital. It was with much satisfaction that the directors had been able to announce the completion and opening for traffic of the Cape-Australian cable as far as Perth, Western Australia. This was only a portion of the important work which the Eastern and the Eastern Extension Companies had been for some time engaged upon with a view to improving their cable services to South Africa and Australia. The first part of the work consisted in the laying of a new cable between this country and the Cape of Good Hope, which was completed in the early part of last year, and when the remaining section between Perth and Adelaide was finished—which was expected to be in February next—the two companies would have laid an additional 15,000 nautical miles of cable at a cost of over £3,000,000. This new route to South Africa and Australia had connected British possessions which were previously outside the pale of telegraphic communication, and telegrams exchanged with Australia by the new route would be transmitted entirely by the Company's employés. Considerable reductions of tariff for local telegrams exchanged between Australia and South Africa were brought into force on the 1st inst. With regard to the prospects of further reductions of tariff for Australia, the traffic returns already indicated that the standard revenue would be maintained for the current year, thus enabling the Company to reduce the tariff to 3s. a word on Jan. 1 next. The reduced rates for the contracting States were still withheld from Victoria, Queensland, and New Zealand, owing to the fact that those States had not yet accepted the Adelaide agreement.

The **Marquis of Tweeddale** seconded the motion, and it was carried unanimously.

AMAZON TELEGRAPH.

Presiding at the general meeting of this Company at the offices, Moorgate Station-chambers, on Tuesday, **Mr. E. B. Ellice-Clark** (chairman), pointed out that in the past year, to June 30 last, there had been a decrease of £9,781 in the expenses attending maintenance of cable, as compared with the outlay on this account in the preceding year. In the credit balance a diminution of £10,326 was shown, but there was an increase of £36,350 in the amount of the loan. The decrease of £10,326 had been caused by the payment of money which had been owing by the Company. On the other side of the balance-sheet it would be seen that £18,604 was expended during the past year on new land lines, and £8,300 on the new ship. In the result there was a debit balance of £69,173. On the face of it this would appear to be a disastrous condition of things. There had, however, been a remarkable increase in the revenue. The loss on the working for 1900, after allowing for debenture interest and sinking fund, was £34,468, whereas the loss on the past year's working was only £5,404. This was attributable to the greater continuity of the Company's service—a circumstance largely owing, he thought, to the way in which the repairs had been made, and to the general activity of the staff in Brazil. It showed what could be done with proper appliances, and fully justified the expenditure on the ship, and also, he thought, the outlay on the land lines. The Company had had great difficulties to contend against. The undertaking was undoubtedly an experiment on a very large scale, and it had resulted up to the present in a very serious financial state of affairs; but the marked advance in the revenue of the past year, during which the Company had been able to maintain a reasonable continuity of the service, showed that along the route of their operations was a business which was capable of extraordinary development. Although the difficulty of maintaining the cables and land lines would, he believed, always be very great, still, with the new ship and a good staff, and with their affairs well looked after in this country and in Brazil, he thought that the potentialities of the Company were very great. He concluded by moving the adoption of the report.

Mr. George Keith seconded the motion, which was unanimously adopted.

POWER GAS CORPORATION.

The statutory meeting of the shareholders in this Corporation was held on Tuesday at the Westminster Palace Hotel, S.W., Sir Henry H. Fowler, M.P., presiding.

The **Chairman**, in the course of a short speech, referred to the report already circulated, which stated that the ordinary shares had been allotted, that the total amount received was £45,872, and that the preliminary expenses of the Company were estimated, as was stated in the prospectus, to amount to about £6,200. The directors had been very much occupied since they commenced business in organising the Company and in making the necessary alterations for the development of the works which they acquired when the Company was formed. There were a great many more applicants for the shares than there were shares to allot. The number of shareholders in the Company was between 580 and 600. The directors were quite satisfied with the progress the Company had made, and, of course, at the end of the first year they would be in a position to give full and complete information, not only as to the progress the Company had made, but as to its prospects.

The meeting concluded with a vote of thanks to the chairman.

LIVERPOOL ELECTRIC CABLE.

The statutory meeting of this Company was held on the 7th inst. at the registered offices of the Company, Vauxhall-road Liverpool

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Hull.—The Electric Lighting Committee invite tenders for six rotatory transformers for continuous current tranformation, 2,000 volts to 220 volts, 90 kw. each. Tenders by Nov. 28. Details in our advertisement columns.

Brighton.—The Council invite tenders for the supply of meters for a period of one year from Jan. 1, 1902. Tenders by Nov. 25. Details in our advertisement columns.

Poplar.—The Electricity Committee invite tenders for one year's supply of continuous-current electricity meters. Tenders by Nov. 27. Details in our advertisement columns.

Stoke Newington.—The Council invite tenders for supplying and laying a system of electric lighting cables. Tenders by Nov. 18. Details in our advertisement columns.

Barrow-in-Furness.—The Corporation invite tenders for wiring new technical school, where between 500 and 600 lamps will be fixed. Specifications, etc., may be obtained of the Town Clerk. Tenders by Nov. 18.

Kirkcaldy.—The Corporation invite tenders for the supply and delivery, in complete running order, of rolling-stock (complete with electrical equipments). Tenders by Nov. 30. Details in our advertisement columns.

Denton (Manchester).—The Manchester Corporation invite tenders for erection of an electricity sub-station at Hyde-road, Denton. Specifications, etc., may be obtained at the office of the City Surveyor, Town Hall. Tenders by Nov. 20.

Heaton Norris (Manchester).—The Manchester Corporation invite tenders for erection of an electricity sub-station at Heaton Norris. Specification, etc., may be obtained from the City Surveyor, Town Hall. Tenders by Nov. 20.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection of 12 water-tube boilers and superheaters, economisers, and feed pumps. Tenders by Dec. 4. Details in our advertisement columns.

Levenshulme (Manchester).—The Manchester Corporation invite tenders for erection of an electricity sub-station at Levenshulme. Specification, etc., may be obtained at the office of the City Surveyor, Town Hall. Tenders by Nov. 18.

Croydon.—The Town Council invite tenders for building an underground electricity sub-station in Addiscombe-grove. Specification, etc., may be obtained at the Borough Electrical Engineer's Office, Factory-lane, Croydon. Tenders by Nov. 18.

Coventry.—The Electric Lighting Committee invite tenders for the supply and erection of triple-expansion low-speed vertical marine type engine and 400-kw. direct-coupled alternator and exciter. Tenders by Nov. 27. Details in our advertisement columns.

Islington.—The Borough Council invite tenders for electric lamp columns, complete with crutches and bases. Specifications, etc., can be obtained on application to the Borough Electrical Engineer, 50, Eden-grove, Holloway. Tenders by Nov. 26.

Bournemouth.—The Town Council invite tenders for engine and boiler houses and chimney shaft. Specification, etc., may be obtained of Mr. F. W. Lacey, M.I.C.E., borough and tramway engineer, Municipal Offices, Bournemouth. Tenders by Nov. 18.

Sheffield.—The Tramways Committee invite tenders for the supply of 400 steel-tyred tramcar wheels. Specification can be obtained from Mr. A. L. C. Fell, M.I.E.E., M.I.M.E., general manager, Tramway Department, Town Hall, Sheffield. Tenders by Nov. 25.

Bermondsey.—The Council invite tenders for the supply of the undermentioned articles up to March 31 next: ironmongery, arc lamp carbons, engine oils, indiarubber cables, and jointing material. Tenders by Dec. 3. Details in our advertisement columns.

Dundee.—The Town Council invite tenders for the construction of new tramways, and for the reconstruction of existing tramways (about 1¾ miles, double line). Specifications, etc., may be obtained on application to Mr. William Mackison, C.E., engineer. Tenders by Nov. 23.

Cleckheaton.—The Council invite tenders for the supply, delivery, and erection of Lancashire boilers, economiser, jet condenser, supply and feed pumps, steam, exhaust, feed, and drain pipes, and cast-iron water-tank. Tenders by Nov. 30. Details in our advertisement columns.

Brussels.—Tenders are invited for electrical installation at Royal Conservatory of Music. The deposit required is 800fr. Specifications No. 136 are to be obtained from, and tenders addressed to, Direction Generale des Ponts et Chaussées, rue de Louvain No. 38, Brussels. Tenders by Nov. 29.

Aberdeen.—The Tramways Committee invite tenders for the supply and erection of overhead linework, the supply and laying of cables, and the bonding of rails (bonds supplied by the Corporation for the equipment of their Union-street and Holborn-street tramways. Tenders by Nov. 26. Details in our advertisement columns.

Liscard (Cheshire). The Wallasey Urban District Council invite tenders for the wiring and fitting for an electrical supply of certain buildings, situate in Seaview-road, Liscard. Specifications, etc., can be obtained from the electrical engineer, Mr. J. H. Crowther, Great Float, near Birkenhead. Tenders by Nov. 21.

Liverpool.—The South Lancashire Electric Traction and Power Company invite tenders for the overhead electrical equipment of certain tramway lines and car depot, the route length of the tramway lines being approximately 19 lines. Specifications, etc., may be obtained at the offices of the consulting engineers, Messrs. Kincaid,

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Waller, and Manville, 29, Great George-street, Westminster. Tenders by Nov. 25.

Boulder City (Western Australia).—The Boulder City Council invite tenders for the construction of about 3½ miles of electric tramway, with all necessary plant complete according to specifications, and the right to construct and run tramways within the municipality. Specifications, etc., can be obtained at the office of the Agent-General, Westminster. Tenders by Nov. 23.

Lancaster.—The Corporation invite tenders for supply of tramway material and the execution of the following works—viz.: (Section A) supply of rails, fishplates, soleplates, tiebars, bolts, bonds, etc.; (B) platelaying, bonding, etc.: (C) supply and fixing of overhead trolley equipment; (D) supply of feed cables, pilot wires, cases, and draw boxes, etc.; (E) supply and erection of tramcars. Specification, etc., may be obtained from the borough electrical engineer, Mr. W. Tester. Tenders by Nov. 27.

Rockhampton (Queensland).—The Municipality invite applications from companies desirous of undertaking the construction and working a system of electric tramways under the Queensland Tramways Act of 1882 and the Amendment Act of 1890, within the municipality of Rockhampton aforesaid. Rockhampton, with a population of 15,461, is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882 and the Amendment Act of 1890, copies of which may be seen at the office of this paper. Applications to be forwarded to Mr. H. W. Johnson, mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31.

RESULTS OF TENDERS.

Hebburn.—The District Council have accepted the tender of the Northern Counties Electricity Supply Company, Limited, for arc lamps, at £24 per lamp.

Sheffield.—The Electric Light Committee have accepted the tenders of the Stirling Boiler Company, of Motherwell, for boilers, at £15,832, and of C. A. Parsons and Co., of Newcastle-on-Tyne, for two turbo-alternators, at £28,282.

London, S.W.—The London County Council have received the following tenders for supply of electrical plant in connection with the reconstruction for electrical traction of the tramways between Westminster and Tooting, &c.:

A.—Continuous-current plant.	Highest.	Lowest.
Allgemeine Elektricitäts-Gesellschaft	£34,655	£26,890
Bergtheil and Young	37,887	30,574
British Schuckert Electric Co.	34,012	26,211
British Thomson-Houston Co.	34,577	29,385
British Westinghouse Co.	39,503	29,335
Brown, Boveri, and Co.	—	36,201
Brush Co.	36,310	31,355
S. Buckley and Co.	36,172	29,369
V. Coates and Co.	38,820	37,020
Crompton and Co.	34,726	30,160
Dick, Kerr, and Co. (accepted)	35,064	25,964
Electric Construction Co.	38,279	29,618
Electric Traction Co.	35,665	31,764
Electrical Co.	34,936	30,266
Fairburn, Lawson, Combe, Barbour	31,612	29,779
Ferranti	30,290	26,673
General Electric Co.	48,257	31,763
Greenwood and Batley	33,705	33,271
Helios Electrical Co.	29,487	27,211
International Electrical Engineering Co.	31,210	24,525
Lahmeyer Electrical Co.	46,269	26,850
Markham and Co.	—	30,686
Mather and Platt	36,195	28,977
C. A. Parsons and Co.	—	29,589
Siemens Bros. and Co.	50,770	31,385
D. Stewart and Co.	31,667	28,392
Thames Ironworks Co.	34,578	33,638
Wallsend Slipway and Engineering Co.	35,684	31,699
Witting Bros. and Co.	33,598	29,236
B.—Three-phase plant.		
Allgemeine Elektricitäts-Gesellschaft	52,226	40,916
British Schuckert Co.	46,369	39,423
British Thomson-Houston Co.	55,086	50,931
Ditto (not to specification)	—	46,215
British Westinghouse Co.	58,594	49,555
Ditto (not to specification)	52,971	43,931
Brown, Boveri, and Co.	51,278	45,647
Brush Co.	—	63,259
Ditto (not to specification)	—	64,569
S. Buckley and Co.	48,633	42,127
Dick, Kerr, and Co. (accepted)	55,570	46,625
Electric Construction Co.	61,260	58,175
Electrical Co.	48,562	43,956
Ferranti	55,808	51,048
General Electric Co.	60,639	45,425
Helios Electrical Co.	41,774	40,095
International Electrical Engineering Co.	46,160	38,006
Johnson and Phillips	—	53,220
Lahmeyer Electrical Co.	64,363	45,835
C. A. Parsons and Co.	49,901	48,481
Siemens Bros. and Co.	63,455	45,725
D. Stewart and Co.	54,041	53,751
Wallsend Slipway and Engineering Co.	63,051	45,206
Witting Bros. and Co.	48,660	44,284
Yates and Thom	—	50,635

Exeter.—The complete tender of the Westinghouse Company of £28,989, with an addition of £718 for larger boilers, making a total of £29,707, has been accepted.

Llandilo.—The Urban District Council have accepted a contract for laying the mains, etc., for the electric lighting, of Mr. Bertram Thomas, Manchester, at £2,770.

Leeds.—The Town Council have accepted the following tenders for plant in connection with the extension of the electricity works: Ferranti, Limited, for switch gear, at £2,000; the New Conveyor Company, Limited, for coal elevating and conveying apparatus, at £3,743; and Joseph Booth and Bros., Limited, for overhead travelling crane. £900.

Fulham.—The Borough Electrical Engineer has obtained the following tenders: British Thomson-Houston Company, Limited—50 10-ampere 200 volt two-wire B.T.H. recording wattmeters with ordinary metal covers, £4. 5s. each; 10 75-ampere 200-volt two-wire ditto, £5. 15s. each; 10 100-ampere 200-volt two-wire ditto, £6 each; subject to 2½ per cent. discount cash monthly account. General Electric Company (1900), Limited—50 10-ampere 200-volt alternating-current 50-cycle "Aron" watt-hour meters in final metal supply, £4. 5s. each net; 10 75-ampere ditto, £5. 2s. 6d. each net; 10 100-ampere ditto, £5. 2s. 6d. each net. Venner and Company—50 10-ampere round-type meters, £2. 10s. each or 50 10-ampere square-type meters, £3. 16s. 6d.* each; 10 75-ampere ditto, £5. 2s.* each; 10 100-ampere ditto, £5. 2s.* each. The above prices are for 200-volt 50-cycle alternate-current meters, and are net. * Recommended for acceptance.

BUSINESS NOTES.

TRACTION.

Salford.—The Town Council are considering the question of the promotion of a Bill for powers to add to the tramways in the borough.

Llanfair Light Railway.—The Public Works Loan Board are now prepared to make a loan of £6,000 in respect of the Llanfair light railway.

Northfleet.—The construction of the electric tramways at this place has necessitated the closing to vehicular traffic of a part of the High-street for a time.

Tettenhall.—An agreement has been come to between the District Council and the Wolverhampton Town Council respecting the laying of the tramway track.

Reading.—The Board of Trade have given their sanction to the borrowing by the Corporation of £11,566 in respect of the purchase of the tramways undertaking.

Thornhill.—The District Council have now approved the route plans of the British Electric Traction Company for the proposed light railways in the district.

Llanelly.—A special meeting of the Borough Council has been called to deal with the question of the delay in proceeding with the electrical equipment of the tramways.

Barrow.—The only obstacle to the conversion of the tramways has now been removed by the consent of the Furness Railway Company to give up control of tramways Nos. 17 and 18.

Bath.—The promoters of the Bath light railway scheme have received a communication from the Board of Trade confirming the final order for the construction of the railway.

Cleckheaton.—The District Council have approved the form of overhead equipment proposed to be adopted by the British Electric Traction Company on their tramways within the district.

Blackpool.—In consequence of the heavy downpour of rain this week the low-lying quarters of the town were flooded a considerable depth, and inland tram traffic had to be entirely suspended.

Alfreton.—The Urban District Council have agreed to support an application by a syndicate for a provisional order to the Light Railway Commissioners for a light railway between Derby and Nottingham.

Dudley.—The Tramways Committee recommend the Council to apply, in conjunction with the Rowley District Council, for a provisional order to construct a light railway from Dudley to Blackheath.

Newcastle-on-Tyne.—A "meeting of councillors only" has decided to "simply respectfully suggest" that the aldermen should not nominate more than six of their body for the Tramways Committee.

Portsmouth.—There was another breakdown on the electric tramways on Sunday night, when the system was brought to a standstill. The Tramways Committee have decided to hold an investigation into the causes.

Cape Electric Tramways Co.—Holders of share warrants to bearer can obtain payment of dividend due to them (by presenting coupon No. 10) at the offices, 55 and 56, Bishopsgate-street Within, E.C., after 19th inst.

Heckmondwike.—Drawings showing the British Electric Traction Company's overhead equipment construction to be adopted in the district has been referred to a special committee of the District Council for consideration.

Solent Tunnel Scheme.—It is stated that negotiations are proceeding with a view to the acquisition by the Solent Tunnel Company of the Isle of Wight Central Railway, and the Freshwater, Yarmouth, and Newport railway systems.

St. Helens.—The Windle City and Parr sections, like those o Denton's Green and the junction of the tramway, have now been connected, and cars run from the city to Derbyshire-hill direct, and from Denton's Green to the Junction.

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Dundee.—The Ferry-road route of the electric tramways has been opened for traffic. A minute of the Tramways Committee states that they have accepted an offer for eight cars to work the Fairmuir route in conjunction with the Lochee route.

Brighton.—Replying to a suggestion that the tramways should be extended to Kemp Town *viâ* Eastern-road, the Tramways Committee state that the general question of the extension of the tramways will be considered in the early part of next year.

Brighton-Shoreham Tramway.—The company owning the above tramways have decided to apply for powers in the ensuing parliamentary session for the purpose of extending the tramway, and also of reconstructing the existing line for electric traction.

Standish.—Notice was received at the last meeting of the Urban District Council that the Wigan Corporation had decided to withdraw from their Bill the proposal to extend the tramways to Coppull and Standish Lower Ground in view of the excessive cost they would involve.

Kent House.—A meeting of the Kent House Improvement Association has decided by a small majority that it is not desirable at the present time that trams should run through the district, but that if it be found necessary to have them the Urban Council should control them.

Rhondda.—The Urban District Council have decided to promote a Bill in the next session of Parliament for powers for the construction of the proposed tramways in the district. Sir Douglas Fox has been appointed engineer, and he will at once proceed with the preparation of plans, specifications, etc., in connection with the scheme.

Heywood.—The Corporation have resolved to apply to the Board of Trade for a provisional order to authorise the construction of electric tramways in the borough, and to empower the Corporation to enter into agreements with the Corporations of Bury and Rochdale in regard to the leasing and working of the tramways in the borough.

Warrington.—The Corporation have adopted a recommendation that application be made to Parliament in the ensuing session for powers to construct a tramway from Stafford-road to the Mulberry Tree Inn, Stockton Heath, and for a tramway along Grappenhall-road and Ackers-lane to join with the tramway in Knutsford-road.

Harrow.—A letter was read at the last District Council meeting informing the Council that at the enquiry on the 1st inst. part of the proposed railway north of the hill was thrown out, so that the only piece of line in Harrow parish was the small piece from the Wembley boundary to Greenford-road, a distance of less than 100 yards.

South Shields.—A special meeting of the Town Council was called for last night for the purpose of considering the promotion by the Council in the ensuing session of Parliament of a Bill for powers to reconstruct the existing tramways, to construct additional tramways in the borough, and to extend the tramways into the adjacent township of Harton.

Folkestone.—During a discussion at the last meeting of the Town Council as to the procedure to be adopted for applying for the necessary powers for the construction of tramways in Broadmead-road and Guildhall-street (which, however, resulted in no action being taken), it was urged that now motorcars were on the road trams were not necessary.

Rothesay.—Plans for the new electric tramways to Port Bannatyne, which are to be proceeded with at once, not being in accordance with the provisional order either in regard to a double line of rails or the laying of granite setts for the roadway, have been returned by the Town Council to the British Electric Traction Company for amendment.

Perth.—A deputation comprising the directors of the Perth and District Tramways Company has had a conference with the Town Council on the subject of the proposals for the purchase of the company's whole undertaking, and the proposals to grant a concession to the company for a period of years to permit of the company introducing electric traction.

Barnsley.—The Town Council have replied to an enquiry from the British Electric Traction Company, that they will be prepared to supply the electric energy required for the working of the light railways proposed by the company when completed. It appears that the work of constructing the railways is in hand, and is to be completed by Aug. 11, 1902.

Torquay.—Notice has been received by the local authorities from the Provincial Electric Supply Company of their intention to apply for a provisional order empowering them to construct an electric tramway from Torquay to Paignton, a watering-place three miles distant, the line to extend to Balbascombe Downs. The length of the proposed route is nearly seven miles.

Leeds.—The City Council have approved the recommendation of the Tramways Committee, noted in last week's issue, to apply for a provisional order for the extension of the tramways to the boundaries of the city at Thwaite Gate, Whitehall-road, and Elland-road: and also for an extension of the system from Oldfield-lane to the Whitehall-road line near New Blackpool.

Proposed Tyne Tunnel.—We note that the scheme for connecting North and South Shields by a tube under the harbour has now assumed a businesslike aspect. The statutory notices in regard to the promotion of the Bill are to be issued at an early date. The passage of the tunnel is proposed to be made by an electric train, a six minutes' service being contemplated.

Wolverhampton.—Three of the new electric tramcars supplied by Messrs. F. Milnes and Co. have now been delivered. Of the three vehicles, one is a double-decker constructed to carry 22 passengers inside and 26 outside; the other two are single-deckers, to carry 32 passengers. Driver and conductor can communicate with each other by means of an electric button.

Greenock.—Announcement was made at the last meeting of the Town Council that the local tramways company, in view of the refusal of the Board of Trade to arbitrate in the dispute regarding the right of the company to run tramcars on Sundays, had intimated that the service would be resumed forthwith. It was decided to meet the directors of the company and endeavour to effect a compromise.

Dewsbury and Batley Tramways.—Of the 155 shareholders in the Dewsbury, Batley, and Birstall Tramways Company, the necessary two-thirds have agreed to accept the terms of purchase offered by the British Electric Traction Company—namely, £10 for the preference shares and £4. 17s. 6d. for the ordinary shares (£9 paid up). The purchase money (£27,769) will probably be paid over within the next week.

Ipswich.—Sir Frederick Bramwell having made his award with regard to the purchase of the tramways by the Corporation, fixing the price at £17,552, application is to be made to the Board of Trade for sanction to borrow the money. A new committee is to be appointed to deal with all matters relating to the erection of the electric light and power station and to the street work in connection with the electric light and the electric tramways.

Worcester.—The Town Council are recommended to give notice to the local tramways company fixing Dec. 1, 1902, as the date for commencement of the supply to the company of electric energy under the Council's agreement with the company. Mr. H. P. Boulnois has held an enquiry into the application of the Corporation to borrow £31,111 for the erection and equipment of a supplementary electric supply station to provide for the traction load.

Merthyr.—With reference to the scheme of the Glamorgan County Council for making light railways at a cost of about £610,000, it was pointed out at the last meeting of the Merthyr Urban District Council that their district would not be touched, although they would probably be expected to help to pay for other districts. It was agreed to oppose the application of the County Council, and that the various rural and urban councils of the county be asked to co-operate with them.

Bradford.—The Tramways Committee report that they have now 61 fully equipped cars in service. A contract has been placed for the supply of material for the complete equipment of 100 additional cars. The total receipts for the year ended Aug. 31 were £48,364. 12s. 6d., as compared with £21,650. 5s. 4d. in 1900. The receipts per car mile worked out at 11·19d., as against 11·57d. in the previous year. During the year 377 accidents were reported, but most of them were of a trivial nature.

Nottingham.—A memorial has been presented to the Town Council asking that a single line of tramways should be constructed in Forest-road. A proposal will shortly be brought before the Town Council that power should be sought in the Parliamentary Bill about to be promoted by the Corporation to form a new street 50ft. wide from a point in Sneinton-road to a point in Manvers-street, and to lay electric tramways along such new street, and to continue the same along Manvers-street, Sneinton Hermitage, and Sneinton-boulevard.

Paddington.—More opposition in the shape of the formation of a strong committee of traders and others is proposed to be offered to the project of the London County Council for constructing tramways along Edgware-road from the Marble Arch to Cricklewood. The scheme would, it was said at a meeting held in Paddington Town Hall, mean "bankruptcy to the traders." Mention was made of the fact that a tube railway from the Marble Arch to Cricklewood would soon be commenced, as the necessary capital had already been subscribed.

York.—Sitting in committee, the Town Council have adopted a recommendation of the Streets Committee to apply to Parliament in the next session for powers to reconstruct the existing tramways, and to lay down new lines. The system of traction will be electrical, and the generating station, repair shop, and one of the car-sheds will be situate on Foss Islands. It is proposed to utilise the existing depot on Fulford-road for car-sheds, and powers will be taken to acquire compulsorily land at Acomb and Clifton for two small car-sheds.

Gosforth.—It was announced at Tuesday's meeting of the Urban District Council that the Newcastle Corporation had notified their intention of extending the tramlines from Lansdowne-terrace to Seaton Burn. The Tyneside Tramways Company had also given notice of a scheme to lay a new tramline up Salters-road around the lower boundary of the city asylum to Coxlodge, and thence by the higher boundary of the asylum to the top of Salters-road. They also proposed to lay another line from Church-road, *viâ* Rothwell-road, up to High Gosforth Park. This line would avoid using the Newcastle tramlines.

Manchester.—The Tramways Committee met on Tuesday to consider the reply of the Salford Tramways Committee to the proposals of Manchester that the difficulty between the two bodies in regard to the tramways should be referred to arbitration. Salford accepted the principle of arbitration, but attached conditions to the acceptance. These conditions the Manchester Committee decline to agree with. The committee state, in a communication addressed to the town clerk of Salford, that under the circumstances "the Manchester Corporation will be under the necessity of including in their Tramways Bill of next session an application to Parliament for such powers as they may be advised."

Grimsby.—Announcement has been made that application is intended to be made to the Light Railway Commissioners by the Grimsby and Saltfleetby Light Railway Company for an amending order for the purpose, among other things, of enacting that the capital of the company shall be £90,000 in 9,000 shares of £10, and that the company may issue any portion not exceeding £45,000 of the said £90,000 as preference capital, and may attach thereto such preferential dividend, not exceeding 5 per cent. per annum, and such rights to priority in distribution of assets as they may think

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fit. It is also sought to extend the period for the completion of the railway.

Proposed New Tramways in Camberwell.—The London County Council are recommended by the Highways Committee to apply in the next session of Parliament for powers to construct tramways for an underground conduit system of electric traction from the Council's tramways at Camberwell-green, *via* Denmark-hill, Champion-park, Grove-vale, and Lordship-lane, to a point near the intersection of that thoroughfare with Crystal Palace-road. The length of the new tramway would be 2¼ miles, the estimated cost of construction £68,650, and the estimated cost of the necessary street widenings about £114,000.

Ayr.—The drawings from the Corporation tramways continue to show a downward tendency, and have now reached the point at which they will just about pay expenses. Negotiations are proceeding between the Corporation and the Ayr County Council with reference to the conditions on which the county authorities will give their sanction for that section of the Burns's Monument line which is outside the boundary of the burgh. The borough electrical engineer has reported that the No. 3 Siemens-Belliss tramway generator was tested last week, and fulfilled the conditions of the contract in all items. He expects that the engine will be ready for running about the middle of December. Mr. Robert Craig has been appointed chairman of the Tramways Committee.

Pemberton.—The District Council have agreed to the draft lease with the tramways company with the following proviso as to the reconstruction of the road: "The company shall pay 8 per cent. per annum on the amount paid by Pemberton for the lines, and on what is really necessary to be expended in order to put the tramways into a proper condition suitable for electric traction, and so that the cost of maintenance shall not be greater than on a newly-constructed line. Such payment of 8 per cent. per annum shall include all maintenance of the track. It shall be left to the engineer of the Council and the engineer of the company to agree as to specification of the works necessary under this clause; any difference between such engineers to be determined by the Board of Trade."

Slough. — If the Urban District Council's electric lighting order should be granted, the *Windsor Chronicle* points out that there will be a public supply in four adjoining places—Slough, Eton, Datchet, and Windsor—and therefore it will be possible for the four parishes mentioned to be further connected with electric tramways. It is reported that the London United Tramways Company contemplate extending their system down the Bath-road to Colnbrook, so that it may not be long before Slough, Eton, and Windsor people will be able to travel right to London by tram. It has been unofficially stated that this prospect really induced the Slough Council to take the course they have. It is difficult, however, to imagine electric trams running through either Eton College or the Home Park.

Clacton.—A letter was received at the last meeting of the Urban District Council from a firm of solicitors stating that they have been instructed to apply this month on behalf of clients of theirs to the Light Railway Commissioners for authority to make a light railway from Clacton to St. Osyth. The railway will probably start at the junction of Pier-avenue and Station-road and proceed along Pier-avenue and Wellesley-road towards Great Clacton. It will pass either along the main road in Great Clacton or more probably through the fields immediately to the south of it. From thence it will be along the road to St. Osyth. It is proposed to form a junction with the Great Eastern Railway at Clacton, and that the motive power will be electricity. The engineer to the scheme is Mr. John Russell.

Bredbury and Romiley. — A sub-committee of the Urban District Council has waited upon the Electricity Committee of the Stockport Corporation with respect to the electric lighting and tramway orders and the intentions of the Stockport Corporation thereunder. The Electricity Committee informed the deputation that they were prepared to supply sufficient current for tramway traction up to the boundary of this Council's district at Hyde. Further, that they would also be in a position to supply any future extensions in the Ashton or Romiley direction. As regards the likelihood of further tramways in the Romiley and Ashton direction being constructed, it was suggested that an early meeting be arranged for the purpose of discussing the matter with the Stockport Tramways Committee.

Proposed Selby and Goole Light Railway.—A private meeting of landowners and others interested has been held to consider a scheme for the construction of a light railway between Selby and Goole. The meeting discussed the proposal at considerable length, and the *Yorkshire Post* understands that, though no definite action was taken in the matter, it is practically resolved to make such a railway which will enter Selby in the vicinity of the Wistow and Cawood Light Railway, passing near the cemetery, and over the North-Eastern Railway Company's Doncaster line and Camblesforth Common to Drax serving the parishes of Newland and Carlton), and, crossing the River Aire, on to Rawcliffe and Goole. The landowners are treating the matter very liberally, and, with few exceptions, favour the proposition, and are disposed to offer concessions in the way of transferring land to the promoters.

Vienna Tramways.—The Vienna correspondent of the *Financial News*, writing on the 10th inst., says that in a few days there will be heard in the Vienna courts a most important lawsuit between the Municipal Administration of Vienna and the Bau und Betriebs-Gesellschaft, the concern which undertook to construct the Vienna tramways. In its unfortunate contract the company bound itself to take the supply of electric current for the lines from the municipal electricity works. At the time the contract was made the parties entirely forgot to fix a price. This means, of course, a great handicap for the company. Moreover, the Municipal Administration now declares that it is alone authorised to lay down the cables for the electric lines. The courts have been appealed to in order to decide the matter, which is of the utmost importance for the existence of the concern.

Light Railways in the Potteries.—At a meeting of the Stoke-on-Trent Rural District Council on Wednesday a letter was received from the Light Railways Commissioners stating that they had submitted to the Board of Trade for confirmation an order to authorise the Potteries light railways (extensions). The order, as finally settled, did not include any provision for the construction of the proposed additional line to Townsend, or of that portion of the additional line to Sneyd Green which would have been in the borough of Burslem. In the former case the Staffordshire County Council made their assent to the line conditional upon the acceptance by the company of liability for the expense of certain road improvements, and in the latter the Burslem Corporation insisted upon certain terms of future purchase which the company could not agree to. The Commissioners had consequently not included these lines with the railways to be authorised.

Hammersmith.—The Borough Council propose to take out further summonses against the Central London Railway Company for permitting black smoke to issue from the shafts of their premises in Wood-lane in such quantities as to be a nuisance on five occasions. The Parliamentary Committee recommend that no action be taken with respect to the noise of the electric trams in the borough pending the decision of the Board of Trade, who have been appealed to on the subject. With reference to the proposal of the London County Council to construct tramways from Harlesden to Putney Bridge, and from Uxbridge-road to Shepherd's Bush-road, the committee recommend that the London County Council be informed that, without prejudice to the *locus standi* of the Council in opposition to the scheme, the Borough Council approves of the construction of tramways along the proposed routes, but that until the scheme of the London United Tramways is produced the Council have deferred their decision.

West Bromwich.—In accordance with instructions, the borough surveyor and consulting engineer has prepared the necessary plans and details for the reconstruction and electrical equipment of the tramways. The Highways Committee's report states that it is proposed to relay the permanent way of the whole of the tramways within the borough with new materials, the rails to be of a heavier section than the existing ones, and special care will be taken as regards the construction of the joints. The lines from the Handsworth boundary to Carter's Green and from Carter's Green to Hill Top and Great Bridge will be double throughout. Several alterations will be made to the lines of curves in Great Bridge and Dudley-road in order to have double lines, and the overhead wires will be carried by centre poles placed every 40 yards apart, which can also be used for street-lighting. It is proposed to allow the Spon-lane and Bromford-lane lines to remain at present single lines, with passing places, and to connect them to the main line both at Dartmouth-square and St. Michael's-street, the overhead wires to be supported by span wires, the poles being placed opposite each other on the footpaths.

Southend.—At a special meeting of the Town Council last week a deputation and several petitions were received against the proposals to extend the electric tramways into the western residential quarter. Eventually consideration of the question was adjourned. We note that it is proposed to separate from the duties of the electrical engineer (Mr. Adamson) the responsibility for the general management and superintendence of the tramway traffic, and to this end the Light Railways Committee recommend the Town Council to terminate the present engagement of Mr. Adamson, and to advertise for a traffic manager and superintendent, at a salary of £150 per annum. The committee also recommend that it be referred to them "to consider and report to the Council as to what salary shall be paid for the services of an electrical engineer for the performance of the limited duties above mentioned, and as to the arrangements to be made for the performance of such duties." Having regard to the small size of the town of Southend, we do not think that the committee's recommendations are well founded, or that the circumstances of the case call for the division of the duties of electrical engineer and traffic manager of the tramways.

London's "Tube" Schemes.—From particulars given by Mr. Yerkes to the *Daily Chronicle*, it appears that parliamentary powers are to be sought for the extension of the South Kensington and Piccadilly-circus line, which he wishes to be connected with the District line at Charing Cross. At the Temple Station there will be a branch line to the Strand joining up the "tube" projected by the Great Northern Railway, and running from Finsbury Park to a spot near St. Clement Danes Church, by way of King's Cross and Holborn. Control of this line has now been given to the Electric Traction Company, and as the Strand and Holborn Stations will be near the thoroughfare that is being constructed by the London County Council, there is reason to believe that the line will be a great boon to those having offices in that avenue. Further, at Holborn there will be a short line running to Piccadilly-circus, and joining the South Kensington system. Piccadilly-circus will soon become a great railway centre, but the exact position of the big station proposed by Mr. Yerkes is not yet decided upon. Asked whether he had any designs on the Baker-street and Waterloo line, Mr. Yerkes replied that the system was still in the hands of the official receiver.

Walsall.—The Tramways Committee recommend that, subject to satisfactory arrangements being made with the South Staffordshire Tramways (Lessee) Company, Limited, for working the extension of the tramways to Bell lane, Bloxwich, for the remainder of the term of three years from Jan. 1 last, the Council proceed at once to construct and equip that portion of the line at an estimated cost of £6,000, and also to make such alterations and construct such new works as may be necessary for equipping the whole of the Bloxwich section of the tramways for taking a supply of current from the Corporation works at a further estimated cost of £3,140. In this connection the Electric

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Lighting Committee recommend that, subject to the company agreeing to take a supply of current from the Corporation works for working the whole of the Bloxwich section of the tramways, including the proposed extension te Bell-lane, until the expiration of their lease for three years, at a price to be settled by the committee, the Council proceed at once to lay the necessary mains, and to construct the necessary work, at an estimated cost of £6,371. 10s.; and that additional generating plant, including engine, boiler, dynamo, and condensing plant, be provided at the generating station at a further estimated cost of £8,800, to meet the probable demand for current for tramway purposes at the end of 1902.

Exeter.—The City Council, who have for a long time had under consideration the question of the conversion of the tramway system in the city, have now received a notice from the Electric Tramways Construction and Maintenance Company of their intention to promote a Bill in Parliament giving them power to cover the whole of the district with a network of electric tramways. There is much division of opinion in the city on the matter. One section, in which are included the shopkeepers of High-street—the main street of the city—contend that the introduction of the trams into that city would seriously affect the carriage traffic and trade of the street; and, further, that there would be a congestion of traffic at its narrow part, where it is not suited for tram traffic. On the other hand, the public at large maintain that in many other towns the tram traffic goes on all right in streets narrower than the High-street in Exeter at the short spot indicated; that trade would be benefited by the increased traffic brought into the city, and that a cheaper system of travelling all over the city would be a public boon. At any rate, there will have to be considerable outlay on the proposed routes, and the Council must decide in the current month whether they will carry out the undertaking themselves or consent to a private company doing so.

Middlesex Light Railways.—Last week the Light Railway Commissioners (the Earl of Jersey and Colonel Boughey) held a public enquiry as to the expediency of granting the applications of the Middlesex County Council and the London United Tramways Company, Limited, for orders authorising light railways in the urban districts of Acton, Ealing, Brentford, Chiswick, Willesden, Harrow, Wealdstone, and Stanmore. At the outset Mr. Cripps, K.C., for the Middlesex County Council, withdrew the proposal for a light railway in the parish of Chiswick, and this was followed by the withdrawal of the scheme of the London United Tramways Company then before the Commissioners. The case for the County Council was then proceeded with, and in the result the Earl of Jersey said the Commissioners would recommend orders to be issued authorising the promoters to construct a line in Edgware which would be a continuation of an already authorised railway, a line from Harlesden along the Harrow-road to Sudbury-Wembley Station, and a line from Stonebridge Park to Churchfield-road, Acton. The lines refused were those from Kilburn Station to Cricklewood, from Cricklewood to Harlesden, the continuation of the authorised line to Acton, through Mill Hill Park and Chiswick, and the continuation of the authorised line to Wembley-Sudbury Station, through Wembley, Sudbury, Harrow, Wealdstone, and Hendon.

London County Council Tenders.—In another column this week we give the list of tenders received by the London County Council for the supply of the continuous-current and three-phase electrical plant in connection with the reconstruction for electrical traction of the tramways between Westminster and Tooting, etc. It will be seen that for both classes of plant the tenders of Messrs. Dick, Kerr, and Co. have been accepted, being, in the opinion of the Highways Committee, the most favourable. In their report on the subject the committee state that they are advised by Dr. A. B. W. Kennedy that there are considerable advantages to be derived from the point of view of convenience and economy in working, superintendence at the generating station, and in connection with duplicate, or spare, parts of the engines, from using exactly the same type of engine for driving both the continuous and the three-phase electrical machinery when installed at the same station. The tender of Messrs. Dick, Kerr, and Co., for the continuous-current plant, with the Ferranti engines proposed, amounting to £25,964, is the lowest of any of the tenders which it was possible to recommend the Council to accept, and their tender for the three-phase plant with the same engine, amounting to £46,626, though not the lowest, was in every way acceptable. The two tenders combined, however, gave a lower total price than any two other tenders for electrical plant, and on the advice of Dr. Kennedy the committee came to the conclusion that Messrs. Dick, Kerr, and Co.'s tender for each kind of machinery should be accepted as being most advantageous to the Council from all points of view. The company undertake to deliver the continuous-current plant within 10 months and the three-phase plant within 18 months from the date of the order, which in the opinion of the committee is quite satisfactory. Messrs. Dick, Kerr, and Co. propose to sublet to the following firms, and this has also met with the approval of Dr. Kennedy and the committee: to the English Electric Manufacturing Company for dynamos, generators, and other electric plant; to Messrs. Ferranti, Limited, for the large engines; and to Messrs. Belliss and Morcom, Limited, for the auxiliary engines.

Proposed Shallow Underground Tramways.—At their usual weekly meeting on Tuesday the London County Council discussed and ultimately adopted unanimously the proposal of the Highways Committee to construct a shallow underground tramway from Waterloo Bridge under the Strand, the new street to Holborn, and so on to Southampton-row, rising by an incline to the surface there and joining the tramway terminus in Theobald's-road. The committee's recommendations were in the following terms: "That the Council do apply in the next session of Parliament (1) for powers to make subways in streets for the reception of pipes, wires, and other things, where desirable, and for electrical traction and other purposes of locomotion; and (2) powers to construct a subway and to construct tramways therein for electrical traction from the Victoria-embankment, along Wellington-street, across the Strand, through the new street, thence to Holborn, under Holborn and Southampton-row, and to take such tramways, by an inclined plane, to the street level at a point in the centre of the carriageway of Southampton-row, and thence to join with the existing tramways belonging to the Council in Theobald's-road." It will be seen from the latter recommendation that the intention now is to bring the tramway to the street level in the centre of the carriageway of Southampton-row instead of in Theobald's-road, as was originally proposed. The following amended report fully explains the alteration in the scheme: "In our report on the above subject, presented on Nov. 5, the consideration of which was, in accordance with the Council's standing orders, adjourned for a week, we stated that we proposed the construction of a tramway subway from the level of the Victoria-embankment, and under certain specified thoroughfares, to and under Southampton-row as far as Fisher-street, and that thence the tramways should be taken up an inclined plane under land on the east side of the thoroughfare, to join with the existing tramways in Theobald's-road, which belong to the Council. It has since been suggested to us that a better and probably less costly arrangement would be for the tramways to be brought to the street-level at a point in the centre of the carriageway of Southampton-row, and to be taken thence to the tramway terminus at Theobald's-road, and we consider this to be a distinct improvement on our first proposal. To allow of this being done, it is necessary that that part of Southampton-row between Fish-street and Vernon-place should be widened to 100ft. instead of 80ft. as first proposed; and we have asked the Improvements Committee to consider the matter with a view to the Council being recommended to approve of the increase in the width of that thoroughfare. We stated in our previous report that the estimated cost of the construction of this tramway subway was £282,000; but we had not before us at that time information as to the probable amount which would have to be paid in respect of interference with, and depreciation of, property. We have since received this, and also a revised estimate of the cost of construction; and we have to state that the estimate for the first item is £70,000, and for the second is £250,000, making a total of £320,000. We have requested our chairman to ask leave of the Council to amend our recommendation (*b*) by striking out all the words after 'plane' in the sixth line, and the substitution therefor of the following words: 'To the street level at a point in the centre of the carriageway of Southampton-row, and thence to join with the existing tramways, belonging to the Council, in Theobald's-road.'"

LIGHTING AND GENERAL.

Shrewsbury.—Extensions of cables, estimated to cost £2,000, are to be made.

Whitby.—It is reported that in a very few weeks the town will be lighted by electricity.

Helensburgh.—The Town Council propose to apply for an electric lighting order for the burgh.

Rhos.—The adjourned consideration of the lighting of the parish by electricity will take place to-day.

Heckmondwike.—The electric current, it is expected, will be turned on at the new works next week.

Llandilo.—The Urban District Council have adopted an electric lighting scheme estimated to cost £2,770.

Share Market.—There was a little business in lighting concerns during the week, but tractions remained unaltered.

Paignton.—The District Council have been considering in committee a report on the two electric lighting proposals received.

East Barnet.—The Urban District Council are obtaining a report upon the most economical method of lighting the district by electricity.

Perth.—Messrs. Callender's Cable and Construction Company, Limited, are now laying mains in connection with the lighting of the Perth bridges.

Telegraph Manufacturing Co.—The directors have declared an interim dividend at the rate of 8 per cent. per annum for the half-year ended Sept. 30 last.

Bredbury.—The Urban District Council have decided to retain the Bredbury electric lighting order in preference to transferring it to the Stockport Corporation.

Tavistock.—The Urban District Council have decided to obtain information from the Urban Electric Supply Association with the view of lighting the town by electricity.

Manchester Telephones.—With reference to a note in another column, we are informed that the Council on Wednesday decide to promote the Bill on the lines indicated.

Aberystwyth.—A suggestion has been made that the Town Council should enter into a guarantee to the National Telephone Company with a view of obtaining a trunk-line connection.

Turton.—The Urban District Council have appointed representatives to confer with the Bolton Corporation upon the subject of establishing a municipal telephone exchange.

Philippine Cable.—The Commercial Pacific Cable Company, which has been incorporated to operate the cable between the United States and the Philippines, is increasing its capital to 3,000,000dol.

Bermondsey.—It is expected that the borough electric lighting works will be ready for opening in five weeks' time. The Council have decided to undertake the wiring of consumers' premises at an initial cost of £1,000.

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Hessle.—The Hull Corporation Electric Lighting Committee have appointed a sub-committee to confer with a sub-committee of the Hessle Urban District Council with reference to the extension of the electric light to Hessle.

Hart Accumulator Co.—We have received a special price list of motorcar ignition cells, of which this firm are making a speciality, as there seems to be a very large demand for them, owing to the greatly increasing motor trade.

Islington.—Applications for a supply of electricity have been granted as follows: to premises in Tollington-park, £670; New Wharf-road, £97; Hornsey-road, £76; and to a factory in North-road, Caledonian-road, £220.

Grimsby.—Tenders were recently invited for the electric lighting of the Flottergate Church, including fittings. We are now informed that the trustees at their meeting held on the 1st inst. decided to adjourn this matter indefinitely.

Bushbury Electric Works Institute.—An entertainment was given in aid of the Bushbury Electric Construction Institute on Monday in the messroom connected with the works in the presence of a large and appreciative audience.

Dover.—The Corporation have agreed to purchase the electric light works and to apply to Parliament for power for the same. The Corporation at present take a great amount of current for their electric tram service and for public lighting.

Rhyl.—The formal opening ceremony in connection with this installation took place on Thursday (yesterday). As we hope to deal fully with this matter in our next issue it is unnecessary to do more at present than record the fact.

Slough.—Application is to be made by the Urban District Council for a provisional order authorising lighting by electricity in the area comprising the present urban district of Slough and the parish of Datchet, both in the county of Bucks.

Stockton.—A letter from the churchwardens of the parish church asking for a reduction in the rate charged for electric energy as supplied to the electric motor which is used for blowing the church organ is before the Electric Lighting Committee.

Alderley.—The Alderley and Wilmslow Electric Supply, Limited, have decided to run electric light mains down West-street, South-street, and George-street, Alderley Edge, and to supply any residents in the above-mentioned streets with current.

Spennymoor.—The Urban District Council have declined at present to accept an offer of the electric supply company to light up the district with incandescent lamps for the sum of 39s. per lamp, and to fix 20 electric arc lamps at a cost of £16 per lamp.

Runcorn.—The District Council have accepted offers from Sir John Brunner and Mr. Posnett to contribute £50 each towards the cost of providing an electric installation at the technical institute for the purpose of electrical experiments, wood turning, etc.

Salford Telephones.—The Town Council are considering the expediency of joining with other local authorities in the Manchester telephone exchange area in the promotion of a Bill for the purpose of providing a system of public telephonic communication in the area.

Borwick.—At the last meeting of the Town Council, as the sanitary authority, the Clerk read a letter from Edmundson's Electric Supply Company stating that they anticipated carrying out next year the work of installation in order to have the light ready for next winter.

London County Council.—The Parliamentary Committee were authorised on Tuesday to advertise notice of a Bill—the draft of which will be sent to the Corporation and the Borough Councils—dealing with the purchase of undertakings for the supply of electricity in London.

Carnarvon.—The County Council have decided to support the application of the Carnarvon Town Council for a provisional order for the borough of Carnarvon, and to oppose Mr. Petersen's application so far as it relates to the borough and the Gwyrfai Rural District Council.

Electrical Trades Exhibition.—We are informed that this exhibition will be opened by the President of the Institution of Electrical Engineers (Mr. W. E. Langdon) on Dec. 16. A grand concert under the immediate patronage of H.R.H. Princess Christian and Lord Roberts.

York.—The Streets and Buildings Committee, after considering the question as to whether the electric cables for the tramways should be laid at the same time as the additional cables for the electric lighting generally, have come to the conclusion that it was not desirable to follow that course.

Loughborough.—At the last meeting of the Guardians an offer of a telephone company to lay a private telephone connection from the workhouse to the clerk's offices was received and declined. At the next meeting it will be proposed to give the work to the National Telephone Company.

Kingston (Surrey).—The Guardians are corresponding with the Local Government Board respecting the proposal to expend £445, exclusive of architect's commission and contingencies, in connection with electric plant to work the lift at the administrative block of the new female infirmary.

Port Talbot.—At the last meeting of the Margam Urban District Council a resolution was passed instructing the clerk to proceed with the application for sanction to borrow £7,000 for works provided in the Margam Electric Lighting Order of 1898, and a committee was appointed to carry the matter through.

Bath.—The Electric Light Committee have been asked to prepare a statement of their probable requirements and of their estimated revenue in respect of further capital outlay, in order that they might be considered in conjunction with other outstanding liabilities of the Corporation, preparatory to the issue of stock.

Nantwich.—Application is to be made for sanction to borrow for electric lighting purposes the following sums: for building of electric light works, £1,200 (repayable in 30 years); for machinery, mains, lamps, and connections, £11,305 (repayable in 25 years); for refuse destructor, buildings, and machinery, £1,275.

Cardiff.—Andrew's Hall, in Queen-street, has been converted during the past few weeks into a modern circus and hippodrome. The electric lighting is supplied from a dynamo on the premises on such a scale that the manager, Mr. George Gilbert, claims that the Andrew's Hall will be the finest-lighted building in the whole country.

Belfast.—The electrical engineer (Mr. V. A. H. M'Cowen) has been authorised to extend the main in Tomb-street. At their next meeting the Gas and Electric Committee will consider the advisability of reducing the price of current for lighting purposes to shopkeepers, and of fixing a uniform rate for current used for domestic purposes.

Wireless Telegraphy.—A Berlin telegram to the *Echo de Paris* states that wireless telegraphy has been introduced in the German Navy, and that all officers are being instructed in the use of the apparatus. At the same time we learn that the officers of the U.S.A. Navy are far from satisfied with the results obtained by them at present.

Norfolk.—The committee of the Norwich Town Council appointed to negotiate with the local electric company for the purchase of the undertaking have decided to recommend the payment of £214,000. This would give the shareholders £19 for each £10 share, the directors would receive £5,000 as compensation, and £2,000 would be provided for back dividends.

Presentation.—On Friday last Mr. G. S. Maben, assistant superintendent engineer at Bradford, was presented with a solid silver tea service, subscribed for by members of every section of the electricity works department, on the occasion of his approaching marriage, and on his leaving to occupy the post of chief engineer of the electricity works, Wellington, New Zealand.

Walker.—The District Council have adopted the Electric Light Committee's recommendation, that the plan of the Newcastle Electric Supply Company showing the position of the feeding part be supported. At the same time the committee could not agree to the request of the company that the feeding part should be held over until the question of supplying the tramways and car-shed in Walker was settled.

Westminster Electric Supply Corporation.—We are informed that from and after the end of the present year the rate of charge for electric energy for power purposes will be reduced to half the lighting rate, and will be as follows: for the first 4,000 units used in each year 3d. per unit, for all units used in each year in excess of 4,000 2d. per unit. These rates are subject to a discount of 8 per cent.

Sale of Plant.—A notable sale of plant is taking place in connection with the New British Incandescent Electric Lamp Company, Limited (in liquidation), by Wheatley Kirk, Price, and Co. on Nov. 26, at 10 o'clock for 11 o'clock prompt, upon the works premises, 8, Hythe-road, Willesden, London, N.W. The stock comprises finished and unfinished lamps, lamp manufacturing materials, etc. Full particulars appear in our advertisement columns.

Bristol.—In consequence of the appointment of Mr. R. W. L. Phillips, deputy city electrical engineer, as borough electrical engineer, Bedford, the following changes have been made in the staff at the Corporation electricity works. Mr. H. Herbert Couzens, second assistant engineer, has been appointed deputy city electrical engineer; Mr. J. H. Bolam, third assistant engineer, to be second assistant engineer; and Mr. W. B. Morgan, of Leeds, assistant mains engineer.

Rhosllanerchrugog.—At a recent special meeting of the Parish Council, a discussion took place on the desirableness of adopting oil lamps, but it was shown that this might be far more expensive than gas. Other members spoke in favour of adopting the electric light, and eventually Messrs. W. M. Jones and J. Evans and the clerk (Mr. J. Trevor Jones) were appointed to interview the clerk and members of the Wrexham Town Council, and to visit the electric light depôt there and to report to the next meeting of the Council.

London Gazette.—The partnership existing between Walter Morton and Arthur E. Ashley (trading as Morton and Ashley), Warrington, has been dissolved by mutual consent. Notices have appeared in the *Gazette* of intention to apply for provisional electric lighting orders by the Edmonton Urban District Council, Frinton-on-Sea and District Electric Light and Power Company, Aberdare Urban District Council, Westhoughton (Lancaster) Urban District Council, Hebden Bridge Urban District Council, and the Corporation of Thornaby-on-Tees.

Portslade.—The Council have approved a draft agreement with reference to the Brighton system of municipal telephones, subject to the insertion of clauses providing (*a*) "that subscribers in the Council's district shall not be charged mileage in accordance with the town clerk's letter"; (*b*) "that if at any time in the opinion of the Council's surveyor it should appear desirable, in the interest of public safety, the Corporation shall, on being called upon, erect additional poles." The Brighton Town Council have agreed that if they did not put an exchange in Portslade they would not charge mileage, which they had proposed to charge after a distance of one mile.

Stock Exchange.—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: Cape Electric Tramways, Limited, further issue of 40,000 shares of £1 each, fully paid, Nos. 400,001 to 440,000; Potteries Electric Traction Company's further issue of 95,000 4½ per cent. debenture stock. Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Central Electric Supply Company's 4 per cent. guaranteed debenture stock; Vickers, Son, and Maxim, Limited, further issue of 1,100,000 ordinary shares of £1 each, fully paid, Nos. 2,200,001 to 3,300,000.

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Battersea.—The electrical engineer's last report states that up to the present time the number of applications for the supply of electricity to premises, including the Council buildings, amount to 92, with an aggregate equivalent of 9,751 8-c.p. lamps, the number of actual consumers being 56, with an aggregate equivalent of 5,285 8-c.p. lamps. Applications for motive power equivalent to 15¾ h.p. have been received.

Colchester.—The General Officer commanding the Eastern District has been authorised to accept the Council's tender for installing the electric light at the Sobraon and Goojerat Barracks. The electrical engineer in his last report states the output of electricity as 10,126 units, as compared with 7,786 in the corresponding period of last year. The number of consumers was 196, against 125, and 11,777 lamps were connected, as against 7,700.

Sunderland Telephones.—The Council propose to apply for a municipal telephone license, and to borrow £23,000 to provide an exchange and plant to supply 1,000 subscribers as a start. It is thought that a charge of £5 per annum per instrument for unlimited use, or £3 per instrument and the 1d. call privilege, would be sufficient to provide for the repayment of the loan and interest and the cost of working, and leave a surplus of profit.

Brush Electrical Engineering Co.—We are notified that, as foreshadowed by his speech at the general meeting of shareholders held in January last, and in consequence of the pressure of other engagements, Mr. J. B. Braithwaite, jun., has resigned his seat on the Board of this Company, Lord Vaux of Harrowden succeeding him as chairman. Mr. Reginald Ryley has been elected a director of the Company in place of the late Mr. J. Slater Lewis.

St. Marylebone.—At the last meeting of the Guardians a resolution was proposed consenting to the execution of works and the provision of fittings and machinery for the purpose of lighting the infirmary by electricity. The Local Government Board had already approved the plans subject to certain modifications, and to the expenditure and borrowing of a sum not exceeding £9,039 for the purpose. After discussion, the further consideration of the matter was adjourned.

Bury St. Edmunds.—The Electric Lighting Committee's last report shows that since the last meeting applications have been received equivalent to 700 8-c.p. lamps, and a supply of energy for a 10-b.h.p. motor. The street-lighting of Victoria-street and Risbygate-street, from Springfield-road to the barracks, has been completed, and mains are being laid in St. Andrew's-street, Cemetery-road, Mill-lane, Hospital-road, and Out Westgate. The salary of Mr. Greig, the engineer, has been increased.

Wakefield.—A suggestion to supply motors on the easy-payment system as a means of getting power customers is being considered by a sub-committee. The tenders for the new 400-kw. plant are in the hands of another sub-committee of the Electric Light Committee. The electrical engineer has been instructed to purchase two 25-kw. transformers of Messrs. Fowler and Co., Leeds, at £52 each, also switch gear for same, for a supply of electricity for power purposes. A main is to be laid at an estimated cost of £150.

Brighton Electricity Works Club.—The second annual dinner of the Brighton Corporation Electricity Works Cricket Club was held on Monday evening at the Unicorn Hotel, North-street, a large company of members and friends being present. Mr. J. Christie presided, and the vice-chair was occupied by Mr. Goodall. Two interesting presentations were made during the course of the evening, Mr. Tyler being the recipient of a couple of armchairs on the occasion of his recent marriage, and Mr. Macey receiving a presentation of a floral character from his colleagues of the fitters' shop.

Bradford.—The number of motors and arc lamps supplied from the Corporation cables continues to increase. On June 30 there were 708 motors supplied from the Corporation mains, of which 487 were owned by the electricity department. The total number of consumers is 1,405, being an increase of 227 in 12 months, or equal to 19·3 per cent. The total number of arc lamps is 51, together with 24 incandescents used for street-lighting. In the course of a week or 10 days the installation of electricity at the Bradford Post Office will be complete. The current will be supplied by the Corporation.

Cowdenbeath.—Some time ago the Town Council agreed to introduce the electric light in the streets of the burgh. The work was placed in the hands of Messrs. Hunter and Jack, electrical engineers, Glasgow, and on Saturday the light was turned on by Provost Wingate in presence of the Council and the engineers. The length of the cable is 11,000 yards, and the steam for the engine is drawn from the boilers of No. 7 pit, belonging to the Fife Coal Company. There are 200 lamp-pillars, and each pillar contains two incandescent lights of from 8 to 16 c.p. The cost of the installation will be from £1,800 to £2,000.

United Electrical Co.—We are informed by Mr. Fernand Espir, of 3, East India-avenue, agent for the United Electrical Company, of Ujpest, near Budapest, that this Company have recently increased their incandescent lamp factories by the erection at Ujpest of lamp works which are fitted for a daily output of 30,000 lamps, and which are capable of considerable extensions. These works, which cover an area of over 50,000 square yards, comprise the following separate buildings: lamp works proper, workshops for the manufacture of lamp caps and other lamp fittings, engine-room, gasworks, filament carbonising furnaces, office building, own post office, workmen's cottages.

Lower Bebington.—The Council, after correspondence with the Higher Bebington Urban District Council, Bromborough Urban District Council, and the Wirral Rural District Council, these bodies all wishing terms of supply of electric light, etc., to be arranged before consenting to the inclusion of their district within the area of supply, have resolved that the application for a provisional order under the Electric Lighting Acts be proceeded with in respect of the district of Lower Bebington only. A sub-committee of the Parliamentary Committee has been authorised to confer with the Electric Lighting Committee of the Birkenhead Corporation in reference to the overtures made to supply in bulk surplus electrical energy to be measured in a meter at the borough boundary.

Worcester.—Mr. H. P. Boulnois has held an enquiry into the application of the City Council to borrow £30,450 for erecting and equipping of a supplementary electricity generating station. The new works have become necessary by reason of the conversion of the tramways to electric traction, and it is proposed to give the British Electric Traction Company, who have acquired the powers to run the trams in the city and district, notice fixing Dec. 1, 1902, as the date for the commencement of the supply of current for traction purposes. The Electrical Engineer (Mr. C. J. Sutherland) explained the nature of the machinery that it was proposed to instal in the station, and Mr. A. B. Rowe, the city architect, gave particulars as to the building itself. The estimates for the building and machinery amounted to £30,800, while the actual cost, it was thought, would be £31,111.

Pemberton.—At a recent meeting of the Electric Lighting and Parks Committee the electrical engineer reported that the cost of the cable to the Worsley Mesnes Ironworks, for the supply of the works alone, would be £1,500, and thought that the charge to be made for supply should be 5d. per unit up to 5,000 units, and afterwards 2d. per unit. Questioned as to the cost of laying a cable similar to that in other parts of the district, he said it would be £2,500. Generally, the supply for motors, he thought, should be at 2d. per unit. He recommended the committee to accept 2d. per unit for supply, with a minimum rent fixed of not less than £100 per year, from Messrs. Melling. It was resolved that the following be advertised for: working electrician, to take charge of the entire station and works; an assistant; two engineers to take charge of the engines; two stokers.

Fulham.—The Borough Electrical Engineer reported at Wednesday's meeting that from Oct. 21 to Nov. 4, 1901, applications equivalent to 1,478 8-c.p. lamps had been received, making a total in all of 24,782 8-c.p lamps. The Borough Electrical Engineer further reported that 234 services had been completed and connected to the mains, representing an equivalent of 10,700 8-c.p. lamps. The Borough Electrical Engineer also stated that from Oct. 21 to the 2nd inst. 1,072 tons 8cwt. 1qr. = 1,589 loads of refuse were destroyed at 1s. 2d., £92. 13s. 10d.; 216 loads of clinker at 1s., £10. 16s.; 11 loads of clinker at 6d., 5s. 6d.; 138¼ loads of fine ash at 8d., £4. 12s. 4d.; 9 loads of trade refuse at 1s. 6d., 13s. 6d.—making a total of £109. 1s. 2d. gross; or, less 122 tons 11cwt. of clinker at 2s. barged away, £12 5s. 1d., of £96. 16s. 1d. net. The average of wages paid for a fortnight to the destructor employés was £86.

Exeter.—At the last meeting of the Council, the tender of the Westinghouse Company was accepted subject to the draft contract being submitted to an expert, to be appointed by the Electric Lighting Committee, who shall incorporate into such draft contract such additions or alterations as they may deem advisable for the protection of the Council in order to secure a complete and efficient equipment of the station; and, further, that the plant be tested on the works at the expense of the contractor prior to the starting of the works, and that a second test at the expense of the Council be made at the expiration of 12 months. The Electric Lighting Committee were instructed to apply for sanction to borrow a sum of £65,000, or such lesser sum as might be found necessary. This amount was made up as follows: plant, £30,000; buildings, £14,000; mains, etc., £16,000; surveyor's fees, etc., £500; ground, £2,800; railway sidings, foundations, brickwork, etc., £1,700.

Colne.—The Electrical Committee have decided to provide for distributing switches by the construction of underground chambers, and have accepted an offer of the British Insulated Wire Company to take back the boxes supplied for the top of Dockray-street and Keighley-road at 90 per cent. of the contract price, less the cost of carriage, and that the construction of underground chambers was estimated to cost £15 each. A rent of 1s. 6d. per quarter is to be charged for the hire of ordinary meters up to 50 lights; special terms will be made for meters of larger sizes. The Electrical Committee reported at the last meeting of the Town Council that at a recent meeting of the representatives of the authorities within the Burnley area it had been agreed to call in an expert to furnish a report on the proposed telephone scheme, the cost to be borne by the four boroughs represented—Burnley, Nelson, Colne, and Todmorden. The electrical engineer, in his report upon the progress of the works during the past month, stated that the battery was expected to be completed in about two weeks.

New Zealand.—We learn from the *New Zealand Mining and Engineering Journal* that the town of Patea is lit by electricity, and has over 2,000 incandescent lamps of 16 c.p. The motive power is water, under a head of pressure of 60ft., and it is distant 1¼ miles from the town. The motor is a 67-h.p. turbine, supplied by the Ateliers de Constructions Mechaniques, Vevey, Switzerland. The lighting plant is by Brown, Boveri, and Co., of Baden, Switzerland, and it is a single-phase plant for lighting purposes. The installation was made by the well-known firm of electrical engineers, Messrs. Turnbull and Jones, of Dunedin, and it is giving entire satisfaction. Good progress is being made with the installation of electric fire-alarms at Newtown. About three-fourths of them have already been installed by Mr. J. Dawson, the electrician who has the work in hand. The South Wellington circuit is expected to be in operation in about a month's time. Good progress is being made with the construction of the building of the electrical department of the school of engineering at Canterbury College.

Bray.—At the last meeting of the Council, Mr. M'Cormick, chairman of the Electric Light Committee, read the following letter from Mr. Hammond: "With regard to the various quotations I have

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obtained for a 50-kw. 1,000-volt alternator, I consider that the choice lies between the following two offers: (1) General Electric Light Company. This is quite a new machine, price £224 net, delivered free in the port of Dublin; speed, 900 revolutions per minute. (2) Crompton and Co., Limited. This machine is second-hand; the exciter is driven by belt; price £132, less 2½ per cent. cash discount; 2 O.R. Bray; speed, 300 revolutions per minute. I have arranged for one of my assistants to visit Chelmsford to-morrow morning, and after carefully examining the second-hand machine offered by Messrs. Crompton and Co., he will telegraph you fully as to its present condition, efficiency, and its general suitability for your requirements." It was decided: "That the report of the Electric Light Committee be adopted, with the addition that the chairman of the Board and the chairman of the Electric Light Committee be empowered to accept an estimate for a 50-kw. alternator if recommended by Mr. Hammond."

Glasgow.—The minutes of the Cleansing Committee adopted at the last City Council meeting stated that the superintendent submitted a plan showing a proposed extension of destructor furnaces at Crawford-street works, comprising furnaces of modern type, two Lancashire boilers, clinker-screening plant, and electrical installation, and explained that with that extension of furnaces worked on the continuous system he would be able to cremate an additional 15,000 tons of refuse per annum, and that sufficient steam would be generated to drive all the machinery of the dispatch works, the clinker crushing and screening plant, and the electric dynamo—thus admitting of the existing boiler being removed. He further explained that, as compared with the present method of disposing of the refuse at Fulwood Moss, exclusive of cost of manipulation at dispatch works, he anticipated that a considerable saving would be effected from (1) revenue from additional clinkers produced; (2) substitution of electric for gas light; and (3) abolition of hand-fired boiler, and substitution of boilers heated from wasted gases of destructor furnaces; and that he approximately estimated the cost of the extension at £5,500, of which sum £2,000 has been provided for in the estimates for the current year, but would not be exceeded during that time. The sub-committee, after consideration, agreed to recommend that the proposed scheme of extension be approved of generally, and that detailed plans be prepared for submission to a future meeting.

Manchester Telephones.—The draft scheme has been published for the establishment of a joint Board under the proposal to set up a municipal telephone service in the Manchester telephone area. The area within which it is proposed to establish telephonic communication is as follows: The city of Manchester, the county boroughs of Salford and Stockport, the borough of Eccles, and the urban districts of Alderley Edge, Altrincham, Audenshaw, Ashton-upon-Mersey, Bowdon, Cheadle and Gatley, Denton, Droylsden, Failsworth, Gorton, Heaton Norris, Knutsford, Levenshulme, Moss Side, Prestwich, Reddish, Swinton and Pendlebury, Sale, Stretford, Urmston, Whitefield, Worsley, Withington, and Wilmslow. The scheme was submitted to the City Council on Wednesday. It is intended under the Bill to be introduced into Parliament to ask that the Postmaster-General may be empowered to grant to the joint Board a license authorising them to provide a system of public telephonic communication within the area or within such smaller area within those limits as may be defined in the intended Act or license, and to authorise the Board to accept such license and to exercise and do all such acts and things as may be necessary or proper for carrying the license into effect, and to empower the Postmaster-General to extend, alter, or amend any license or to grant new or additional licenses. Powers to carry the telephone wires through the necessary streets and highways are also to be asked, subject to restrictions with regard to overhead wires and other matters.

St. Pancras.—At the last meeting of the Borough Council a report was read, which stated that in consequence of the delay on the part of the London and North-Western Railway Company with regard to determining whether or no they would provide a railway siding into the Harmood-street site, it was now too late to seek compulsory powers this session. In these circumstances the chief electrical engineer had been asked what additional plant could be installed at King's-road sufficient to carry over the demand for current to the winter of 1902, without taking the houses fronting on Great College-street or building an additional chimney shaft. To effect this the chief electrical engineer proposed that so much of the engine-room be constructed (in accord with original plan) as shall accommodate 2,200 h.p., including the necessary boilers and auxiliary plant. To do this they should demolish only the two houses in Pratt-street owned by the department, and cut off some 25ft. of yard from 96 and 98, Great College-street, and absorb the portion of the destructor yard and mess-room. Regarding the capacity of the existing chimney, Mr. Baynes estimated they could press it up to about 1,200 h.p. more, and if then it did not respond to their further needs of 2,200 h.p., they could obtain the required results by shutting off the dust destructor, only during the hours of full load, for about five weeks nearing Christmas time. It would be conceded that this would not be much of a hardship, whilst it permitted of a great benefit on account of saving in capital. Roughly, Mr. Baynes estimated the cost of providing the 2,200 i.h.p., with buildings and complete equipment of all auxiliary plant, at £35,000. The committee had appointed a small sub-committee to make enquiries upon what terms the head lease of 77 and 79, Pratt-street and the portions of the yard at 96 and 98, Great College-street could be acquired. In the meantime the committee recommended that the Council approve of the extension of the King's-road works on the lines indicated, and that tenders be invited for carrying out the work. After discussion the committee's proposals were agreed to.

Various Contracts.—The International Electrical Engineering Company, of Clun House, Surrey-street, Strand, W.C., inform us that, amongst other large contracts, they have in hand the following: Dundee Gas Commissioners, one 500-kw. traction steam dynamo with Willans engine; Hull Corporation, one 300-kw. traction steam dynamo with Belliss engine; Erith Urban District Council, three three-phase steam alternators with Allen engines and one three-phase main switchboard; British Xylonite Company, two 250-kw. three-phase slow-speed steam alternators of a new design, the poles being outside the armature, and main switchboard, and about 30 motors, ranging from 3 b.h.p. to 120 b.h.p., with all necessary controlling switches (the engines will be by Easton and Co., of the Schmidt superheated steam system); Messrs. J. and E. Hall, Limited, Dartford, Kent, one 100-kw. slow-speed continuous-current flywheel-type dynamo, and six motors, ranging from 5 b.h.p. to 18 b.h.p., also specially-designed electrical travelling block; Bahia Blanca and North-Western Railway Company (to the order of Messrs. Mordey and Dawbarn), four electric capstans specially designed with revolving table so that all the mechanism can be readily examined; also 20 motors, ranging from 5 b.h.p. to 25 b.h.p., complete with controllers for driving cranes, traverser capstans, etc.; Stevenson's Yard, Hebburn-on-Tyne (to the order of Messrs. Warren, Beattie, and Co., Middlesbrough), 39 continuous-current motors, ranging from 5 b.h.p. to 60 b.h.p., each complete with controlling switch; Scottish Co-operative Society, Glasgow and Leith, 10 continuous-current motors, ranging from 1 b.h.p. to 12 b.h.p., complete with starting switches. Also work for the central stations of Glasgow, Colne, Middleton, Bloemfontein, the Cape Town Electric Lighting Company, Birmingham Tramways Company, etc. Also complete transmission of power installation for the Hasard Colliery, the Noel-Sar Culpart Colliery, and for three coal mines at Gilly, near Charleroi. The latter contract includes two 600-h.p., slow-speed, three-phase, 3,000-volt steam alternators, three 200-h.p. motors, one 130-h.p. motor, and many smaller motors, etc. There is about eight miles of transmission line, and the total contract price is nearly £20,000.

Hertford.—Although the formal opening of the works of the North Metropolitan Electrical Power Distribution Company for supplying Hertford with electric light will not take place till the proposed street-lighting is ready and other arrangements have been completed, the ceremony of "switching on" was performed by the Mayor on Monday evening. The *Hertford Journal* says: "Through the courtesy of Mr. Gatrill we are able to give the following particulars: the site of the power-house has been carefully selected, and possesses the advantages of being alongside the River Lea, giving barging facilities, and is in close proximity to two railway goods yard. It is intended to run a railway siding into the works alongside the coal bunkers. At present the coal is shot through sliding doors into the bunkers from a raised roadway, and is taken from them as occasion requires by means of balanced doors opposite the furnaces. The boiler-house is 28ft. 6in. by 45ft. 4in., and the height varies from 18ft. 3in. to 28ft. 6in. A storage tank capacity of 1,200 gallons forms a roof over the stoking floor. The roof over the bunkers is glazed, and makes the boiler-house light, a great advantage in comparison to many boiler-houses of the present day. Here are installed two water-tube boilers by Babcock and Wilcox of 1,204 square feet heating surface each, both capable of evaporating 3,800lb. of water per hour from cold feed to a working pressure of 160lb. per square inch. The grate area is 25 square feet, and natural draught is used. The furnaces are designed for Yorkshire coal, and both boilers are fitted with superheaters capable of imparting many degrees of superheat to the steam after it leaves the boilers. The waste gases are taken away by a main flue and a steel stack, mounted on a brick and masonry base. The shaft is 4ft. 9in. inside diameter at the top, which is 70ft. above the ground level. Foundations are in position for a duplicate pair of boilers, and flue accommodation is provided for them. The feeding arrangements comprise two Weir's patent differential feed pumps, which have a capacity of 7,600lb. of water per hour, with and against 160lb. boiler pressure. The feed pipes are duplicated, one range for cold feed and the other for hot through a Wheeler feed heater, which economises the waste heat in the exhaust steam from the auxiliary plant. The hot and cold feeds can be used instantly, either separately or simultaneously. The top of the main flue has been paved, and provides ready means of access to the superheater gear and for boiler-cleaning purposes. The engine-room is reached from the boiler-house by a flight of steps, and is 46ft. by 25ft. 9in., by 23ft. 9in. high to the base of the roof trusses, and is fitted with a five-ton overhead travelling crane by Messrs. Carrick and Ritchie. The present generating plant consists of two Raworth-Mordey steam dynamos, manufactured by the Brush Company, of Loughborough, each set developing 100 kw., either condensing or non-condensing, at a speed of 300 revolutions a minute, and being designed to withstand an overload of 25 per cent. without sparking, with the brushes fixed in one position. The dynamos are four-pole, and wound with Mordey's patent chord winding, and are designed as traction generator, if necessity arises. Foundations are provided for an extension 200-kw. set of similar design, to be installed at an early date. At one end of the engine-room are two 20-kw. balancers direct coupled to two 10-kw. boosters for battery charging. The exhaust pipes from the engines are taken direct into the basement, into the exhaust main running the length of the condenser room, whence the steam passes off either to the atmosphere or through an oil separator to a Blake and Knowles jet condenser and air pump. The suction water is drawn from the River Lea, whence it is returned with the addition of the condensed steam Provision is here made, as elsewhere, for extensions. The main switchboard, built by Veritys, Limited, of enamelled slate, is arranged on the three-wire system, separate panels being provided for generators, regulators, accumulators, and feeders, the pressure at various points in the distributing network supplying the town being recorded by pilot meters. Provision has been made for extension of the switch gear. Next to the engine-house is the accumulator-room, in which are erected 250 Hart cells, in glass boxes arranged in two tiers. This battery will be used as an emergency reserve, and also to supply the town when the main generators are not running. From the main switchboard, triple-concentric feeder cables run direct to various feeding points in the town, whence the current is dis-

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tributed to consumers by means of networks of three-core cables. Disconnecting boxes placed in brick pits with iron covers provide means of access to the mains for testing and disconnecting purposes. All the mains are Messrs. Callender's well-known vulcanised bitumen-sheathed cables, laid in tarred wooden troughing filled in solid with bitumen. The service are similar cables, 'T' jointed on to the distributors, and terminate on the consumer's premises in cast-iron cut-out boxes, which, together with the meter and demand indicator, are fixed on one board, making a neat and very compact arrangement All the company's apparatus is sealed, and is kept in order by them. Services are put in free of charge up to 60ft. in length. The charge for current is 7d. per unit for any quantity of electricity up to an amount which would be consumed in 100 hours by the maximum number of lights burning at any one time during the quarter. All current used in excess of this is charged at 2d. per unit. Under this system the small consumer gets the light as cheaply as the large consumer. A separate building from the works includes a storeroom, offices for the engineer and his assistant, and general and pay offices. The building work has been carried out by Messrs. Ekins and Co., of Hertford."

PROVISIONAL PATENTS, 1901.

Nov. 4.

22152. Improvements in electric cable conductors. William Ernest Hitch, 40, Station-road, King's Heath, near Birmingham.

22183. Connections for telephone exchanges with automatic switching off of the operator's telephone. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actien-Gesellschaft Mix und Genest, Germany.)

22188. An aerial and electric overhead railway. C. E. Borchgrevink, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

22219. Improvements relating to electric telegraphy. Donald Murray, 323, High Holborn, London.

22220. Improvements relating to perforators for electric telegraphs. Donald Murray, 323, High Holborn, London.

22223. Improved electric igniter for internal-combustion engines. Pierre Mauguin and Henri Paul Martin, 47, Lincoln's-inn-fields, London.

22224. Improvements in electrical steering gear for ships. The Hon. Reginald Thomas Dudley Brougham, 24, Southampton-buildings, Chancery-lane, London.

Nov. 5.

22279. Improvements in electric motor control systems. Albert H. Armstrong, 83, Cannon-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 8, 1901, being date of application in United States.) (Complete specification.)

22290. Improvements in or relating to outlet boxes and terminals for electrical conduits. Alfred George Brookes, 55, Chancery-lane, London. (Robert McKean Thomas and Hobart Dominic Betts, United States.) (Complete specification.)

22298. Improvements relating to electro-dynamic traction. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Julien Dulait, Leon Rosenfeld, and Constantin Zelenay, Belgium.)

22303. Improvements in and relating to secondary batteries. Pascal Marino and Guy Marino, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

Nov. 6.

22367. Improvements in automatic guards or protectors for electric or other tramway cars and the like. William Dewar, 41, Reform-street, Dundee.

22371. Improvements in and appertaining to trolley heads of electrically-propelled vehicles. William Alphonsus McKnight and Edmund Gormly, 8, Lombard-chambers, Bixteth-street, Liverpool.

Nov. 7.

22422. Improved trolley for electrically-propelled tramcars. Aaron Jonah Jacobs, 8, St. Paul-street, St. Pauls, Bristol.

22439. An improved combination pocket tool for use by electrical engineers. Francis Bernard Weetman, 70, Market-street, Manchester.

22472. Improvements in electrical cables, and method of and apparatus for manufacturing them. George Edward Heyl-Dia and Archibald Frank Stevenson, 6, Lord-street, Liverpool.

22477. Improvements in electric dynamometers. George William Johnson, 47, Lincoln's-inn-fields, London. (Hartmann and Braun, Germany.)

22482. Improved process or processes for coating or impregnating conducting materials, such as iron, with minute particles of other materials, such as carbon, by means of electric currents. Jasper Wetter, 37, Essex-street, Strand, London. (Hugo Bremer, Germany.)

Nov. 8.

22497. An attachment to the spindle of the pulley of the trolley pole to guide the said pulley in catching or connecting with the overhead wire in electric traction. Joseph Greaves, 106, Brompton-street, Oldham.

22540. Improvements in electric rheostats. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frederick Mackintosh, United States.) (Complete specification.)

22541. Improvements in air-pump governors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Samuel B. Stewart, United States.) (Complete specification.)

22542. Improvements in electric air compressors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Asa F. Batchelder, United States.) (Complete specification.)

22543. Improvements in systems of electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

22544. Improvements in circuit breakers for electric currents. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Robert H. Read, United States.) (Complete specification.)

22545. Improvements in incandescent electric lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (John W. Howell, United States.) (Complete specification.)

22546. Improvements in systems of electric motor control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Alexander S. Garfield and Carlos E. d'Ornellas, France.) (Complete specification.)

22582. A new and improved telephone system. Gustav Amberg, 77, Chancery-lane, London. Complete specification.)

Nov. 9.

22586. Telephone note register. Walter Park Little, 30, South-street, Exeter.

22597. Improvements in life-saving guards for electric tramcars and the like. William Gibson Primrose, 17, St. Ann's-square, Manchester.

22620. Improvements in electric tram and railways. Robert Hacking, Augustus Wyvill Hancock, and John Leighton, 24, Southampton-buildings, Chancery-lane, London.

22622. Explosive detonat fog and electric wire signals for the engineman and signal box. Charles Gladwin, 65, Pilsworth-buildings, Kilton-road, Worksop.

22640. Improvements in automatic apparatus for controlling and operating the points of electric railways and tramways. Thomas Bell Stewart and William Herbert Turner, 8, Quality-court, Chancery-lane, London.

22647. Improvements in electric motor control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

22658. Controlling apparatus for electrically-propelled trains. Coloman de Kando, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 30.

1900.

20573. Electric controllers. Harfield.

21909. Wireless telegraphy. André Eugène Blondel. (Date applied for under International Convention, May 3, 1900.)

23254. Telephone systems. Sleebos.

23397. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Steinmetz.)

1901.

180. Telephone index boards. Davidson.

365. Electric car trolley head. Littler.

6445. Switch mechanism more especially applicable for use in electric motors. Lamm.

13048. Electrodes for accumulators. Tribelhorn.

13563. Transmission of electrical energy. Lake. (Tesla.)

15816. Storage batteries and alarms therefor. Lloyd.

15817. Storage battery boxes or jars. Lloyd.

15819. Storage batteries and ventilation thereof. Lloyd.

16128. Electric accumulator batteries. Tribelhorn.

18246. Magnetic separators. Scholl.

18331. Systems of electric motor control for electric railways or trains. Case. (Date applied for under International Convention, Feb. 15, 1901.)

19062. Conduits for electric railways and the like. Connett.

19226. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Edwards.)

19228. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Everest.)

19245. Dynamo-electric machines. Schneider.

19509. Electric cables. Bennet and Johansson. (Date applied for under International Convention, March 29, 1901.)

19761. Underground conductors for telephones, telegraphs, or the like. Somssich.

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TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Nov. 9	615	577	+ 38	18,781	16,921
Birmingham Tramways	,, 9	4,125	4,490	+ 365	203,500	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 8	482	437	+ 45	22,755	20,223*b*
Blackpool Corporation	,, 7	271	253	+ 18	35,720	26,782
Blackpool-Fleetwood Tramways	,, 9	184	170	+ 14	19,845	19,256*b*
Bolton Corporation	,, 10	1,342	1,269	+ 73	65,649	54,091*b*
Bradford Corporation	,, 10	1,001	673	+ 328	40,640	20,376
Bristol Tramways Company	,, 8	3,653	2,941	+ 712	—	—
British Electric Traction—						
Croydon	,, 8	462	272	+ 190	14,494*b*	3,442*a*
Devonport	,, 8	394	—	—	8,027*c*	—
Dudley-Stourbridge	,, 8	598	516	+ 82	29,739*b*	14,206
Gateshead	,, 8	606	—	—	15,954*i*	—
Greenock-Port Glasgow	,, 8	207	—	—	970*e*	—
Hartlepool	,, 8	211	198	+ 13	10,291*b*	9,001
Kidderminster	,, 8	91	92	- 1	5,566*b*	4,899
Merthyr	,, 8	198	—	—	7,978*f*	—
Oldham-Ashton	,, 8	431	460	- 29	22,546*b*	19,350
Poole	,, 8	223	—	—	9,161*f*	—
Potteries	,, 8	1,362	1,214	+ 148	62,962*b*	44,234
Southport	,, 8	126	158	- 32	7,497*b*	10,215†
South Staffordshire	,, 8	670	790	- 120	34,978*b*	32,582*a*
Swansea	,, 8	398	402	- 4	19,908*b*	15,692
Taunton	,, 8	56	—	—	1,057*g*	—
Tynemouth	,, 8	195	—	—	9,581*h*	—
Wolverhampton District	,, 8	78	106	- 28	2,933*b*	2,281
Carlisle Tramways Company	,, 9	129	152	- 23	3,652*b*	3,592
Central London Railway	,, 9	6,974	5,699	+ 1,275	113,976	—
City and South London Railway	,, 10	2,505	1,847	+ 657	37,170	30,242
Cork E. T. and L. Company	,, 7	416	382	+ 34	21,006	18,643*b*
Darwen Corporation	,, 8	194	176	+ 18	8,500	6,959
Dover Corporation	,, 9	170	185	- 15	9,931	9,429*b*
Dublin & Lucan Electric Railway	—	—	—	—	—	—
Dublin U. T., electric cars	,, 8	3,372	3,511	- 139	—	—
Dublin S. District, Electric	,, 8	742	751	- 9	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	—	—	—	—	—	—
Halifax Corporation*	,, 10	1,818	1,414	+ 404	36,877	24,939
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 9	1,576	1,357	+ 219	33,411	26,311
Liverpool Corporation	,, 2	9,167	8,556	+ 611	396,644	348,859*b*
Liverpool Overhead Railway	,, 10	1,390	1,541	- 151	30,725	31,996
Portsmouth Corporation	,, 9	319	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 10	3,378	—	—	—	—
Southampton Corporation	,, 7	780	693	+ 86	—	—

a Part. *b* From Jan. 1. *c* From June 21. *d* From April 1 *e* From Oct. 3. *f* From April 5. *g* From Aug. 21. *h* From March 22. *i* From May 8. * Fortnightly. † Reconstructing.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £165 increase.
Barcelona Ensanche y Gracia, £23 decrease. Barcelona, £94 increase.
Brisbane, £197 increase.
Buenos Ayres and Belgrano Electric, £833 increase.
Calcutta, £134 increase.
Cape Town (month of Oct.), receipts, £14,063; expenditure, £6,817.
La Capital Traction and Electric, Buenos Ayres (month of Sept.), £5,880 increase.
Mexico Electric (month of Oct.), receipts, £17,400; expenditure, £10,100.
Perth Electric, £150 increase.
Port Elizabeth (month of Oct.), receipts, £3,240; expenditure, £1,960.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	3/4-7/8
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	1/2-3/4
—— Ordinary, 1-125,000	1 ..	1/8-1/4
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-5¾
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5-5½
Brush Electrical Engineering, Ordinary	2 ..	1⅞-1⅞
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	112-116
—— Ordinary	5 ..	16-17
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	3/4-7/8
—— 5 per cent. Debentures	5 ..	1½-2½
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10½
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	23-24
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	37-41
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref.	5 ..	5½-6½
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	3/4-7/8
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-102
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10½
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	7⅞-8¼
—— 7 per cent. Preference	5 ..	8¼-8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7¼-8¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10½ xd
Charing Cross and Strand"	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5-6½
—— 40,501-50,936	5 ..	4⅜-5¼
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9¼-10¼
—— 6 per cent. Cumulative Pref.	10 ..	11¼-12¼
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	104-107
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5⅛-6
—— 6 per cent. Cum. Pref.	5 ..	5⅛-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4⅜
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5⅜
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10¼
London Electric, Ordinary	3 ..	1⅛-1⅜
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	113-116
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15¼-16½
Oriental, 1879	1 ..	1⅛-1⅜
—— £5 Shares	5 ..	7⅜-8¼
—— £4½ Shares, New	4½ ..	7-7½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-2⅜
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11¼-12¼
Electric Railways.—		
Central London, Ordinary	100 ..	108-111
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	107-110
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	55-58
—— Ordinary	10 ..	5-5¼
—— 4 per cent. Debenture Stock	100 ..	113-118
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, '96	100 ..	125-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	3⅞-4⅛
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-128
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2⅞-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6-6¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11⅞-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	121-124
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¼-2¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅝
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
—— Prov. Cert., all paid	100 ..	100-103
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅞-2⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	8-8¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	104-106
New General Traction, Ordinary	5 ..	2¼-3⅛
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	98-102
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10⅜
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-10¼
—— 4½ per cent. Debenture Stock	100 ..	108-111
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8s. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Telephones.—		
National Telephone, Ordinary	5 ..	4¼-4⅜
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-4⅜
—— 4 per cent. Deb. Stock, Red.	100 ..	96-99
—— 3½ per cent. Deb. Stock, Red.	100 ..	96-99
Oriental Telephone and Electric Company	1 ..	15/16 1 1/16

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NOTES.

International Telephones.—It is reported that the telephone line connecting Milan, Turín, and Paris is nearing completion, and will shortly be opened. This line passes over Mont-Cenis. It will be the first international telephone connection with Italy. Connection is also to be established between Milan and Zürich, to complete which there remains only the section between Como and Chiasso to construct.

Physical Society.—The above society has received an offer from Mr. William Ford Stanley (a Fellow) of £500 worth of ordinary stock, fully paid up, in the London, Brighton, and South Coast Railway Company. At a special meeting of the society, to be held this evening at Burlington House, a resolution will be proposed that the offer be accepted, and that the shares be held upon the trusts declared by a deed poll.

Projected Edinburgh Exhibition.—The proposal to hold an international exhibition in Edinburgh is assuming definite shape. A meeting of representative citizens of the Scottish capital has agreed that the exhibition shall be held in 1907, and we understand that application is to be made at once to the Corporation to grant the use of the West Meadows and the lower part of Bruntsfield Links as the most suitable site for the buildings.

Treatment of Diseases by High-Frequency Currents.—We are pleased to hear, according to a paper read before the West Kent Medico-Chirurgical Society by Dr. Thomas C. Meggison this month, that high-frequency electrical currents have been successful in the treatment of the following diseases: pulmonary tuberculosis, tuberculosis of joints, tuberculous laryngitis, lupus, eczema, psoriasis, rodent ulcer, malnutrition from rickets and dyspepsia, sciatica and neuralgia, and diabetes.

Army Electricians.—In military circles in America the opinion seems to be that there is a good opening for electricians in the United States Army. We see that the matter has been brought to the notice of the authorities, and in an appendix to a departmental report just issued it is stated that all officers employed to operate the mining defences of harbours should have a thorough understanding of both theoretical and practical electricity. The appendix further makes a suggestion that a volunteer reserve should be organised, and officered by electrical engineers who are graduates of technical schools.

Acetylene Lighting.—We note that a new syndicate of carbide of calcium producers has been formed on the Continent "for the benefit of the industry in general." The new organisation is stated to be constituted on a firmer basis than that of the unsuccessful syndicate which was created a year ago, as the outstanding works have been induced to participate in the enterprise. It is proposed in the first place to increase the price of carbide of calcium, and, therefore, the cost of acetylene gas lighting, but the question of counteracting this scheme is reported to be engaging the attention of large consumers.

Electric Automobile Construction.—From experience gained in some exhaustive tests carried out on the Continent, a Mr. Mueller lays down the following general rules for the construction of electric automobiles. First of all, the wheels should have large diameters. Then both the wheels and axles should be light, and as much as possible free from other parts of the construction. The carriage springs should have a large variation of form, with a small variation of load. The upper part of the automobile, with all its accessories, should be a self-contained unit. In concluding his remarks, the experimenter says that while these rules are often not followed in the German automobile industry, certain types of American machines are very near to fulfilling all these conditions.

Berlin.—The company which is experimenting with high-speed electric traction on the military railway between Marienfelde and Zossen have met with a degree of success which augurs well for the future of the undertaking. According to the records kept by the two automatic speed indicators employed, the speed attained by the car reached a maximum of 160·2 km. per hour during a recent trial trip. The engineers concerned are naturally jubilant. Neither the permanent way nor the equipment of the car seem have suffered so far, and it is therefore intended to increase the speed still further, even with the present overhead wires. The greatest difficulty disclosed by such high speeds has been the air resistance, to overcome which motors capable of a normal output of 1,100 h.p. and a maximum of 3,000 h.p. have been found necessary.

Electrical Navigation Lights.—A novel electrical system for providing for the safe navigation of the St. Lawrence River between Montreal and Quebec, Can., at night time, is the subject of a recent patent in that country. The main idea seems to be to sink an electric cable in the centre of the navigable channel, and to have two lines of electric lights supported by cork floats, one on each side of the channel, at or above the water-level. Power would be transmitted from Montreal, and it is proposed to have the lights on one side of the channel of a different colour to those on the other side. The arrangement aims at doing away altogether with the use of lighthouses for the night navigation of the St. Lawrence, but of course, the system, if successful, could be applied to any inland navigable waters.

New Appointments.—We are pleased to see that Mr. H. H. Simmons, who for several years has successfully conducted the local department at the Goldsmith's Institute, New Cross, has now been appointed senior demonstrator at the Finsbury Technical Institute. This position, which is really that of first assistant to Prof. Silvanus P. Thompson, is a most responsible one, and we wish Mr. Simmons the same success in his new sphere which he has already achieved at New Cross.—We understand that the vacancy on the staff of the Northampton Institute caused by the retirement of Mr. John Ashford, the head of the mechanical engineering and metal trades' department, has been filled by the appointment of Mr. Charles E. Larard, A.M.I.C.E., A.M.I.M.E., the head of the civil and mechanical engineering department of the Huddersfield Technical College.

Electrical Illuminations in Canada.—We hear that during the visit of the Prince and Princess of Wales to Canada—or the Duke and Duchess of Cornwall, as they then were—no less than 135,000 incandescent lamps were brought into use for electrical illuminations over and above the regular service in the three cities of Montreal, Toronto and Ottawa. In fact, the illuminations appear to have been on a most elaborate scale, and reflect much credit not only on the authorities responsible for the electrical decoration of the public buildings, but also on the electrical firms who were called upon to carry out the work and supply current. Perhaps the most pleasing feature about the electrical displays, involving an expenditure of £25,000 and the use of thousands of horse power of current in the three cities referred to, was that not a single accident occurred, nor did any of the illuminations fail.

Trade Exhibition in the Bahamas.—Early in 1902 a twentieth century trade novelties' exhibition will be held in the Bahamas, under the auspices of the leading professional and business men of the colony. A circular

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letter which has been issued to British manufacturers and exporters draws attention to the opportunity the exhibition will afford to manufacturers of bringing their goods before the people of these islands. It is proposed to hold the exhibition in Nassau, opening on Feb. 10 next, when the city is most crowded with American, Canadian, and English visitors. Sir Gilbert T. Carter, the governor of the colony, has promised to perform the opening ceremony, and there is every reason to believe that the first exhibition ever held in the Bahamas will prove a huge success. All further information may be had from the Rev. F. W. Gostick, the organiser of the exhibition, Trinity House, Nassau, N.P.

Russian Tramways and American Proposals.—It appears that the municipal authorities of St. Petersburg, Russia, are receiving favourably the proposals of an American financier, a Mr. A. Verner, of Pittsburg, P.A., to buy up the whole of the existing tramways in the city with a view to reconstructing the same for electric traction. We gather from our American contemporaries that Mr. Verner's proposal is, briefly stated, to organise a company under the laws of Russia with a capital of about eight millions sterling, and to issue bonds to the same amount. He would agree to complete the conversion of all existing lines to electric traction within four years from the date of the franchise. The overhead trolley system would be adopted, and double-deck cars would be abolished to make room for "trains" with three separate classes. A useful stipulation is that Russian materials and Russian engineers should be employed as far as possible. Among other proposals it is suggested that the Municipality should have the right to purchase at the end of 25 years, again after lapse of an equal period, and thereafter every 10 years.

The Great Siberian Railway.—Mr. J. M. de Lodijensky, Commissioner-General of the Russian Section, Glasgow Exhibition, has sent us an official pamphlet dealing with the subject of the construction of the Great Siberian Railway, which is eventually destined to place Europe in direct railway communication with the port of Vladivostok, on the Pacific coast of Siberia. The first stone of this uninterrupted line of railway across the whole of Siberia was laid by the Czar in March, 1891, and by 1901—*i.e.*, for 10 years of construction—3,800 miles of lines were laid down—viz., 380 miles a year. The total cost of the railway will amount to 80 millions sterling, of which 58 millions were expended by 1901, and about 9½ millions have been assigned for the current year. However large this total may seem, the feeling in Russia is that it is insignificant in comparison with the advantages held out to that country by the exploitation of the shortest railway route between the Atlantic and the Pacific, in conjunction with the stimulation of the rich productive powers of a vast country like Siberia, and the development of Russia's commercial intercourse with the countries of Eastern Asia.

Californian Water Power.—The Mammoth Power Company, of California, which is planning for the construction of a large water-power plant on the San Joaquin River, proposes to deliver in San Francisco 50,000 h.p. over a distance of 180 miles. We understand from the *Western Electrician* that the territory located by the company for the main drainage area comprises about 1,000 square miles. The extreme elevation of this territory is about 13,000ft., and the lowest point, or where the intake to the tunnel is to be located, is 3,500ft. above the level of the sea. In this large area are many sites for storage reservoirs, to be utilised in case of a series of dry seasons. It is proposed to locate the power-house 21 miles from the intake, and the water to furnish the power will be conveyed in a series of tunnels from the intake to the power-house. These tunnels, of which there will be 45, will be cut through solid granite, and each will be 8ft. or 9ft. in diameter, having a fall of 7½ft. to the mile. From a point on the mountain, about a mile away from the power-house, the water will be conveyed down the slope to the power-house, 1,730ft. below, through an inclined tunnel, and after doing its work it will be conducted back to the river again.

Stuttgart.—The introduction of electric traction on the Filder Railway is reported by the West Germany Railway Company to be making good progress. The rack section between Stuttgart and Degerloch and the adhesion section connecting Degerloch, Mohringen, and Vaihingen, together 5½ miles in length, are to be first equipped. In view of the eventual conversion of the remaining sections, a central position has been selected for the power-house. In this power-house alternating currents will be generated at a pressure of 6,000 volts for transmission to sub-stations, where rotary converters will transform these currents into continuous currents at a pressure of 600 volts for the line. Both the adhesion and the rack sections are to be worked by motorcars and not locomotives. These cars are so arranged that the motors will act as generators downhill, returning current to the accumulators provided in the transformer sub-station. Another interesting feature of the undertaking is that the generating plant is designed to supply not only the requirements of the line, but also energy for lighting and power purposes to factories and townships, etc., within a radius of 16 miles. Provision has been made for an eventual large demand from these extraneous sources.

London Chamber of Commerce.—The Right Hon. Lord Brassey, K.C.B., is to give an address on the "State and Requirements of the Navy" at a special meeting of the London Chamber of Commerce next Wednesday. The meeting is called for 2.30 in the afternoon in the hall of the Worshipful Company of Skinners, Cannon-street, E.C. Prospective arrangements of the chamber include a meeting on the 18th prox., when Mr. R. Percy Sellon (chairman of the Electrical Trade Section) will read a paper on "The Electrical Industry and Legislation: the Need of Revision." The second dinner of the session will take place next Wednesday, when the subject for discussion will be "Trade Marks"; and the third dinner is fixed for Jan. 15, the topic to be discussed being "British Commercial Interests in Japan." The chamber has now issued a prospectus giving information as to arbitration under its auspices. The following clause is recommended for adoption in all contracts, agreements, etc.: "All disputes which may arise relating to this contract shall be submitted to arbitration under the rules for the time being of the London Chamber of Arbitration." Arbitrations take place before the president, Mr. Thomas Hewitt, K.C., sitting alone, or before any other arbitrator chosen, or before three arbitrators, or two arbitrators sitting with an umpire, at the option of disputants.

Inner Circle Equipment.—The enquiry as to the electrical equipment of the Inner Circle by the Metropolitan and the Metropolitan District Railway Companies is now concluded. Elsewhere in this issue will be found the closing speech of Mr. Fletcher Moulton, summing up his case for the District Railway. The enquiry has been the means of eliciting much information as to the results which can be obtained by means of polyphase motors in railway working. Much of this evidence came almost as a surprise to electrical engineers in this country. We do not think we shall be far wrong in stating that the Ganz Company have been induced to improve their system to a point beyond their own expectations by the keen com-

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petition which they knew would arise from enquiry. It remains, after all, to be seen whether the decision will not be given on the grounds of the tried *versus* the untried. In any case the Ganz Company will, we understand, not be the losers, as it is stated that under their agreement the Metropolitan Company will order the electrical equipment for their portion of the Inner Circle from that company. It will be remembered that the Ganz Company equipped the Metropolitan Railway of Paris, using direct-current motors on the trains. The Hon. Alfred Lyttleton, the arbitrator in the enquiry, has to report to the Board of Trade, and we presume that in due course the Board of Trade will issue their decision in the matter, and will, we trust, publish the report in question at the same time.

Arbitration Clauses.—We notice on the agenda paper of the London County Council for Tuesday last a motion by Mr. Sears, to be seconded by Mr. Benn, which reads as follows: "That it be referred to the General Purposes Committee to consider and report as to the advisability of modifying the arbitration clauses in the Council's contracts, so that whilst questions affecting the conduct of the works should remain subject to the sole control and decision of the chief officers of the Council, questions of dispute relating to accounts and claims should be referred to an independent and outside arbitrator, and then only on the termination of the contract." At the time of writing we do not know how far this motion was agreed to by the Council, or even if it were discussed at all, but it is distinctly a move in the right direction. Any arbitration clause which makes an interested party, such as we are bound to consider the staff of the Council, the sole arbitrator, is not fair to parties tendering. Unfortunately the London County Council are not the only body at fault in this respect, as a number of specifications issued by electrical engineers contain the same objectionable clause. It is only right that the engineer drawing up the specification should have the sole control of the quality of the work to be done, but there are financial questions arising out of nearly all specifications which may sometimes require the opinion of an outside and independent arbitrator. We trust that the London County Council will modify their arbitration clause as suggested above.

Telegraphs and Telephones in New Zealand.—Official statistics of the New Zealand Post and Telegraph Department issued for the year 1900-1 show a steady growth in both the telegraph and telephone systems in the islands. On March 31, 1901—the close of the fiscal year—there was a total of 20,682⅝ miles of telegraph wire in use, as compared with 19,228 miles on the corresponding date in 1900. The number of offices increased during the year from 915 to 991. A total of 3,898,128 telegraph messages was transmitted, as against 3,469,631 for the previous year. The total revenue from the telegraph service amounted to £137,861, compared with £119,641 for the preceding year. During the period under review the telephone subscribers increased from 7,150 to 8,210, the total revenue from the exchanges amounting to £49,117. After deducting the working expenses, £45,348, a balance of revenue remained amounting to £3,768. The Wellington exchange—the largest in the colony—was reported in a satisfactory condition. An additional section, with a capacity of 300 subscribers, was added to the switchboard, bringing the total capacity of the exchange up to 1,800 subscribers. Two more sections have been ordered, which, when installed, will bring the capacity up to 2,400. The total number of subscribers connected up in Wellington on March 31, 1901, was 1,585, an increase of 168 for the year. The telephone lines of the entire colony are 545 miles long, and a total of 6,987 miles of wire has been strung. The departmental report further informs us that during the year 1900-1 the telegraphic submarine cables connecting the two islands were increased in length from 242 knots to 244 knots, and the cables used for telephonic purposes were increased from 8 knots to 11·6 knots.

Physical Properties of Liquid and Solid Hydrogen.—An instructive paper by Mr. James Dewar on this subject is abstracted in the current issue of the *Journal* of the Chemical Society as follows: "A helium thermometer has given 20·5deg. absolute as the boiling point and 16deg. absolute as the melting point of hydrogen. The lowest temperature recorded in gas thermometry is 14·5deg. absolute, but with solid hydrogen, with more complete isolation and lower pressure of exhaustion, it will be possible to reach 13deg. The latent heat of liquid hydrogen at its boiling point, as deduced from the vapour pressures and helium-thermometer temperatures, is about 200 units, and the latent heat of solid hydrogen is not greater than 16 units. From (1) the percentage of liquid hydrogen which has to be quickly evaporated in order to reduce the temperature to the freezing point, and (2) the latent heat of evaporation, the average specific heat of liquid hydrogen between freezing and boiling points has been found to be about 6. It thus appears that hydrogen obeys Dulong and Petit's law, and has a greater specific heat than any other known substance. The surface tension of hydrogen at its boiling point is about one-fifth that of liquid air under similar conditions, and about $\frac{1}{3\frac{1}{5}}$th that of water at the ordinary temperatures. Experiment gives 1·12 as the refractive index of liquid hydrogen, whilst the calculated value is 1·11. Thus the refractivity of hydrogen, like that of liquid oxygen and nitrogen, is in accordance with theory."

Charging Storage Batteries from Alternate-Current Mains.—Mr. F. J. Kock in an illustrated communication to *Elektrotechnische Zeitschrift* describes a new system of getting direct current from alternating-current mains. From a short abstract of the article in the "Digest" of the *Electrical World* it seems that if an alternating current with sinusoidal E.M.F. is converted by means of a synchronously revolving commutator, the E.M.F. of the current has a wave form which consists of a series of half sine waves of the same polarity, and the E.M.F. pulsates continually between zero and a maximum. Such a current is not adapted for charging a storage battery. Only those parts of the wave of E.M.F. are adapted for this purpose in which the E.M.F. is greater than the counter E.M.F. of the battery. The other parts of the current must be cut off by the commutator. The current which is supplied from the commutator to the battery has, therefore, the following wave form: it increases from zero to a maximum and decreases to zero, remains zero for an interval, increases then again to a maximum, and so on. He describes a commutator devised by him for this purpose. It is somewhat similar to a polarised relay. A special feature is the use of a condenser to counteract the effects of the self-induction of the coils of the commutator. To adjust the capacity and the self-induction relatively to each other he varies the self-induction by means of an auxiliary choking coil, the iron core of which is movable. The author claims that his commutator interrupts and closes the circuit exactly at those moments when the E.M.F. of the current supplied from the commutator is exactly equal to the converter E.M.F. of the battery. There are, therefore, no sparks at the point where the contact is made and broken. The magnet arms of the apparatus have two windings, one supplied with current from the battery, the other from the alternating-current mains. By properly adjusting these windings contact may be made only by the surplus of the

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alternating E.M.F. of the mains over the counter E.M.F. of the battery.

Glasgow Section Report.—In the fulness of time the committee of the above section of the Institution of Electrical Engineers have issued their first report, which deals with the doings of the branch from February, 1900, to November, 1901. As a matter of fact the committee ought to have rendered a report to the annual general meeting last May; but owing to the parent institution not being able to define the area till subsequent to the date of that meeting, the matter was delayed. We now find that the area allotted to this Local Section is defined as "that enclosed by a circle with a radius of 50 miles from Glasgow, excluding such portion of the circle as is situate to the east of the meridian 3deg. 30min. west longitude, with the understanding that in special cases where a more distant member (in Scotland) proposes to attend the meetings of the section, such cases should be specially considered by the committee of the section, and the member claimed if it is thought right." Under the above definition this section has the right to claim a total of 158 members of all standards, as against 104 in the previous year, showing an increase of 54 members. A point of interest in the report is that Mr. J. D. Cormack has resigned his place on the committee, owing to his acceptance of the chair of engineering at the University College, London. The officers for the session 1901-2 are: past-chairman, Lord Kelvin; chairman, Prof. Magnus Maclean; vice chairman, Mr. Henry Mavor; hon. secretary, Mr. E. George Tidd; ordinary members of committee: Messrs. A. R. Bennett, W. A. Chamen, M. B. Field, W. W. Lackie, William McWhirter, J. M. M. Munro, W. B. Sayers, and Thomas Young. The committee wish to point out that the success of the section will largely depend upon original contributions and the discussions on same, and the members are therefore urged to offer papers even if they are not of sufficient originality or importance to be published in the Institution *Journal*, as they might nevertheless be the means of introducing most valuable discussions.

Steam-Pressure Regulator.—We notice in the November issue of the *American Electrician* a description of an arrangement in use at the Joseph Dixon Crucible Company's works in connection with an electrical system of factory driving. The object of the device is to keep uniform steam pressure independent of fluctuations in the load. In passing, it may be interesting to note that the two Babcock-Wilcox boilers which are used in these installations are only designed for 90lb. steam pressure, which seems to us to indicate that the plant is much behind the times. Also, the boilers are hand fired. The automatic device consists of a diaphragm regulator which acts as the relay. If the steam pressure fall, it admits steam into an auxiliary cylinder, the piston of which operates the damper, opening it wide, and at the same time turns on a hot air blast to the fire. This hot air blast is fed by superheated steam, which passes through a pipe just under the cylinders of the boilers. The hot air and steam mixed is delivered usually under the firebars, but there is also a by-pass by which hot air can be admitted above the grate to aid in the combustion. We gather from the description that the device works only on the hit-and-miss principle—*i.e.*, either the damper is right over and the hot air blast is on, or else the hot air blast is off and the damper in its normal position. This seems to us to be somewhat of a difficulty, and the question arises as to how far, in a small installation with two hand-fed pumps, it is well to introduce an automatic device for keeping the steam pressure constant. The stoker has to be on the spot, and if he cannot secure regular steam pressure, it would perhaps be wise to look for a new man who can. We can quite see that with a large installation in which induced draught is employed an automatic arrangement of increasing the draught as the steam pressure falls would be of use, but it must be remembered that all these automatic arrangements will be of no use unless the fireman also keeps the fires in proper order, and sees that the extra fuel required is at once supplied. Otherwise the automatic device, although increasing the steam pressure automatically, will in the long run interfere with the regular working of the steam-raising plant.

Subways in Public Streets.—The disorganisation of the traffic of London caused by opening up streets to lay electric light wires, gas and water mains, etc., has been frequently commented on in our columns. The obvious solution of the difficulty appears to be that suggested by the London County Council of constructing subways in which all these services of public convenience could be placed. Unfortunately, there is a great obstacle in arranging such a system of subways and compelling the various companies to place their pipes and wires in the same. Of course, in a new street, such as the London County Council are now constructing from Waterloo Bridge to Holborn, there is no such difficulty, as the subway can be constructed in what is practically clear land, and then the pipes and wires required for the new street can be laid at once in the subway. The difficulty increases one hundredfold, however, when the conduits, and also a conduit for tramways, have to be made in a street the houses in which are already erected. In view of the large number of pipes required to be run along a street, the tramway conduit would have to be constructed at a considerable depth below the street level, and would, in consequence, disturb the foundations of the houses along the line of route. We have before us illustrations in an American journal of the excavation work which is now going on in New York due to the construction of these subways in the city. It would appear from the illustrations that the whole street is closed, the only traffic which is maintained being the electric tramcars. In order to support the heavy double tracks of the Metropolitan Street Railway lines, the contractors use a pair of steel or wooden trusses. The ends of the two trusses are given a firm footing on the natural soil, and transverse trenches are then cut beneath each of the cast-iron yokes that support the trolley tracks. Into these trenches are inserted 12 by 12 timbers, which are hung from the bottom chords of the trusses by stirrups of 1in. wrought iron. The excavation is then completed, leaving the track entirely supported by the trusses. As soon as the excavation is down to grade, 12 by 12 posts are placed beneath the transverse sills, leaving the trusses free to be moved forward from 40ft. to 50ft. as the case may be, and the operation repeated. It remains to be seen how far the London County Council will seek powers to make these conduits in the streets of London other than the one to which we have alluded.

Provisional Order Procedure.—We are pleased to see that the Convention of Royal, Parliamentary, and Police Burghs of Scotland have not succeeded in persuading the Board of Trade to alter the present mode of procedure with regard to electric lighting provisional orders. This convention recently forwarded to the Board of Trade a memorial which, amongst other things, contained a paragraph as follows: "That it would be in the interests of local authorities were it arranged that an electric lighting company, on giving notice of its intention to apply for a provisional order to introduce electric lighting, should produce, along with its application, the consent of the local authority to its obtaining such an order; but if the Board of Trade consider it advisable to retain its present power,

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it is submitted that the question of dispensing with such consent should be disposed of by the Board immediately after the notice to the local authority is given by the company, and thus afford sufficient time to local authorities to apply themselves for an order to introduce electric lighting into their communities if the Board consider its introduction advisable." In reply to this the Secretary to the Board of Trade has distinctly pointed out that the present method of procedure is fair both to companies and to local authorities. In an ordinary case an order is not granted unless the consent of the local authority concerned has been obtained, but there is every reason why these local authorities should not have an absolute veto on electric lighting matters, as is evidently wished by the memorialists in question. The secretary in his reply proceeds to point out that in the present procedure any company applying for an order has to serve the local authority with a notice some months before the application to the Board of Trade is actually made, and that this gives the local authority in question ample time to make up its mind as to whether it will ask for an order itself. As the matter stands now, the Board of Trade retain the right to consider whether the consent of the local authority should not be dispensed with in exceptional cases. This is only right, and we expect to find in the future cases arising in which provisional orders already granted the local authorities will be revoked where these have only been obtained to block out a company, and have not been put in force. We are sure that anyone looking at the matter impartially will find that the Board of Trade has acted most fairly in the question, and that, if anything, favour has been shown to the municipal electrical undertakers.

Military Telephones.—We notice in the *Gazette de l'Electricien* a long description of the military telephone system which has been devised by Captain Charollois, of the French army. In this article the editor points out that there are two systems of military telephones in use in France, the first of which is recognised officially, while the other, to which we refer above, is the outcome of private enterprise, and is not recognised as a Government system. The authorised military telephones are equipped with batteries, insulated wires, and other costly accessories, which are required to give a permanent connection in all states of weather between military outposts. The object of the system devised by Captain Charollois is, however, to obtain a cheap and regular connection between a moving force and headquarters. With this end in view, he uses an insulated wire, which in dry weather is laid direct on the ground. The diameter of this wire is only $\frac{6}{10}$mm, and its weight 8¾lb. per mile. This enables a man to carry some four or five miles of wire, which is wound on a drum, which can be of exceedingly light construction. Experiments are quoted to show that the system has been exceedingly successful, even when the wire has been laid on a road over which other troops have had to pass. In one instance some 17 miles were laid and taken up again in the course of a day. The whole question arises, however, as to how far this bare wire, with earth as return, is available in wet weather. We gather that Captain Charollois advises its being supported on trees or houses in times of rain, but it seems to us, after all, that an insulated wire laid on the ground is likely to be of more permanent service. Our corps of Electrical Engineers has obtained experience in telephone work in the South African War with the use of such insulated wire laid direct on the ground. It will be remembered that Colonel Crompton devised an attachment on a bicycle which enabled the wire to be rapidly paid out across the veldt. In this case the drum was arranged to carry about two miles of bare copper wire. It was found that a cyclist could ride along at the rate of 10 to 15 miles an hour and lay the wire behind him, without any fear of kinking or breaking. After use the wire was picked up by hand at the rate of about four miles an hour. The use of the telephone in South Africa has shown that with a bare copper wire, and using the earth as the return circuit, one can speak for three or four miles with the wire trodden into wet ground, and even with a broken wire. The Electrical Engineers Volunteers' contingent was eminently successful in the use of bicycles for laying the wires, and great advantage was derived from being able to provide speaking communication between two fixed points with such dispatch.

Electrical Wave Transmission.—Mr. Michael I. Pupin recently contributed to the Massachusetts Institute of Technology a paper wherein he gives the results of some experiments he has been making concerning the transmission of electrical waves over wire conductors. The author's claim is that by a proper distribution of inductance coils at periodically recurring points—say one-eighth of a mile apart along the line—the inductance reaction can be made very much larger than the resistance reaction for all frequencies which are of importance in telephony, and thus the dissipation diminished to any desired limit. He goes so far as to assert that this discovery may confidently be expected to result in telephonic transmission across the Atlantic. Mechanical analogy showed that it is more efficient to transmit energy over a heavy than a light cord, and that a cord, if periodically loaded, may be made equivalent within any degree of approximation to a heavier uniform cord. It is to be observed that the distance between consecutive loads must be smaller than the length of the wave which is transmitted. Other experiments suggested to the author, in the earlier stages of the research, the manner of attacking the electric problem. In any circuit the magnetic inductance (which does not dissipate energy) is limited. It is well known that coils of wires possess large inductance; consequently such coils should act for an electric circuit in the same way that sinkers do for a cord, and the problem of electrical wave transmission should reduce itself to the placing of inductance coils at proper periodically recurring points on the wire. In order that such a non-uniform or loaded conductor may act as a uniform conductor of large inductance, it is necessary from mathematical analysis to distribute the loads at periodic distances which are small in comparison with the length of the wave which is being propagated. Since electrical waves in telephony are many miles long, it was impossible for the author to carry out investigations on an actual line. An artificial cable, equivalent to 250 miles of line, was arranged in the laboratory at Columbia University, and inductances were placed at periodically recurring points. The current was measured, and the waves plotted for the 250 miles. Using several frequencies, the results of measurements were compared with the mathematical theory, and, according to the author, were in splendid agreement. The practical value claimed by him for this discovery is: (1) that wave energy for telephony and telegraphy may be transferred over much greater distance; (2) if the distance remain constant it enables wires of smaller size to be used, thus decreasing the cost of installation; (3) with the same weight of wire as in use at present, the distance of transmission may be greatly increased. We trust that the author is correct in his claim, but from the meagre details he gives it is impossible to draw conclusive deductions from his experiments.

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TESTS OF NERNST LAMPS.

In a recent number of the *Elektrotechnische Zeitschrift* there appeared an article by Prof. W. Wedding, in which the results of some experiments with Nernst lamps of different models, manufactured by the Allgemeine Elektricitäts-Gesellschaft, are given. The following is a translation of the same :

A. *Tests of a Number of Lamps to Determine the Accuracy of the Makers' Figures.*—These tests were made with a number of finished lamps in order to determine their

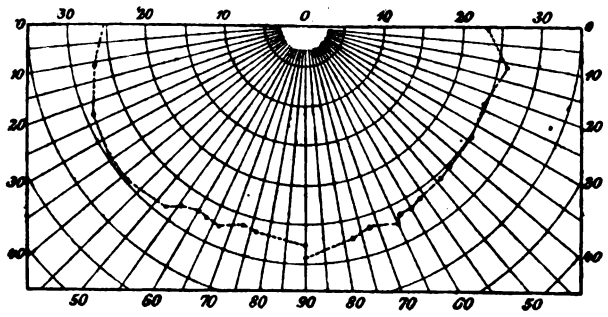

FIG. 1.

efficiency, and to check the values given by the makers relating to measurements taken in the factory without globes and to the light intensity for the hanging lamps in a horizontal direction at right angles to the axis of the electrode.

TABLE I.—Type B.

No.	Makers' figures. J_1.	K_1.	Tested values. J_2.	K_2.	T″.	—	Results. A.	A/K	Mean.
1	0·184	27	0·169	24·2	10·3″	Clear glass globe	37·18	1·54	1·45
2	0·18	25	0·177	27·3	9		38·94	1·43	
3	0·385	54	0·359	55·1	20·9		78·98	1·44	
4	0·395	52	0·347	54·9	35·4		76·34	1·39	
5	0·19	26·5	0·185	25·6	8·2	Frosted glass globe	40·7	1·59	1·70
6	0·365	55	0·302	36·7	68·9		66·4	1·81	

In Table I. the figures given by makers for the current and candle-power are listed respectively under J_1 and K_1,

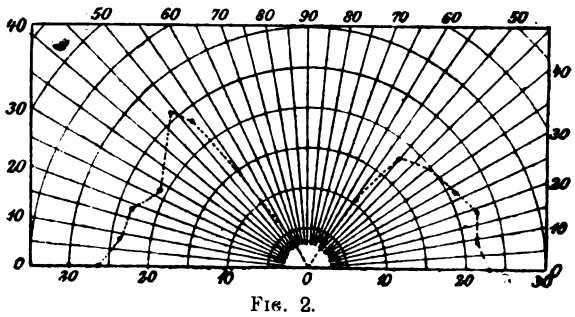

FIG. 2.

while under J_2 and K_2 are given the values obtained from tests with the lamps enclosed in globes. The time required for ignition—T in seconds—is also stated. From the ratio of the consumption in watts, A, to the candle-power, K, we obtain the value $\frac{A}{K}$ as the specific consumption in watts per candle. The voltage of the lamps was 220. The

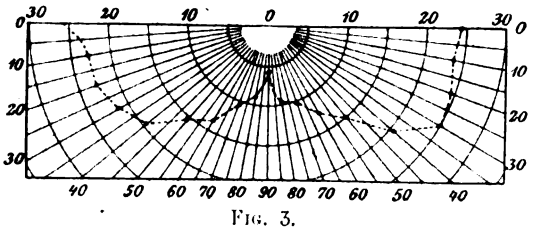

FIG. 3.

lamps to which the first set of figures relate were of the firm's B type.

A further batch of lamps was subsequently tested, when the Allgemeine Elektricitäts-Gesellschaft placed at the writer's disposal three 65-c.p. lamps, each for 220 volts and 100 watts, and five 65-c.p. lamps for 110 volts and 100 watts. These lamps were of the type marked "A" in the firm's price list. The results of these tests are given in Table II.

TABLE II.—Type A.

No.	E.	J.	K.	T″	A	A/K	Mean.
1	220	0·466	102	30″	102·5	1·01	1·11
2	220	0·464	90·2	27	102·2	1·13	
3	220	0·466	85·1	27·7	102·5	1·20	
4	110	0·886	67·4	36·5	97·3	1·44	1·43
5	110	0·911	71·7	36·5	100·1	1·40	
6	110	0·895	69·0	36·5	98·3	1·43	
7	110	0·891	70·0	36·5	97·9	1·40	
8	110	0·931	70·0	36·5	102·4	1·46	

The values from 1 to 8 relate to measurements taken without globes. From the figures given in Tables I. and II.,

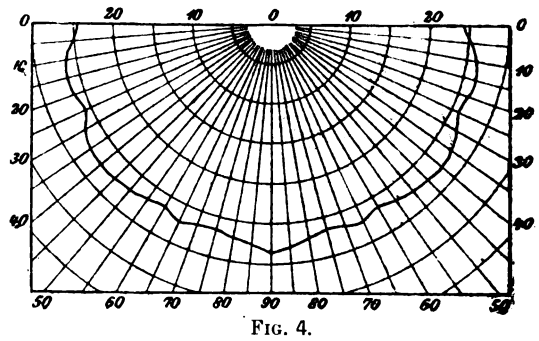

FIG. 4.

it is seen that with one exception for the lamps in Table I, the tested values not only attain the normal declared values, but in some cases even exceed them. Comparing the results with previous tests, it is also apparent that considerable improvement has been made latterly in the manufacture of the electrodes. The time required for ignition has been considerably reduced. For instance, in the B type, which is suitable for table lighting where the tables are numerous and one lamp is used for each, the time required for ignition averages under 30 seconds, while in the A type, which is suitable for illuminating larger areas, the time has been reduced to about 30 seconds. Moreover, as the last-mentioned lamp becomes further developed, it

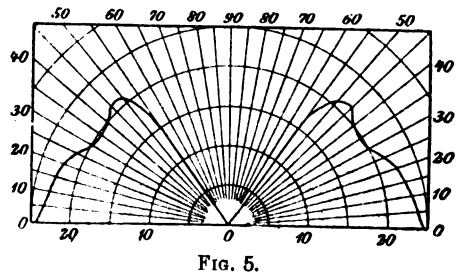

FIG. 5.

seems quite within the bounds of possibility that its consumption will be reduced to about one watt per candle-power, as has already been done in the case of the three first lamps in Table II.

B. *Measurement of the Distribution of Lighting from the Lamp.*—The diffusion of light from a 27-c.p., 220-volt, 0·184-ampere hanging Nernst lamp of the B type, with horizontal electrode and a clear globe, was investigated in two planes

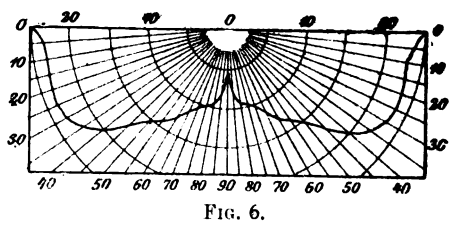

FIG. 6.

perpendicular to each other—first in the vertical plane perpendicular to the axis of the electrode, and then in the horizontal plane from the direction perpendicular to the axis to the direction of the axis. The values obtained

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simultaneously on two diametrically opposite sides are given in Table III.

TABLE III.—Type B.

J	a_l	K_l	a_r	K_r	—
0·17	−51·4	23·6	−54·0	11·0	Vertical plane. Above the horizontal
0·17	−48·5	26·2	−50·3	17·5	
0·17	−27·3	21·4	−27·3	21·4	
0·17	−18	23·0	−18·1	22·6	
0 17	− 8·35	23·4	− 9·1	22·3	
0·17	0	26·4	0	23·1	
0·169	0	25·6	0	22·8	Vertical plane. Below the horizontal
0·169	11·5	27·0	11·6	26·4	
0·169	22·5	28·1	23·4	24·5	
0·168	32·8	29·2	34·1	25·3	
0·160	40·9	29·4	47·7	25·6	
0·169	52·4	28·6	53·9	25·8	
—	55·7	27·8	56·7	26·1	
0·169	59·6	27·0	60·0	26·6	
0·169	62·9	27·5	63·5	26·9	
0·17	67	27·8	67·4	27·4	
0·17	72·5	26·7	72·7	26·6	
0·17	77·5	27·2	77·4	27·5	
0·17	90°	27·9	90°	29·3	
0·17	0	26·1	0	24·2	Horizontal plane
0·17	10	22·9	10	23·6	
0·17	20	22·6	20	24·5	
0·17	30	21·9	30	25·1	
0·17	40	19·3	40	20·9	
0·17	50	15·8	50	15·1	
0·17	60	13·6	60	12·6	
0·17	70	10·9	70	10·9	
0·17	80	8·88	80	9·89	
0·17	90	5·86	90	5·91	

These values for the diffusion are plotted as functions of the angles in Curves 1, 2, and 3. From the mean values of the light intensity measured on both sides at the same angle, we obtain the mean curves (Figs. 4, 5, and 6). By integrating the latter we obtain for the plane above the horizontal a mean illumination of 17·6 candles; below the horizontal, 26·5 candles; and in the horizontal plane, 19·7 candles.

The diffusion from a second hanging lamp (Type A) was tested in order to determine the effect of the vertically arranged electrodes in the latest type of Nernst lamp. The diffusion in the vertical plane was first of all measured without a globe, and subsequently with a star-pattern frosted globe, the pressure at the lamp terminals being constant at 220 volts. The results are given in Table IV.

The graphic representation of these results is shown in Fig. 7, from which the two mean curves (Fig. 8) were plotted. By integrating we find for the lower hemispherical

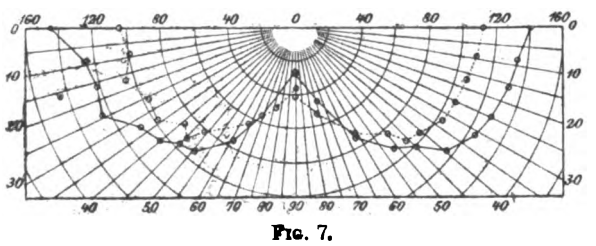

FIG. 7.

intensity in regard to the lamp without globe the value 108·4 candles, and for the lamp with a globe 91·3 candles—a decrease in the latter case of 15·8 per cent. in the light diffused from the lower half.

To determine the amount of light absorbed by the

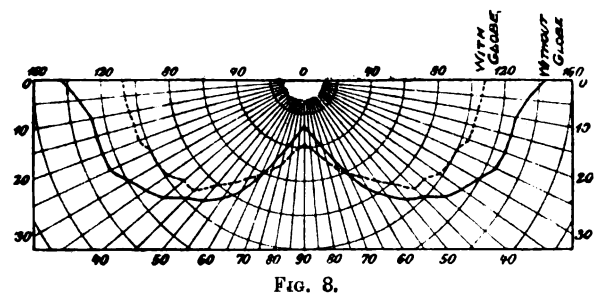

FIG. 8.

frosted globe, the spherical diffusion, and mean spherical intensities, another lamp of the A type for 220 volts, 0·88 ampere, 150 c.p., was tested. The time required for ignition was 29 seconds. The results are given in Table V. under similar headings to those in the previous table.

TABLE IV.—Type A.

Lamp without globe.					Lamp with globe				
J.	a_l	K_l	a_r	K_r	J.	a_l	K_l	a_r	K_r
0·818	0°	146	0	142	0·800	0°	106	0	111
0·808	8·4	124	8·3	134	0·800	8·7	98·9	8·6	110
0·805	16·6	122·4	16·4	133	0·799	17·1	105	17·1	107
0·803	24·4	124	24·3	129	0·799	25·5	96·9	25·2	106
0·800	32·3	110	31·5	124	0·800	32·8	88·9	32·7	103
0·800	39·8	105	39·2	116	0·800	41·1	87·5	40·4	96·2
0·800	45·0	98·9	44·9	101	0·800	45·6	89·9	45·5	92·6
0·800	51·0	94·7	51·3	92·1	0·799	48·9	82·0	48·7	83·5
0·800	60·6	75·5	61·0	74·2	0·799	62·8	63·5	61·7	70·1
0·799	69·4	54·2	73·3	43·9	0·794	76·5	49·6	76·3	50·6
0·800	90·0	27·5	90°	28·6	0·798	90°	36·8	90°	40·7

TABLE V.—Type A.

Lamp without globe.					Lamp with globe.				
J.	a_l	K_l	a_r	K_r	J.	a_l	K_l	a_r	K_r
Upper half horizontal.									
0·8763	− 55·4	58·4	− 55·4	23·7	0·8863	− 55·4	49·2	− 55·4	45·2
0·8763	− 38·7	109	− 37·2	95·4	0·8863	− 39·8	87·5	− 40·8	79·6
0·8763	− 28·1	123	− 28	120	0·8803	− 28·2	115·5	− 28·6	108·6
0·8763	− 16	137	− 16	128	0·8813	− 16·8	96·4	− 16·9	95·6
0·8823	− 8·1	138	− 8	137	0·8753	− 8·6	89·9	− 8·6	92 1
Lower half.									
0·8763	0	138	0	148	0·8743	0	111·5	0	109
0·8763	7·9	131	8	148	0·8743	8·2	114·2	8·3	113·9
0·8763	16·2	127	15·8	143	0·8743	16·1	124·9	16·4	116·0
0·8763	24	123	23·7	126	0·8743	24·8	98·2	24·2	111·0
0·8783	31·2	117	30·8	122	0·8743	32·3	94·6	31·7	102·0
0·8753	38·9	106	37·9	114	0·8693	40	88·7	39·1	96·6
0·8753	43·9	98	43·2	104	0·8713	44·7	87·7	43·8	94·3
0·8763	50·5	86·6	49·2	95·8	0·8718	50·9	82·8	50	86·8
0·8763	54·8	77·8	53·2	88·5	0·8743	60·6	65·9	58·6	74·8
0·8803	62·4	57	57·4	83·7	0·8738	76·9	41·8	73·0	51·1
0·8763	—	—	73·4	49·7	0·8733	89·0	32·9	83·4	39·8
0·8763	90°	17·0	90	16·8	0·8743	90°	40·8	90°	37 7
0·8769 × 220 = 192·9 watts.					0·8752 × ·220 = 192·5 watts.				

These values are graphically represented in Figs. 9 and 10. The variations in the curves (Fig. 10) for the lamp with a

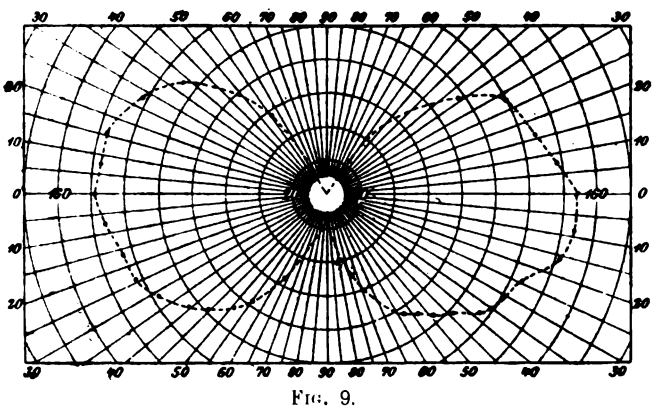

FIG. 9.

globe may be attributed to the presence of the stars in the frosted pattern. Figs. 11 and 12 represent the mean values

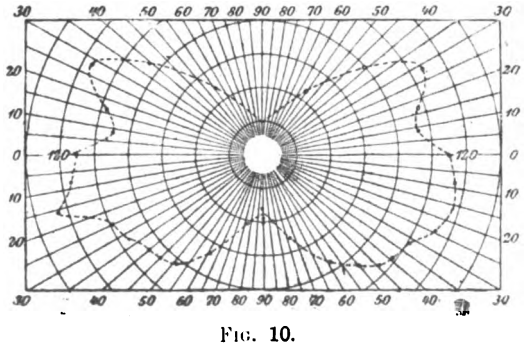

FIG. 10.

obtained. For the mean quantity of light yielded we obtain the following values:

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	Mean light for	lower half of lamp without globe	110·3	c.p.
	,, ,,	upper ,, ,, ,, ,,	96	,,
Hence	,, ,,	whole lamp ,, ,,	103·1	,,
	,, ,,	lower half of lamp with globe ...	93·6	,,
	,, ,,	upper ,, ,, ,, ,, ...	83·4	,,
Hence	,, ,,	whole lamp ,, ,, ...	88·5	,,

It follows that the light absorbed by the frosted globe amounts to $\frac{103\cdot1 - 88\cdot5}{103\cdot1} \times 100 = 14\cdot2$ per cent., while the decrease of light for the lower half of the lamp amounts to 15·8 per cent The mean consumption of the lamp without globe was 192·9 watts. Hence we obtain $\frac{192\cdot9}{103\cdot1} = 1\cdot87$ watts as the specific consumption for the mean spherical value of the light.

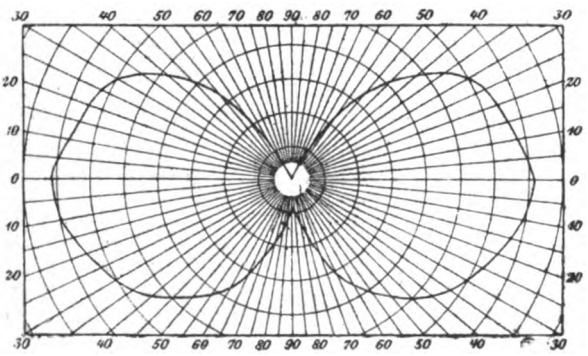

FIG. 11.

C. *Comparison between the Specific Consumption of the Nernst Lamp and that of the Ordinary Incandescent Lamp.*—In making the above comparison, a 118-volt incandescent lamp was employed. First of all, the mean quantity of light yielded in the horizontal plane with the lamp in an upright position and turning through 360deg. by 10deg. outwards was measured. The mean value was ascertained to be 21·8 c.p., while the current amounted to 0·5161 ampere. Hence the watt consumption was 60·9, and the specific consumption for the horizontal illumination obtained 2·8 watts.

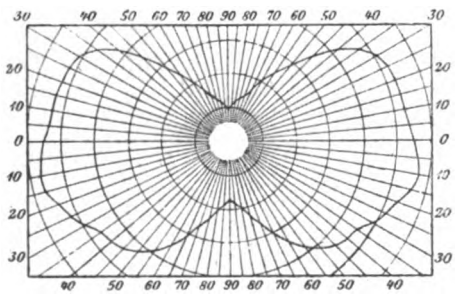

FIG. 12.

Subsequently the intensity of the light and its diffusion in the vertical plane were tested in the most favourable position relative to the horizontal plane. The best result in the horizontal plane was 23·6 c.p., the diffusion for the corresponding vertical plane being determined. The measurement of the latter yielded 19·27 c.p. for the mean quantity of light emitted by the upper half of the lamp and 18·18 c.p. for the lower half. Therefore the mean spherical candle-power for the whole lamp was apparently 18·7. Since, however, the mean horizontal light amounted to only 21·8 c.p., we must reduce this value by

$$\frac{23\cdot6 - 21\cdot8}{23\cdot6} \times 100 = 7\cdot62 \text{ per cent.},$$

in order to obtain an approximately correct value. Hence for the mean quantity of light yielded by this lamp we obtain 17·29 c.p. The ratio between the mean spherical illumination and the mean horizontal illumination is, therefore, as 17·29 : 21·8 = 1 : 1·26. If we adopt as our standard incandescent lamp one having a specific consumption of 3·1 watts for a mean horizontal illumination of 16 candles, then the specific consumption for the spherical illumination obtained = 1·26 × 3·1 = 3·91 watts.

As the specific consumption relating to the spherical illumination obtained with the Nernst lamp has been found to be 1·87 watts, it follows that the ratio of the specific consumption of the Nernst lamp to that of the incandescent glow lamp is as 1·87 : 3·91 = 1 : 2·1.

(To be concluded.)

STEAM-ENGINES FOR DRIVING ALTERNATORS IN PARALLEL.

At the meeting of the Société Internationale des Electriciens on Nov. 6 some interesting communications were received and discussed on the above subjects. We are indebted to *l'Industrie Electrique* for the abstract of the *Proceedings* from which the following translation is made. The meeting of the society was presided over by Mr. Hillairet.

The proceedings were opened by Mr. Maurice Leblanc, who briefly recalled the history of the question as to the regularity in running of steam-engines and the coupling of alternators in parallel. After the exhibition of 1900 he had obtained from the principal makers of steam-engines with one, two, three, and four cylinders particulars as to the regularity in torque and speed which they could obtain. The answers received were so vague, and often so contradictory, that the first section of the committee specially devoted themselves to the investigation of the subject, in which they received most valuable assistance from the large engine-building firms. Mr. Leblanc proceeded to explain the programme of the work of the committee. He reminded those present that a steam-engine driving an alternator was worked under peculiar conditions. This might be likened to a workshop transmission when it is not connected to an electric lighting network. There was considerably more to be thought of when the machines were coupled in parallel The conditions were then changed totally, and might then be better compared to a transmission shaft carrying gear wheels, each of which received power from a steam-engine, but which was coupled to the shaft by means of a somewhat elastic coupling. These gear wheels would then be able to take up oscillatory movements, one with respect to the other, which movements might often be a cause of danger. It would be seen that, given these elastic couplings, it would be necessary to pay attention to the harmonic values of the oscillatory movements, and to suppress those which tended to give rise to great displacements by being of the same frequency as those of the gear wheels.

After this short introduction Mr. David read a communication on the calculation of the coefficient of irregularity of steam-engines. He explained that in the design of electric generators, the flywheel is in many cases the point of connection between the mechanical and the electrical construction. It was necessary in the first instance to verify by experiment the coefficient of regularity obtained by calculation. For this end, the firm of Messrs. Weyher and Richemond had made a special apparatus which was exceedingly simple, and could be easily applied to all machines. The coefficient of irregularity could be made to record itself theoretically by means of a graphical trace. In using this effect, the diagrams drawn by the indicator give the curves of angular displacement, and from this could be deduced the coefficient of regularity. Unfortunately, this calculation is only correct for a simple case, because of the effect of the inertia of the moving parts. Mr. David defined this coefficient, which represents the regularity in the speed of the engine for a single revolution, as the ratio between the angular speeds as follows :

$$\frac{\omega \text{ maximum} - \omega \text{ minimum}}{\omega \text{ mean}}.$$

For convenience, and to be in keeping with the electrical results obtained by Mr. Boucherot at the same meeting, it is convenient to take the coefficient of regularity as being one-half of the above expression. The special apparatus designed by the above firm was made to measure the angle of lag θ, or the maximum angle which the crank of the machine made with the crank of an ideal engine revolving at an absolutely

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uniform rate. The apparatus consists essentially of a circular disc of wood, which can be attached to the end of the shaft of the machine to be investigated. On this disc is placed a sheet of paper covered with lampblack. This can be done while the disc is revolving in position. Against the paper, at a certain distance from the centre, a tuning-fork is placed on a solid support from the ground so as to trace a sinusoidal curve on the paper. The tuning-fork is so mounted that it is only brought up just to touch the paper when required. A practical difficulty arises that it is necessary that the disc should be perfectly true on the shaft, and that the point of the tuning fork should only remove the lampblack deposit from the face of the paper. As it was difficult to obtain this absolute truth with the disc, and as, on the other hand, a small lateral play caused great increased friction between the paper and the point of a tuning-fork, a device had to be adopted to prevent the tuning-fork from being stopped vibrating. They used, therefore, a small roller, which advanced when the tuning-fork was brought forward, and which, bearing against the disc, kept the point of the tuning-fork just touching the lampblack deposit. The sinusoidal curves thus obtained were exceedingly regular, and gave a diagram which could easily be analysed The tuning-fork employed had a period of vibration equal to 100 periods per second. It was then only required to divide the circumference into equal parts, and the angle θ was easily measured by comparing the distance between the summits of these sine waves for equal divisions of the circumference. The tuning-fork need not be electrically driven, because the measurements were taken during only one revolution of the engine, occupying at the most one second. The advantage of this method is that it gives the angle θ on the actual diagram. This apparatus necessitates there being one end of the shaft available. In the case of a machine with two cranks, one displaces the disc of wood, and wraps round the shaft itself a sheet of blackened paper, on which the vibrations of the tuning-fork are inscribed. It is then found that the diagrams are long when uncoiled, and, moreover, slight longitudinal displacements of the shaft give rise to considerable trouble to the experimenter. Mr. David then gave the accompanying table of recent results on machines of different makes. He concluded that it would be necessary to make many more experiments in order to avoid personal errors, and to arrive at accurate mean results.

Machine.	Angle of maximum deviation θ in degrees. Calculated.	Measured.	Remarks.
A	0·29	0·2	Engine driving an alternator by a single transmission.
B	0·8	1	Lift machine (Ville de Paris).
C	0·09	0·3	
D	0·074	0·6	Tramway plant at Vincennes with variable load.
E	—	0·65	Two-phase steam alternator.
J	0·075	—	
	0·102	—	
K	—	0·62	Triple-expansion engines in the Moulineaux.
	—	0·3	
	0·09	0·25	
G	—	0·48	Alternator coupled to compound engine with slide valves.
	—	0·47	
H	—	0·50	Alternator coupled to steam-engine with Corliss valves.
	—	0·75	

The next communication was by Mr. Cornu, who explained an optical method of measuring the angle θ. By means of simple and pretty experiments Mr. Cornu showed the type of phenomena which served as the basis of his method. He mounted on the extremity of the shaft of the machine to be experimented with a corona carefully centered and pierced by a series of equally distant round windows at 20deg. apart, for instance. If a source of light is placed at the centre of the corona, and if one looks at it from above, one sees a luminous trail produced by the succession of windows passing before the eye. If there is then placed perpendicular to the plane of this corona a revolving disc with an absolutely uniform motion and pierced by a number of gaps equal to those of the corona; if, then, this disc revolves in the reverse direction to the corona, and if the two pieces of apparatus are maintained in synchronism, the eye of the observer before the disc will see the circular window immovable in space. In short, the two windows will move the one towards the other at the same speed, and will appear immovable when a ray of light traverses them simultaneously. If the shaft of the machine has an irregular movement, the image will oscillate between two extreme limits, which will give the angle θ. The author explained how to measure this angle, either by means of photography or by a micrometer.

The rest of the evening was taken up by Mr. Boucherot with a mathematical and diagrammatical analysis of the vibrations which could be set up. He considered two cases—the first the case of a single electric generator, and next the case of an electric generator coupled to an infinite source of power of invariable frequency. Mr. Boucherot by means of mathematical formulæ, which are too long to reproduce here, carefully examined each case. He showed in passing the curious effects of mechanical resonance, and cited a striking example. A German central station had been provided recently with an electric generator, consisting of a steam-engine with two cranks, carrying at each end a flywheel alternator. A rigid muff coupling joined the two shafts at the centre. The two machines which were thus equipped could not be worked together in parallel, but had always to be worked singly. This fact was due to the shaft possessing a certain amount of elasticity, and had been shown that when trying to work the machines together, the coupling had been sheared by the violent strains set up. It was put forward by the author that it was most probable this was due to oscillations set up by mechanical resonance.

A PLEA FOR THE BOW TROLLEY.

BY E. KILBURN SCOTT, M.I.E.E.

American tramway practice is so omnipresent that in visiting various countries thousands of miles from each other one finds the same apparatus, the same types of trolley wire fittings, etc., to a degree which is almost monotonous. There is one feature of car equipment, however, in which the Continent has refused to follow America, and that is in the current-collecting trolley. It is quite a relief to go to Germany and find the fishing-rod trolley pole almost entirely displaced by the Siemens bow trolley. It may be interesting to consider for a moment the advantages and disadvantages of collecting current by means of a bow contact and by means of a wheel. First and foremost, the bow trolley has the great feature that it is impossible for it to jump the trolley wire. The number of accidents and stoppages of traffic that can be traced to the fishing-rod pattern of trolley jumping the wires are legion. It is quite the commonest accident that occurs on a tramway system, and it is just the one accident that in the very nature of things cannot occur when a bow trolley is employed. With the trolley pole there have been cases of injury to passengers through the wheel and its bracket becoming detached, either by working loose in the ordinary way or receiving a blow against a space wire or bracket arm due to the pole jumping the wire. Now, with a bow trolley there is nothing to get loose—that is to say, there are none of the pins, bolts, etc., which go to make up a trolley head. Many of the accidents which occur from time to time on account of trolley wires breaking are traceable to the wrenching and hammering which the overhead fittings receive from the trolley wheel. The actual wearing surface of a bow with the trolley wire is very considerable and is always changing, so there are practically no renewals to be made. Once the bow trolley is fixed, there it remains for years without any alteration, whereas in the case of the pole the trolley wheel must be renewed at frequent intervals.

As the rubbing contact of a bow is entirely on the underside of the wire, the overhead fittings may be very simple, and it is possible to pass over switches and go round corners, etc., at a good speed. With trolley pole, on the other hand, the wheel wraps round the wire to a certain extent, and both switches and frogs—in fact, all the trolley

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wire attachments—have to be specially designed to meet this condition, which is of a wrenching character. With regard to noise, the writer's impression is that the bow gives much less noise—at any rate, the hissing noise of a bow is always the same—whereas as the wheel gets worn it becomes more and more noisy. Noise is not noticeable in a busy street, but along a suburban road, with residences on each side, it is a point requiring consideration. In changing direction at termini, the height of a trolley wire can be arranged so that the bow will adjust its rake automatically for the return journey. With the trolley pole, on the other hand, the guard must reverse the rake and fish about until he gets the wheel on the wire; at a suburban terminus on a dark night this is not always easy. In the case of a block or breakdown the bow trolley is much more handy, as the car can run quite readily in either direction, and thus leave the guard free to attend to other duties. This turning round of the trolley pole to change the direction is a great nuisance, in that suitable provision has to be arranged (in some cases contacts) in the trolley standard. In the case of the bow trolley, with its movement in one place only, there is no trouble whatever. Of course, where the Dickenson trolley pole, with a large amount of side swing, is employed, then bow trolley is not applicable, but in the most modern practice, as at Glasgow, for example, the trolley wires are immediately over the car right along the route. It may be objected that the bow trolley is not so suitable for cars carrying outside passengers, but the writer considers the supposed difficulty could be easily met; it is, after all, only a question of mechanical design: arranging a suitable hinge and spring on top of the present trolley standard.

Regarding the picking up of current, it is a matter of interest to know that the result of the experiments in Germany on high-speed traction has shown that the bow is far and away the best method of collecting current. It will collect larger amounts of current and admit of much higher speeds than a wheel contact, and the spring of the bow itself appears to present important advantages over the more rigid wheel construction. Another point of interest is that it is quite easy to have two bows on one car, and so break the trolley wire connections at crossings or complicated places in much the same way as an electric railway train is worked. To put two trolley poles on one car would be risky and expensive to say the least. In some towns the authorities will not allow trolley wires along some of the main streets, and accumulators are employed, as at Hanover. In such cases it is common practice to have two bows, one to collect current for the motors and the other for the cells.

NOTES ON PRACTICAL ELECTRICAL INSTRUMENT MAKING.

BY JOHN C. BAGOT.

The working instrument makers, generally speaking, though they have the inclination, seldom have the necessary leisure at their command to enable them to go very deep into the theory which forms the basis of those instruments they are from time to time called upon to construct. Consequently many of the little details, "perhaps of the greatest importance as far as the successful working of the instrument is concerned," appears to them at the time unnecessary. Thus very indifferent attention is given them, because their utility is not seen, whilst if it is seen, the importance of it is not recognised, and in many cases the men feel as though working against their own convictions. The assertion is often made that they have no right to their convictions, but the best results are not brought about by the workman who merely follow instructions without any interest in the matter whatever. But rather when he is so assisted as to become acquainted with the particular effect that has to be produced, then he can to a certain extent apply his own ingenuity and ability to the best advantage in manufacturing the cause. It is to the removal of some of these difficulties that special attention will be given in these notes, always as far as possible from a practical point of view, there being already a good supply of literature on amateur work in this direction. Nevertheless, there are many points in such works that the practical instrument maker will find of great service, if for no other purpose than to see that the general utility of an instrument depends very much on the manner it is employed. And seeing the differing circumstances under which the same instrument may be employed, he is at once led up to the principles on which they are based, by the study of which he may not derive any pecuniary advantage, yet will have greater pleasure in his avocation.

The design and mechanism of all electrical instruments are based upon the known effects of the current on various bodies under different circumstances—that is, the magnetic, chemical, and heating effects. To consider the instruments, or these effects in the order of their importance, the magnetic effect would claim first attention, and the first requirement is a simple instrument to detect the presence of the current in a circuit—that is, a simple galvanometer. It will be advantageous to consider at some length the action of the current in this case, for although simple, nevertheless the great majority of instruments depend upon some modification of the same laws. This magnetic effect may be illustrated by the experiment of Oersted by holding a wire carrying a current over a magnetic needle in the direction of its length, the needle being free to move in the azimuth, and capable of coming to rest in the

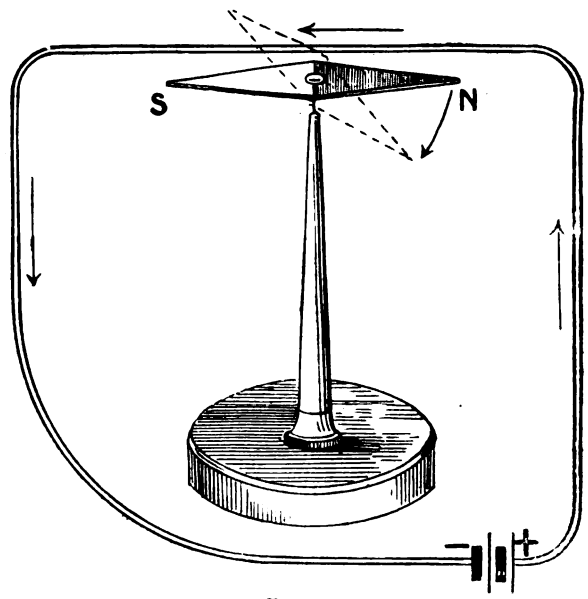

FIG. 1.

magnetic meridian when not otherwise influenced. Now, on holding the wire over this needle the latter will be forced round out of the meridian, and this force depends upon: (I.) the strength of the current in the wire; (II.) the strength of the magnetic poles of the needle and their distance apart; (III.) on the distance between the wire and the magnetic needle. This effect is shown in Fig. 1, the direction of the current being shown by the large arrows, and the deflection of the needle by the curved arrow. Remembering always that the end of the needle which points north is south magnetic, the effect shown is due to the current passing over the needle but once, and if the wire were held underneath the needle with the current still flowing in the same direction, the motion of the needle would now be reversed. Now this action is not due to the conductor itself becoming magnetic, but to the condition assumed by the space immediately round it. The condition of this space is such that if it were possible to suspend a single magnetic pole of either north or south polarity within it, the latter would tend to revolve round the conductor in a direction depending on the polarity and the direction of the current in the conductor.

An approximate idea of the condition of this space, and the position taken up by a suspended needle, is given in Fig. 2, and it will be seen that the needle sets itself so as to assist the flow of these magnetic lines by turning its greater length in the direction of their flow. Further, the steel being a much better conductor than air for these

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magnetic lines many become bent out of their natural course so as to pass through the needle, which would not be the case if it was made of brass. This inherent quality is called permeability, thus the action in this simple case depends upon the permeability of the space ronnd the conductor.

Now, it is evident that if this conductor be bent so as to form two parallel conductors, the magnetic lines that are assumed to circulate will coalesce and form a magnetic

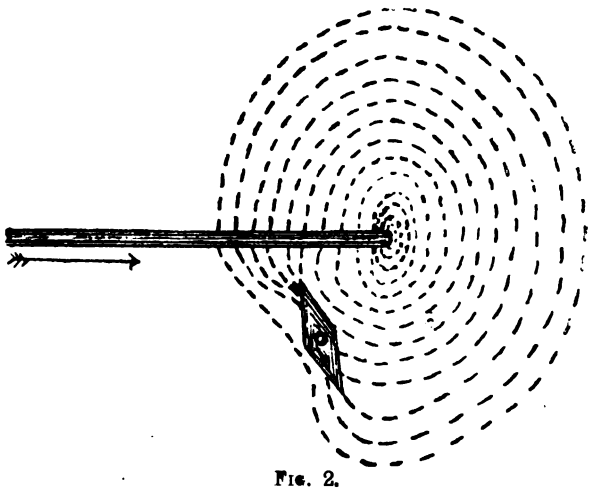

FIG. 2.

field of double the strength. So that by coiling the wire many times round the needle, the effect is multiplied almost indefinitely; of course, as the wire is wound on, the mean distance from the needle will become greater, but for practical purposes we may assume that the actual force acting on the needle varies directly with the current, the number of turns, and the mean distance, providing that the magnetic field set up in the coil is at right angles to the magnetic axis of the needle within it. But from a practical point of view this action very much depends upon the nature of the suspension or the quality of the pivoting, for

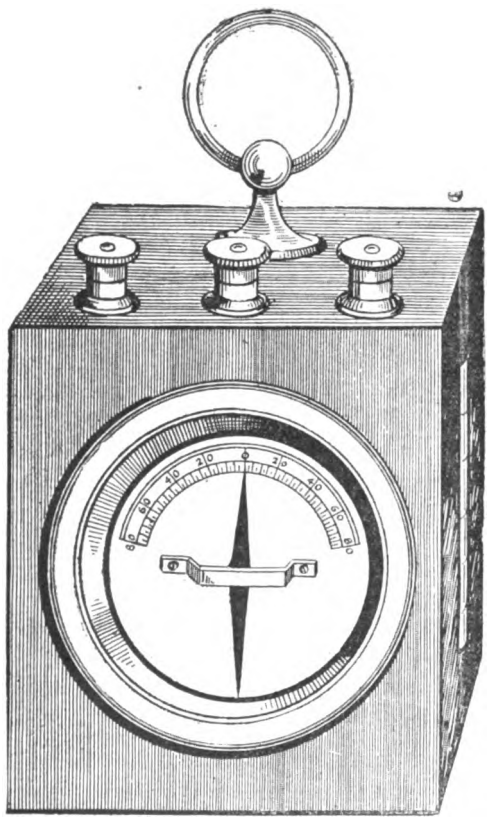

FIG. 3.

the conditions to be fulfilled in the case of all instruments "where the needles are not controlled by torsion of any kind" is that the needle must return to zero when not influenced by the current.

It is quite clear that these conditions cannot be fulfilled by blunt-ended pivots rolling about in large holes, not only on account of the greater friction, but also the change in their position in the pivot holes every time they are deflected, and cannot be expected to come back to zero unless the delicacy of the instrument is destroyed by adding weight to the needle, which means more turns of wire or greater current, and in any case not the same effect. The best form of pivot is one that is brought to a point, "but not sharp," and is allowed to rest at the bottom of the pivot holes, the angle of which is made slightly greater than the angle to which the pivot is brought, and when these are allowed to rest at the bottom of the holes almost without endshake, there is practically no friction, and they cannot change their position, which is the cause of the common defect, more especially in telegraph instruments and in the galvanometer under consideration—that is, the magnet coming in contact with the wire inside the coil.

The vertical detector complete, with the exception of the glass, is shown in Fig. 3, and it will be noticed that instead of a simple angle piece a bridge is employed to support the front pivot, which has the advantage of always keeping central, and is in every way better. The deflections, of course, cannot range beyond 80 deg,, but such is not necessary, for even if the instrument should be calibrated

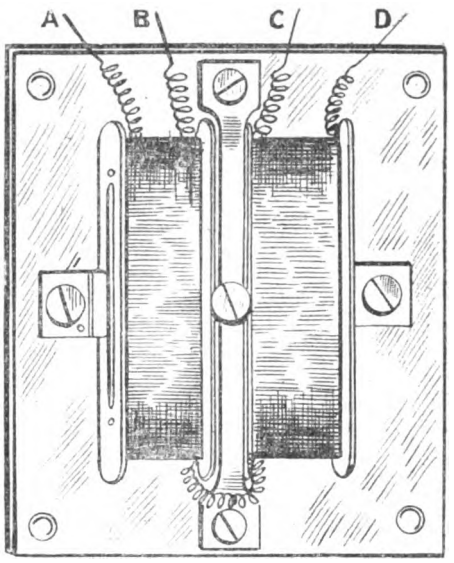

FIG. 4.

so that the deflections were some known value of either E.M.F. or current, these would be useless beyond 80deg., for in this position the magnet inside the coil is almost in the maximum field, so that a current which would deflect the needle, say, 10deg. from zero would not effect it when at 80deg.—that is to say, the deflections are not proportional to the current passing through the coils. But with the pivots fitted as described, and only just sufficient weight on the needle to bring it to zero, then the deflections may be expected to be nearly proportional within a range of 55deg.

The various other points will be sufficiently illustrated by the diagram, and require no further explanation; it will be noticed, however, that there are three terminals. The coils are wound with two sizes of wire, so that the instrument is applicable for the measurement of fairly strong as well as weak currents. The thick wire consists of two layers of No. 18 S.W.G.; the inside end of this wire is soldered to the coil frame, which is of brass, and are in contact when put together. The other ends are brought out as shown in Fig. 4. The thin wire, which should have a resistance of about 400 times as great, is wound on the top with all four ends brought out clear of the frame, the inside ends being joined up as shown. The other four ends are put direct to the terminals, A and B to the left, C to the middle, and D to the right-hand terminal, so that the thin wire or greater resistance is between the two extremes and the thick between the middle and the left-hand terminals. The resistance of the thick wire should be about ·4 ohm and the thin 160 ohms; then the ratio will be as 1 : 400. The manner in which the coils are made up will be seen from the figure, and it will also be noticed that the bridge in

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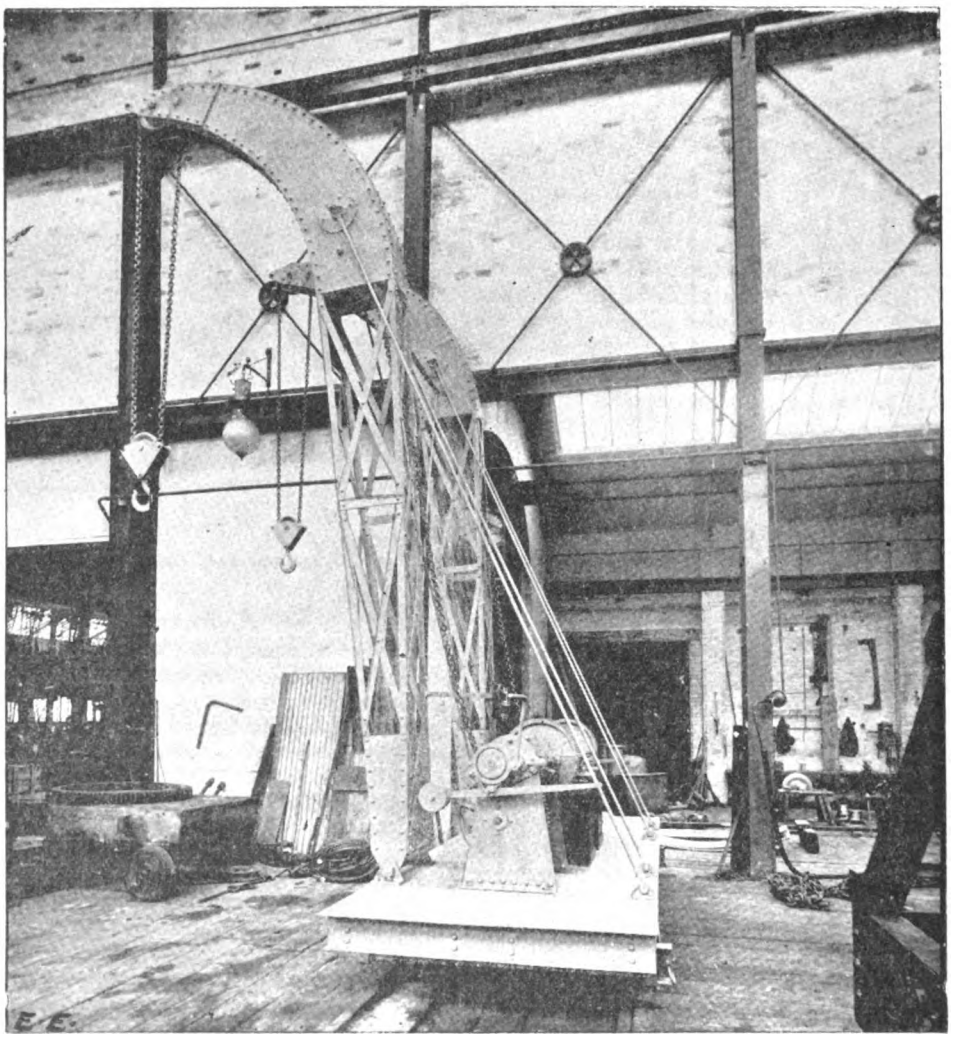
this case forms a base for the coil cheeks to rest against, thus preventing any slip, "along with its consequences," if subjected to rough usage. By means of the double winding of the coils the instrument can be used either as an ammeter or voltmeter, and by careful calibration and with the constant thus arrived at along with the resistance recorded inside the case for reference, the utility of the instrument is increased far beyond what its name implies.

(To be continued.)

ELECTRIC CRANES.

The illustration which we give herewith is of an interesting electric crane designed by the firm of Messrs. Jessop and Appleby Bros., Limited, of Leicester, for the British Electric Car Company, Limited, of Trafford Park, Manchester, to suit the conditions set forth by their engineer and general manager, Mr. J. W. Wainwright, M.I.C.E. These conditions are, in brief, that the crane is to raise tramcar bodies weighing six tons off their carriages, the bodies to be suspended from two points 7ft. 9in. apart. Two latticed steel curved jibs are employed, their feet resting on one edge of the carriage, and the lower ends of the tie-rods being secured to the opposite edge of the carriage. The effective overhang of the jibs is 7ft. 3in., equivalent to a distance between centres of crane and tram-tracks of 10ft. 3in. The carriage is carried on four wheels, the track being 4ft. 8½in. gauge, and the wheel base 9ft. 6in. Extending under-girders are provided for use when lifting, and loops to engage with them are secured in the ground at the places where the crane is employed. Each jib has its lifting crab driven by separate series-wound reversing electric motor of 4 b.h.p., running at 650 revolutions per minute, and using continuous current of 500 volts, and supplied with controller. The two controllers, together with a double-pole main switch, with fuses, are brought to the centre of the carriage, between the crabs, and the brake levers for controlling the raised load are in a handy position for the operator. The crane is arranged to travel "empty," one of the lifting motors being used for the purpose, coupled with suitable bevel and spur gear to one of the carriage axles; the speed of travel is 70ft. per minute. The crane was tested on a seven-ton load, which is well above the average working load. A brief consideration of this crane will show the great advantage it has in car works.



A Jessop and Appleby Crane for Lifting Electric Tramcar Bodies.

NAVAL ENGINEERS AND ELECTRICIANS.

A correspondent has addressed the following communication to us:

"I want you, if you would be so good, to give me a little information as to how to get into the navy as an engineer—whether it is by examination, and, if so, what course would you advise? or, if it is possible to start and work up to a post. Do you think it is a career with much scope for getting on? I am nearly out of my time with a large electrical firm, and am 20 years of age. Could you refer me to anyone on the subject?"

As the matter to which our correspondent refers is of general interest to young engineers who may have an inclination for a seafaring life, we append the following particulars as to the conditions to be observed by candidates entering for the engineering branch of the Royal navy: Applicants for direct appointment as probationary assistant engineer in the service must not be under 20 nor over 23 years of age, and must have attended the regular day engineering course (either civil, mechanical, or electrical) at a

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recognised college for technical education for not less than one college year. They must also have been not less than three years under training in approved engineering establishments. Thus, the total time under training must have been from 4 to 4½ years. Among other conditions is one which will readily commend itself—viz., candidates for entry must produce certificates of ability to swim. The number of appointments to be made each year is fixed by the Lords Commissioners of the Admiralty. The examinations are held annually at the Royal Naval College, Greenwich, in May or June, and embrace the following obligatory subjects: general paper in elementary mathematics and mensuration; statics, hydrostatics, and hydraulics; dynamics; chemistry; physics; applied mechanics and graphical statics; elementary theory of mechanism and machinery; heat, combustion, and metallurgy; steam and the steam-engine; practical engineering; workshop appliances and practice; mechanical drawing. The following are the optional subjects which candidates may take up: higher algebra and trigonometry, conic sections; conic sections, differential and integral calculus; practical physics; design of details; engineering. If a candidate obtain 60 per cent. of the 10,000 marks, which is the combined total of the obligatory and optional subjects, he is allowed to take a further course of instruction at the Royal Naval College at Greenwich. Other certificates are awarded, depending on the result of the above examination, as follows: the standard for passing with a second-class certificate is 50 per cent. of the total number of marks (6,800) for obligatory subjects, and with a third-class certificate the standard is 30 per cent. of this total. Candidates who obtain less than 30 per cent. of the total of obligatory subjects are considered ineligible for appointment as probationary assistant engineers. Successful candidates, up to the number of vacancies requiring to be filled, are entered in the Royal navy as probationary assistant engineers on July 1 succeeding the examination, and are appointed to one of the dockyard reserves. Officers who qualify for the course of further instruction at the Royal Naval College, if they so desire, have the privilege of proceeding there on Oct. 1 succeeding their examination. All candidates after passing the educational test are subjected to a thorough physical examination by naval medical officers before being admitted into the service, and as sometimes it is only found at this stage that they are not physically fit, it is recommended that attention should be paid to this matter before deciding to prepare for entry into the navy.

On the question of pay we find that on entry probationary assistant engineers receive 6s. a day. After one year's service with a third class certificate and six months' service with a second-class certificate officers are nominated assistant engineers, and the pay increases to 7s. 6d. a day. Being promoted to the rank of engineer, officers with four years' service are paid 10s. a day; after four years' service, 11s. a day; and after eight years, 12s. a day. The salary of a fleet, staff, or chief engineer ranges from 16s. to £1. 10s. a day, according to length of service; while an inspector of machinery, which is the next highest position after fleet engineer, gets £1. 15s. a day, and a chief inspector of machinery £2 a day. In cases of special appointment to responsible positions in some of our large naval ports at home and in the colonies, the salary of an inspector of machinery, we believe, often runs into four figures. There is also what is known as "charge pay," engineer officers in charge of the machinery of ships (including torpedo boats) on commission, receiving from 1s. to 5s. a day in addition to their regular pay. So that our correspondent will doubtless be pleased to see that the engineering branch of the Royal navy affords ample "scope for getting on," especially when one compares these rates of pay with the meagre salaries of some central-station and other engineers on shore, whose responsible duties often call for more generous remuneration. It must also be borne in mind that on retirement after a specified length of service, naval officers are entitled to pensions which compare very favourably with their pay while in active service. For instance, the maximum retired pay of an officer of the rank of engineer is from £162 to £187 a year; of a chief, staff, or fleet engineer, £450 a year; inspector of machinery, £500 a year; and chief inspector of machinery, £550 a year.

Turning now to another branch of the service—*i.e.*, that of naval electricians—we find that the Admiralty are engaging able-bodied young men to these positions with experience as fitters in electrical shops. The age limit is from 21 to 28 years. The examination for the post of electrician is divided into three sections—viz., educational, theoretical, and practical. Under the first of these heads the candidate is examined in sixth standard work—vulgar and decimal fractions, simple interest, dictation, and reading. As regards theoretical training, he must have knowledge of the general construction of electrical apparatus, instruments, motors, etc., and simple testing, while his practical training must include relining and adjusting bearings, using a lathe, screw-cutting test for bolt and nut, repairs to any part of electrical apparatus, instruments, motors, etc. On entry, an electrician receives 38s. 6d. a week; after three years' service, 40s. 3d.; after seven years, 42s.; and after 12 years' service, 45s. 6d. a week. On completion of eight years' service, however, electricians are eligible after examination for advancement as vacancies occur in the rating of chief electrician with a weekly wage of from 49s. to 52s. 6d. a week, according to length of service in that capacity. Candidates for this branch of the naval service are examined for entry on board H.M.S. "Vernon" at Portsmouth and H.M.S. "Defiance" at Devonport. Men accepting service in the navy as electricians are allowed to remain till 50 years of age, and life pensions of over £1. 1s. a week are granted after 22 years' service. The rating of electrician is practically equal to that of petty officer in the navy.

INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address.

BY WILLIAM LANGDON, PRESIDENT.

During no period in the history of this country has commerce expanded, or the arts, science, and literature made such rapid progress as during the past century, and especially so during the latter portion of that period. For the reason we have not far to seek. Scarcely can a country's commerce advance, nor can trade flourish, without means of communication. Rob us at one fell stroke of our railways, our steamboats, our telegraphs. Conceive the position! Yet during a great portion of this period such was the condition under which the trade and commerce of the country was conducted. With the advent of railways there sprang into existence a new life. A new era dawned, not only upon England, but upon the whole world. Intercourse was facilitated, energies were stimulated, and ideas more readily disseminated. Men no longer lived the humdrum life limited to the road wagon or the stage coach. Big potentialities loomed in the distance, and men's minds rose to meet it. Manufacture and commerce grew, and England became more than ever the great engineering and commercial centre of the world.

Whether animated by those stirring events which accompanied the advent of railways or not, their establishment was soon followed by the production of the need of the moment, a means of communication still more rapid—that first great application of electrical science, the electric telegraph, which, coming as a handmaid to the railways, was shortly to link together every land and people. 1850 saw England and the continent of Europe joined. 1860 hailed the completion of that great enterprise which bound together in bonds of brotherly enterprise and unity—never, we hope, to be severed—the Mother Country and the great continent of North America. Gentlemen, who shall venture to estimate the value of these two great inventions, these great processes by which the commerce of the world was electrified into new life; by which nations were brought within touch and speech of one another! Who shall say how powerful they have proved as factors of peace between the peoples of the earth, or determine their effect on civilisation and the moral and material welfare of mankind! To them, to their authors, England owes much

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of that greatness of which she may be justly proud; but, richly as they contributed towards the advancement of the world at large, deep as must ever be our debt to them and to those who have worked with them, we do not forget there are others, whose brilliant achievements, if not at present so far-reaching in their beneficence, have greatly added to the lustre of the past period. We, with our feet on the threshold of this new century, would be ungenerous, nay, unjust, did we not recognise this fact, and pay tribute to those other great discoveries which so brilliantly mark electrical progress during the latter portion of that period.

The telephone! Electric lighting! Wireless telegraphy! The various applications of electricity to chemistry and metallurgy! That great boon to suffering humanity, the discovery of the Röntgen rays, by which the surgeon is enabled to locate by the eye many of those internal derangements of the human frame which hitherto had to be found by more tedious means, and oft with pain and suffering to the patient. And, lastly, but by no means the least, that outcome of Faraday's brilliant discovery of the relationship between the electric current and magnetism—the dynamo. As with wireless telegraphy, so with all these great discoveries, each marking a solid advance in electrical science, it is possible, nay, even probable, that we are still only treading on the fringe of something greater to follow. It is such events as these that raise the tone of a nation; that make men feel there is something higher and greater than the possession of wealth for which to work. Emblazoned on the annals of that period are names of which we, as Englishmen, may well feel proud—James Watt, Faraday, the Stephensons, Cooke, Wheatstone, Bright, Kelvin, Siemens, Swan, Wilde. Need I mention to you names—these and many others, labourers in the field of electrical science. Names ever in your mind; names recorded in history; names that will never die! From them we of this century have reaped a rich inheritance. Great is their claim on our gratitude; great our debt to them.

It is impossible to look back upon that period to which I have referred—to those great and brilliant achievements which mark especially the latter portion of it, without associating with it and with them the name of England's greatest Queen. The Victorian era will ever shine forth as a lustrous jewel in the history of the world. During no previous reign has art and science so progressed, has civilisation and the amenities of life been so richly endowed, or the ties of love and friendship between the Motherland and her Colonies been so worthily recognised, and so happily cemented, as under the benign influence of that life—so pure, so dignified, so devoted to the duties of her exalted state, given to the nation in the person of the nation's venerated Queen. Impossible as it is to overestimate the influence which such a life has exercised over the nation's progress, happy are we as a nation in the knowledge that she who has thus left her name engraven not only in history, but in the hearts of her people, is followed by one whose devotion to the welfare, the advancement, and the interests of that vast community over whom he has been called to reign is in every way worthy of the great and brilliant example of her whose life he so nobly seeks to emulate. Gentlemen, our prayer is that King Edward VII. may long be spared to thus watch over the interests of the peoples of his great Empire, to promote the accomplishment of even greater achievements, greater ameliorations of life than those associated with that glorious era which has marked the passing of the past century; that as the reign of his beloved mother will ever be characterised as that of England's greatest Queen, so his may prove to be that of England's greatest King.

The past stands before us hallowed by the magnificence of the work accomplished. To us it is the gift of a century to improve: still to advance. Competition in every path of life day by day grows keener. How to facilitate our movements; how to economise time; how to crowd the work of two days into one; to be present in all places at one and the same time; to cheapen production; to smooth the rough corner stones of life—are questions ever clamouring for attention, ever seeking aid at the hands of the engineer and the chemist. Clamouring for attention, three subjects present themselves for urgent consideration: the overcrowding of our cities; the advantages of electric traction; the economical distribution of electrical energy. Turn we first to

Locomotion in our Towns and By-Ways.—Writ large in the history of the past century will be the influence which steam exercised in the progressive advancement of civilised life. Much, however, as the world has benefited by steam, greater still may we anticipate will be the benefits to be derived from electricity. The establishment of railways changed the face of the country. Towns sprang into existence where none existed before. Villages became important centres. Factories and stores gathered around them. Population increased, and with its increase has come that congested condition of life which, unless speedily relieved, is destined to form one of the most serious questions of our time. Well may we ask what is to be the effect of electricity on this? Is this centralisation of life, with all its evil consequences, to find redress in that electric service which is now being established in and around so many of our larger and more populous towns? Are we to look to it to again alter the conditions of life, create new suburbs, and carry into the rural districts some of those advantages which attended the establishment of railways? No one can look around and remain insensible to the fact that our present mode of locomotion is destined in the near future to undergo great modifications. Our railways are becoming congested; the streets of our chief towns are year by year becoming more than ever blocked with traffic. Will the electric tramway deliver us from the latter difficulty? It is very doubtful. One would say the streets of Glasgow were made for the electric tramcar, yet there are times when even there congestion is rife. What will it be in towns where the streets have not been laid out with that liberal regard to space which characterises the streets of that great city?

The question we have to approach is one of enormous magnitude. It is not merely one of business, or one of interest from an electrical point of view, but one which, inasmuch as it affects the moral and physical welfare of a great portion of the community, must sooner or later affect our national welfare. We have not merely to consider the ingress and egress of that population which is at present residential beyond the boundaries of the chief towns, but that greatly larger body, the pent-up worker, who exists between the factory, whence he earns his bread, and the crowded street, the slum court, or confined alley. To afford them the means of living in a healthful atmosphere, beyond the precincts of the town, means something far beyond any present provision, or the aid to be derived from shallow subway tramcar services; and yet to its accomplishment must we look if the moral and physical advancement we aim at is to be achieved. Year by year the difficulties consequent upon concentration of population become more apparent, and there exists no large town which would not welcome a more rapid mode of transit between its centre and its boundaries. How this is to be best accomplished is a question that must shortly call for grave and careful consideration, and especially so in this great city of London.

The electric tramcar—those moving palaces of light—has come to stay; but its field in the larger towns will doubtless be local traffic only, and with that it will scarcely cope. Traffic between the city and the more distant residential districts will require to be supplemented by a more direct, more rapid, and more extensive means of transit. If these surmisings are correct, and I believe I shall carry you with me in my conclusions, the relief we seek will, in respect of the larger towns, resolve itself into short suburban lines of railway radiating from one or more centres into the suburban districts, supplemented by a tramway service both in the city and in the suburban district. This it appears to me will prove the solution of the impending changes associated with city life locomotion, and in it will, I believe, be found the means of affording the pent-up population, growing more dense every year, that relief which is felt to be so necessary for the moral, social, and sanitary condition of the people.

But the question is one which goes far beyond the needs of city locomotion. Is it to the interest of the community that this ready means of communication should be limited

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to city or local areas? Have we not in it a means of supplementing the utility of our railway system, so that not only may populous villages be provided with easy and comparatively rapid means of access between each other and the neighbouring town, but also with the near railway station? It will be evident that to afford these facilities to rural districts alone would prove unremunerative. The point for consideration, then, is how can both municipal area and rural district be so served as to become a pecuniary success of such a character as to extend, as population increases, its advantages farther afield. There can be no question of pecuniary success accompanying the service of the town and its suburban area, but will this accomplish that full benefit desired? Even the suburban district of a town is by no means a fixture. As population increases, as districts become populated, as property increases in value, provided covenience for locomotion is established, so will the man of small means find it to his interest to go farther afield—even to adjacent villages. To afford free intercourse between town and village it is apparently desirable that the limitation imposed upon this means of communication should be restricted neither by boundary of town nor county, but that the basis of its extent and operations should be as nearly analogous as possible to that of the railway system. How this can best be accomplished, whether by joint enterprise, as with the railways, or by county or municipal enterprise, is a question which demands careful and far-seeing consideration. The convenience which a well-conducted service is calculated to afford may be, to some extent, gauged by the announcement made on the occasion of the opening of the Southall extension of the London United Electric Tramways Company, to the effect that during the previous three months between eight and nine million passengers had been conveyed over the 7½ miles of electric route, then completed, at fares which did not amount on an average to ½d. a mile. To effect the common weal we must carry, to the farthest point remuneratively possible, the advantages which attach to this means of communication. By it will the resources of the provinces be more fully developed, and to the cottager be brought some of the advantages of the neighbouring town. As one associated with our railway system, I ask myself in what way is this service destined to affect existing railway interests. The question is an important and a difficult one. In some instances, as has been the case with the Dublin, Wicklow, and Wexford Railway, it will undoubtedly make its mark on the railway revenue. In residential and in pleasure districts it will be most emphasised; but, on the other hand, there is reason to believe that, in many districts, it will ultimately bring to the railways as many passengers as, in other respects, it takes from them. With increased facilities for intercourse will come the growth of local industries; the desire to see what others are doing; to keep abreast of competitors; to see the world. Trade and a love of travel will be stimulated by the facilities with which it is nourished. I next turn to

Electric Traction on Railways.—Is electric traction, which is being so rapidly developed in towns, to prove of service to our railway systems? With the economies which might be fairly anticipated, were our main lines of railway operated by electrical energy instead of by numerous steam units as at present, I have, to some extent, dealt previously. To many it will, I daresay, appear that the economies which I then set forth might properly have been extended. In this I agree, and I equally agree that there may have been charges on the other side which I failed to take into account. Of this, however, I think we must all be aware, that if it were possible to convert the existing systems into electrically-worked systems great advantages should accrue. The conservation of our coal, the greater purification of the atmosphere, the increased cleanliness of all things forming part of or bordering upon the railway, are national advantages contributing to the welfare of the community at large. If such a change could be effected at once, very many improvements in the mode of dealing with the traffic would appear feasible. Thus trains might be dispatched at more frequent intervals—trains of lesser magnitude, capable of travelling at a higher rate of speed. It is obvious that this might also, to some extent, be accomplished by the steam locomotive, but to do so would mean a large increase in the number of engines and tenders, increased engine-shed accommodation, and all attendant expenses. In my official capacity it is not my duty to determine the speed at which trains shall travel, but I cannot refrain from expressing my conviction that if it were possible to lessen the enormous difference which now characterises the speed of passenger and goods trains great advantages would follow. This can only be accomplished by lessening the mass of the goods and mineral trains, and bringing it more under the control of the brake—a result which probably will never be attained under the steam locomotive *régime*.

The advantages that would accrue from a facilitation of the traffic scarcely calls for demonstration. Wherever the traffic is of a mixed character, involving the movement of trains at speeds varying from, say, 20 to 60 miles an hour, time must, even where scheduled time is observed, be sacrificed; and this loss must be greatly aggravated by the shunting of the heavy trains for the passing of those of a preferential character. The magnitude of the results arising out of this is not, perhaps, fully appreciated, for the existing mode of working the traffic scarcely admits of its consideration. But let us assume that in shortening these slow and heavy trains we are able to run them at a speed of not less than 40 miles an hour. As there would be no shunting, for the reason that, with the exception of the express trains, all would be moving at about the same speed, it is clear we should practically double the capacity of the line, and that without increasing the labour charges, because, although we double the trains, we halve the time. The number of trains that would come under this category would probably be 75 per cent. of the entire number, and if the method would admit of the acceleration of the expresses also it may well claim an increased capacity of 100 per cent. In other words, such a result would avoid that duplication of lines which is now unavoidable, and which is adding so many millions, year by year, to the capital account. The operation by electrical means of the passenger traffic as it is conducted to-day would appear to present no difficulty, for, if necessary, each carriage could be provided with the necessary motors for its propulsion; but to work a railway economically—to reap the full advantages of an electrical service—it is necessary that the entire traffic of the line, goods as well as passenger, should be worked by the same means. To work one class of traffic by electricity and the other, as at present, by steam units, although such a course is quite practicable, would involve a large increase in both capital and current charges; for the cost of establishing and operating electrical working for the passenger traffic would be very little less than it would be if dealing with the entire traffic, and there would still remain the cost attending that portion worked by the steam locomotive. Such a course appears to me impracticable. Therefore, in considering the initiatory stage of replacing the steam by the electric locomotive, we have to face the present condition of traffic—to deal with the trains as they are made up for the former type of motor. Assuming it were determined to test the possibilities of electricity on a given section of a line of railway, whatever that section might be—whether terminal or intermediate—the electric motor would require to haul the trains that might reach that section of line as they were handed over from or required to be carried forward by the steam locomotive. It would, in fact, have to take the place of the latter and do its work. It may be said its capabilities to do this under all conditions has not been proved. It will, however, be clear that, assuming one electric locomotive incapable, there is no reason why two should not be coupled together in the same manner that steam locomotives are coupled. And in doing so, it is worth while noting that we should reap some advantage, for not only would it be possible for the two to be controlled by one man, or one set of men, but in distributing the weight over a greater wheel base we should to that extent reduce the impact on bridges and other structures over which the vehicles pass. The importance of this will be apparent when we realise that the total weight of a modern locomotive and tender loaded exceeds 100 tons; that of this weight some 34 tons is comprised within a wheel base of 9ft. 6in.; 26 tons and 24 tons

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each within 5ft. 6in. The tendency of the day is to increase the speed of passenger trains and the load of the good and mineral trains, and to this end to employ larger and more powerful engines. In either case this course must involve greater stress on both permanent way and structural works; and to this extent it would appear that the two electric locomotives would be more acceptable to the engineer of the line than would the steam locomotive. Much interest no doubt attaches to those railway conversion problems in hand here and in other countries; but assuming them proved—assuming them to be a success—would that success be deemed sufficiently definite to lead to its adoption on main lines generally? I scarcely like to commit myself to that opinion. I have full faith that our railways will be worked by electrical agency, but I want, with you, to look the probability squarely in the face. Every line of railway has its own mode of dealing with its traffic, and the character of the traffic is not the same on all lines. The only satisfactory way to prove the power of electricity to meet existing conditions is to impose upon it the work to be done. To do so on a suitably selected section of line would not be a great tax upon the resources of any one of our great railway companies, especially as it need not in any way, for the time being, derange the steam-worked traffic passing over that section of line.

Now, let us look at the subject from another point of view. Electricity is credited with the power of accomplishing greater speed at a less cost than steam. An impression is abroad that greater facilities for rapid transit between large centres of commerce are a necessity of the day. If it should transpire that electrical propulsion is inapplicable to main-line traffic as a whole—a conclusion which few would, even at the present moment, accept—it will unquestionably lead to the establishment between the chief commercial centres of high-speed passenger electric traction on independent lines. Communication between Manchester and Liverpool has, so far, been met—and one would say amply so—by three lines of railway, all running a good train service, yet the construction of an electric line on the monorail system has received parliamentary sanction. It is an object lesson, and tempts me to ask whether the requisite powers would not have been preferably granted to one of the existing lines of railway—a line of railway capable of interchange of stock and of connection with other lines—to employ electrical agency as its motive power had powers for that purpose been sought.

Nothing could be more disastrous than that competition of such a character as, for instance, that thus initiated between Liverpool and Manchester should arise. Whatever success may attend competitive electrical enterprise in this respect must be, to some extent, prejudicial to the established systems. If the former should prove a pecuniary success, the reverse must be the condition of the latter. The capital invested in existing railways exceeds 1,300 million pounds. The wholesale depreciation of such a vast sum, the interest of which forms the income of numerous families and annuitants, would be little short of a national calamity. Naturally, were independent electric lines of railway to be established between the chief centres of commerce it would still leave a large mileage of the existing lines of railway unaffected by them, but is it from those parts of a railway system that the earnings come? The consequence must be, at the least, a decreased dividend, and probably in the end an enforced establishment on the older lines of a similar electric service between large towns.

(To be continued.)

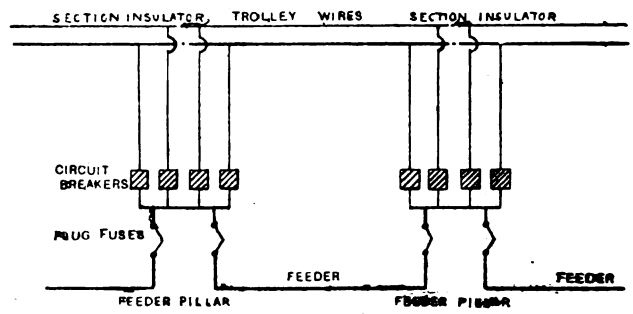
CONTROL OF OVERHEAD TROLLEY WIRE BY CIRCUIT BREAKERS IN FEEDER BOXES.

BY A CORRESPONDENT.

The principal cause of delays on an electric tramway system is short-circuits due to fall of trolley wire, guard wire, and insulation burning out. The fall of guard wire is most frequently the cause, for when the trolley pole is dislodged from the trolley wire it not unfrequently tears down the guard wire either when it springs up or when it is pulled down by the trolley man. When a short-circuit takes place the entire section is dead until one of the engineers either cuts out the trolley wire on which the fault is by means of plugs in the feeder pillars, and traffic resumed on the other trolley wire, or repairs the fault. This generally means a delay of 15 minutes or more.

Now, this delay could be minimised if the trolley wire on which the fault is were cut out by an automatic circuit breaker in the feeder pillar instead of fuse plugs or switches. The circuit breaker would be set to come out at something above the maximum load on the particular section, say two cars starting and two running at the same time, about 60 amperes. A short-circuit, even when not a perfect earth, means usually something over 200 amperes breaking away. The circuit breaker set at about 80 or 90 amperes would be on the safe side.

At present, with fuse plugs in the feeder boxes, when guard wire falls on to the road with one end touching the trolley wire, when the engineer replaces the switch in the power-house, which he generally does five or six times at intervals of about 20 seconds, there is great danger of horses and persons becoming entangled in this fallen wire and receiving dangerous and perhaps fatal shocks. With the circuit breakers in the boxes, however, once the short has occurred, the fallen wire can be handled with safety.



One drawback to this system is that a short sometimes occurs owing to the trolley pole touching the guard wire and trolley wire simultaneously without doing any permanent injury, and thus one trolley wire on the section would be cut off needlessly. But with competent men on the section always handy, such as certain of the motormen and inspectors, the circuit breakers could soon be replaced.

The initial cost of circuit breakers would certainly be more than that of fuse plugs; they would last longer, however, as fuse plugs receive somewhat rough usage, as a rule, and when of the porcelain type require frequent renewals. Allowing for this, circuit breakers would certainly be the cheaper in the long run.

The ideal system would be to control each small section from the power-house. This would necessitate pilot wires to each feeder pillar, controlling an electromagnetic device for cutting out the faulty trolley wire. The cost of this would be prohibitive, and taking into consideration the great prevention of serious accidents which it ensures to the general public, the control of the trolley wires by automatic circuit breakers in the feeder boxes should commend itself to traction engineers.

[N.B.—Will the writer of the above kindly forward his full address.—ED. *E. E.*]

ELECTRIC TRACTION ON THE "UNDERGROUND."

(Continued from page 700.)

FRIDAY, NOV. 15.

The enquiry into the dispute between the Metropolitan District and the Metropolitan Railway Companies as to the system of electric traction to be employed on the Inner Circle, was concluded before the arbitrator, the Hon. Alfred Lyttleton, K.C., M.P., assisted by Mr. H. F. Parshall and Mr. T. Parker, at the Royal Courts of Justice.

Mr. Fletcher Moulton, K.C., addressed the Court on behalf of the District Railway Company. Both the parties, he said, were agreed that the direct-current system was perfectly capable of being applied to the Inner Circle without any electrical or engineering risk at all, and the question for the arbitrator to decide was which of the two systems proposed was the wiser and more prudent to adopt. He

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pointed out that the statute provided that the arbitrator should not be an electrical engineer, which points to the conclusion that the question for him was a purely practical one. That the direct-current system could be applied to the Inner Circle with perfect safety and efficiency was not disclaimed by the other side, and Mr. Cripps, throughout the conduct of his case, had not attempted to contest that position. It was admitted that there was only one system of electrical traction in use at the present time, and yet the Court was asked to decide for a system which was not used anywhere, and which was absolutely untried. Even on those railways which did use polyphase motors, the system was totally different from the Ganz system proposed for the Inner Circle. Experience had perfected one system and made it a certainty, whereas experience had not begun to be formed on the other. That the polyphase system had merits in some features he had no doubt, but he submitted that until experience had brought it into shape it would be utterly unwise and imprudent to apply the system, untried as it was, to a railway having probably the heaviest and most congested traffic in the world, and where interruption of traffic would be of the utmost seriousness. Mr. Blathy had given his evidence with conviction, but that very conviction showed that he was utterly incapable of being a practical adviser. Mr. Blathy had a half-tried system, and so little did he value the experiments on the mile of line at Budapest and at Sondrio that he was quite ready to toss them over for something on paper which had fairer promise. He did not appear to appreciate the difference between systems on paper and systems in practice. Proceeding in his criticism of the Ganz system, Mr. Moulton claimed that the evidence given with regard to the method of control was vague. On the question of cost of installation and working cost, it had not been attempted to justify the Ganz tender, nor was it suggested that it was complete. Messrs. Preece and Parker had obviously never compared the two tenders, or they must have seen that the direct-current system was cheaper to instal and more economical in working cost than the polyphase system. His case was that beyond the evidence of the expert engineers—the best to be obtained—given for the District Company, that the Ganz system was the more expensive system both to instal and to work, there was no admissible evidence of the relative cost and efficiency of the two systems. He argued that Mr. Blathy had shrunk from a fair comparison of the two systems. He had increased his acceleration figure from 1·5ft. per second per second to 2·6ft., which considerably reduced his figure of cost, whereas the acceleration of 1·5ft. in the direct-current system had been adopted by his clients as being the most practical to meet the requirements of the present case. The whole Ganz scheme, both in figures and in form, had been changed by Mr. Blathy. He contended that the weight of evidence was clearly in favour of the direct-current system, both in point of efficiency, cost of installation, and working cost. The learned counsel then criticised the Ganz system in detail. He found fault with the proposed water rheostats, which he said had never yet been tried in traction work, and dwelt at some length upon the serious delay which would result on the Inner Circle from fractures on the overhead conductors in the Ganz system. The penalty of a failure in any one of the numerous details of this system would be a complete stoppage of the traffic for a time at any rate, and possibly at an hour of the day when the bulk of the receipts on the Inner Circle were made. Speaking on the question of safety, Mr. Moulton argued that enormous experience had proved there was no danger with the direct-current system, whereas there was absolutely no experience whatever as to the safety of the Ganz system. The consequence of any act of negligence, such, for instance, as the touching of the overhead conductors with a voltage of 3,000 on the line, would be fatal. In conclusion, he asked the tribunal to say that the District Company had made out their case that the direct-current system, which both parties had agreed was perfectly competent at the present time to undertake the electrical equipment of the Inner Circle, was the one to be preferred.

This concluded the speeches, and **Mr. Cripps, K.C.**, urged the importance of the arbitrator making known his decision at the earliest possible date.

The **Arbitrator** said it did not rest with him when the result of the enquiry would be announced, as under the statute he, and the two gentlemen who assisted him, had to report to the Board of Trade, which would then give its decision. He thanked all parties for the assistance they had given him throughout the conduct of the enquiry, and the proceedings closed.

LEYTON ELECTRICITY ACCOUNTS.

From the accounts of the Leyton Urban District Council electricity works it appears that the total expenditure on capital account to March 31, 1901, amounted to £98,022. Herewith are given abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.:

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.O.T. units		724,220
Quantity sold: Public lamps	210,862	608,674
Quantity sold: Private consumers by meter	397,812	
Quantity used on works		45,000
Total quantity accounted for		653,674
Quantity not accounted for		70,546
Total maximum supply demanded (kilowatts)		469

Number of public lamps—283 incandescents, 63 arcs.

REVENUE ACCOUNT.

Dr.				£ s. d.
Generation of Electricity.				
Coal or other fuel	£2,679	18	2	
Oil, waste, water, and stores	265	5	5	
Proportion of engineers' salaries	367	8	1	
Wages at generating station	656	11	7	
Repairs and maintenance of buildings and plant	624	17	7	
				4,594 0 10
Distribution of Electricity.				
Repairs, etc., of mains	56	12	7	
Repairs, etc., of meters, etc.	19	15	8	
Repairs, etc., of other apparatus	7	6	11	
				83 15 2
Public Lamps.				
Attending and repairs	526	8	5	
Renewal of lamps	98	1	2	
				624 9 7
Rents, rates, and taxes				326 13 4
Management Expenses.				
Salaries—viz., engineer's department	836	18	7	
Stationery and printing	102	13	2	
General establishment charges	123	12	9	
				1,063 4 6
Law and parliamentary expenses				796 16 9
Special Charges.				
Insurances, etc.	92	9	11	
Self-insurance against breakdown	80	0	0	
Interest on deposits	3	3	9	
				175 13 8
				7,664 13 10
Amount carried to net revenue account				1,086 19 1
				£8,751 12 11

Cr.	£ s. d.
Sale of current by meter	6,418 5 10
Sale of current for public lighting	2,155 15 4
	8,574 1 2
Less bad debts written off	25 15 4
	8,548 5 10
Rental of apparatus on consumers' premises	169 14 10
Rent receivable	10 0 0
Profit on installation work and repairs	23 12 3
	£8,751 12 11

GENERAL BALANCE-SHEET.

Dr.	£ s. d.
Capital account—amount received	93,984 0 0
Sundry creditors	2,603 18 5
Amount due to treasurer (less cash in hand)	11,467 18 7
Self-insurance fund	131 0 0
Consumers' deposits	170 18 6
	£108,357 15 6

Cr.	£ s. d.
Capital account—amount expended for work	98,022 2 6
Stores on hand	133 19 7
Sundry debtors for current supplied	2,799 0 5
Sundry debtors for work done	380 0 5
Net revenue account	7,022 12 7
	£108,357 15 6

APPOINTMENTS VACANT.

Clerk of Works, Hornsey Urban District Council electricity works, £250 per annum, Dec. 2. Full particulars in our advertisement columns.

Assistant Draughtsman, with office and outdoor experience in the overhead equipment of electric tramways, for borough engineer's office of a large town, £2. 5s. per week, Nov. 26. Full particulars in our advertisement columns.

Junior Demonstrator in the Electrical Engineering and Applied Physics Department, Northampton Institute, London, E.C., £80 per annum, Nov. 27. Full particulars in our advertisement columns.

Demonstrator of Electrotechnology at the R.I.E. College, Coopers Hill, Staines, £150, rising to £200. Full particulars in our advertisement columns.

Draughtsman for switchboard design, Manchester district. Full particulars in our advertisement columns.

General Manager and Traffic Superintendent, Southend-on-Sea Corporation electricity tramways, £150 per annum, Dec. 2. Full particulars in our advertisement columns.

Jointer, Swansea Corporation. £2 per week, Nov. 27. Full particulars in our advertisement columns.

Foreman Motor Attendant, to take charge of the maintenance of electric motors, arc lighting, and repairs of wiring in a large factory in the North, wages 45s. Full particulars in our advertisement columns.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

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TELEPHONE COMPETITION IN LONDON (?).

On March 10, 1899, when the Government Bill for providing two millions for telephone competition in London had just been introduced in the House of Commons, we wrote a leader headed "Purchase, Confiscation, or Competition." This leader commenced: "The Government proposals relating to telephones are now known, and have been hailed with delight by all parties. This unanimity of sentiment is somewhat startling, and requires careful investigation before admitting its correctness." We went on to show that the Government by the careful way in which it tried to explain the morality of its proposed action had doubts as to the same. Be that as it may, the Postmaster-General received with two millions of money instructions to provide an efficient competition to the National Telephone Company's London system. This everyone took to mean that not only would a more prompt service be given, but also that the rates for telephone connections would be reduced. Every business man expected that in consequence of this competition he would derive a benefit directly, and the Government looked on the step it had taken as being to a certain extent a solution of the awkward question as to what was to happen when the National Telephone Company's license expired. The Post Office officials proceeded to provide a thoroughly good system of underground conduits for their conductors, and in so doing rode rough shod over the obstruction of the local authorities which had hampered the National Telephone Company for years. A few of these local authorities had the temerity to refuse consent to their streets being opened, and were politely informed that their consent was only asked as a matter of compliment. While the work was in progress no news could be obtained as to the policy of the Postmaster-General, and it is not until this week that we get the full particulars as to the keen and efficient competition for which we have to pay two millions. The result is startling, and yet, after reflection, the Postmaster-General is perhaps to be commended for making the best of a bad job. Whatever the morality of the competition he was instructed to provide, he had no legal power to get cross-connection between subscribers on the competing exchanges in any one area. This difficulty, of course, does not occur on trunk-line calls. Without such cross-connection between the rival exchanges, the Post Office would have to secure all the large firms in any area before their system would be of value to their subscribers. This would result in these large firms belonging to both exchanges, and however keen the rate competition might be, it is not likely that these large subscribers would get connection on the two exchanges for the same annual charge as the National Company have made recently. Even if this were the case, endless confusion would arise. All these big firms would have two telephone numbers, and even their own staff would find it impossible to avoid wrong calls. The confusion would become worse confounded in consequence of the smaller subscriber, who would not pay the double fee, but who would belong first to the one system and then to the other. It was, therefore, of the utmost importance to the public that the Postmaster should secure for subscribers to his exchanges the right of free intercommunication with the National Company. Reading between the lines, we should say that the National Telephone Company refused to give this connection, which could only be obtained by agreement, unless the rates were maintained at practically their present values. An agreement was accordingly made—the full text of which, we trust, will be made public—by which all competition, as it is understood by business men, is at an end before it existed except on paper.

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Both the National Telephone Company and the Post Office have now introduced other systems of charges for a message-rate service and party-line service, which do provide cheaper telephones to infrequent users. The party-line subscribers do not get secrecy in conversation, and yet this service is intended to meet the wants of the domestic user, where secrecy is most highly valued. We can conceive of no more disastrous innovation in suburban society than that ten ladies who know each other should be connected on to the same party line. The message-rate system will be of great service to the infrequent user. It now is worth considering what are the opportunities which the Postmaster-General has in the competition, which is only on the grounds of efficiency of service. In the first instance, with only a few subscribers on the Post Office exchange, practically all the connections will be made between a subscriber on the one system and one on the other. If these two subscribers happen to be in the same area, there will be one more operation involved than if they were both on the National exchange. This will result in a slight delay, which may influence a new subscriber in favour of the old company. In other cases there will only be the difference due to the promptitude of the operator, and in this the probable advantage lies with the National Telephone Company in view of the bad effect on a staff which permanency of service has. We say this without disrespect to the young ladies (free from brogue) whom the Postmaster is collecting, and who will become permanent servants of the Government It would seem to us, therefore, that although the Postmaster-General has taken a course which avoids great inconvenience to commercial men, he has only one point in his favour in what can hardly be called the competition. This is, that he has underground wires. The other point from which the matter may be viewed is a serious one, although it is outside the Postmaster-General's control. Two millions of the public money are being spent in order that in every district in London there shall be two systems of telephones where one would do, and would give much better service. While this does not involve twice the annual expenditure, there must necessarily be a great waste of money which ultimately falls upon the public. What will happen at the expiration of the National Company's license remains to be seen, but in view of the agreement now come to, purchase seems inevitable With a keen competition it might have been possible to ensure that all subscribers should have a Post Office telephone on their premises on the date the National telephone service must cease. With the present agreement as to prices, which prevents competition, this is utterly impossible. As pointed out in our leader of March 10, 1899, the only honourable course then to pursue was to agree with the company and take over their system. Even now it seems to us that a great saving of public money and private individuals' valuable time would be effected if this duplication of telephone equipments were prevented by purchasing on business lines.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LIGHTNING CONDUCTORS.

SIR,—Mr. Dalby and "J. W. F." both appear to have jumped to the conclusion that I advocate bad "earths." I have nothing to say against good ones; in fact, it is indisputable that the "earth" should have the lowest resistance obtainable for the particular building on which the conductor is placed, but a good "earth" is only a matter of comparison, and is only *one* of the points for consideration, and by itself will not constitute either efficiency or non-efficiency. Side flash or lateral discharge will occur between a conductor and other metals sufficiently near it, good "earth" or not. The sparking distance depends on the severity of the lightning discharge (for flashes vary in intensity), the insulating material between, whether the metal is "earthed" or not, and the resistance to earth of the conductor itself. With a conductor on ordinary masonry and with a so-called perfect "earth," that is under one ohm, I am of opinion that the extreme sparking distance to equally well "earthed" metals, like gas or water supply pipes, might be as much as 4ft. 6in. With insulated metals the distance would be very considerably less, and would depend on the capacity of such metals. Increasing the resistance of the conductor "earth" means increasing the sparking distance also.

Mr. Dalby's suggestion that in the Nottingham case the whole of the discharge left the conductor for the gas-pipe because the ohmic resistance of the supposedly damp wall was less than that of the "earth," is untenable. I do not know whether this conductor was tested after the accident or not, but I should think, from my experience in testing similarly made "earths," that the resistance would not be more than 1,000 ohms, and possibly not more than 600 or 700. If Mr. Dalby will try and test the ohmic resistance through masonry 4ft. 6in. thick under somewhat similar conditions, I think he will see the weakness of his suggestion As to the term of expression in the case referred to, I shall probably be saving space by quoting the words used by Dr. Lodge in reference to precisely such phenomena: "The whole discharge divides itself between the two paths according to the laws of divided current appropriate to these conditions."

The cases in which so-called bad "earths" have not caused failure are innumerable—in fact, every conductor erected before comparatively recent times (if we except ships' conductors), that is, from Franklin to Snow Harris—had what would now be called a bad "earth," and if they had failed whenever struck their popularity would not have spread in the face of prejudice and superstition. There are plenty of cases in recent times also where the ground has been blown up only, or the conductor has answered when the discharge passed to it from some unprotected part struck first. When testing old conductors, I sometimes come across cases where the only evidence of their having been struck are the unmistakable marks of fusion at the point.

I fail to see why Mr. Dalby considers it necessary to call my remarks as to the possibility of criticising the theories propounded in the replies a boast. Any theories are open to criticism (good or bad), and it is perhaps possible that even a practical man daily engaged in the protection of buildings from lightning, and whose reputation and living depend on his successful results, may be as qualified to criticise as those who rely on theory unaided by experience. The reason I did not make a few concise remarks is that they lead to just such jumping at unwarranted conclusions as he has been indulging in, and one cannot adequately criticise three columns within the necessarily limited space that I presume you, Sir, could spare for a letter on a subject which is probably not of especial interest to the majority of your readers.

My former remarks were intended as a protest against what I may call side issues being brought into account for so-called failure of lightning conductors while the real reasons are ignored. We have had a time when the absence of earth-plates or the existence of oxidised joints were considered sufficient to account for failures, and it appears as if we were now approaching a time when a bend in a conductor would serve the same purpose. If a bend *did* constitute inefficiency, it would not be possible in many cases, for practical reasons, to protect buildings at all; but I think the zigzag anti-induction arrangement should be a sufficient answer to the suggestion that bends increase self-induction.

I cannot now go into my reasons for saying that inductance need not be taken into account, but I may point out that "J. W. F." and "J. C. R." as well appear to have missed the sequel to the experiment referred to. In the discussion which followed Dr. Lodge's paper before the Institute of Electrical Engineers in 1889, Mr. Wimshurst

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showed experimentally that the discharge did not jump across the air-gap instead of going round, but that the spark there was in the opposite direction.—Yours, etc.,

Nov. 18, 1901. ALFRED HANDS.

REVIEWS.

We have received from the Street Railway Publishing Company, 120, Liberty-street, New York, a copy of a work entitled "The Practical Electric Railway Handbook," by Albert B. Herrick, consulting electric railway engineer. In the preface we are told that the author's present attempt is to collect together under one cover all such data as is directly applicable in the construction, testing, or operation of electric railway systems, showing such appliances, structures, and methods as have been adopted in practice by street railways in the United States. The use of mathematics and formulæ has been limited as far as possible, so as to make the book useful to the great majority of practical workers. An examination of the contents of the book fails to disclose any failure on the author's part to accomplish his self-imposed task. The 400 pages, or thereabouts, of descriptive matter and data which he has compiled seem well calculated to give the reader a good idea of modern street railway—what we should call electric tramway—practice in the States. Included are numerous well-executed drawings and diagrams, besides the usual quota of tables, etc., without which no work of this kind would be complete. It is unnecessary here to detail the whole contents of the book. Suffice it to say that its scope extends to all questions relating to the power-house equipment, track, and rolling-stock of a modern electric tramway system. We have no hesitation in recommending the "Practical Electric Railway Handbook" to those who may be interested in American practice.

TERRESTRIAL MAGNETISM.

Sir Wm. H. Preece, K.C.B., F.R.S., president of the Royal Cornwall Polytechnic Society, lectured before the members at Falmouth on the 6th inst. on "Terrestrial Magnetism." Magnetism, he said, was first dicovered in China, but the knowledge of magnetism never extended beyond the Great Wall until in the thirteenth century Marco Polo visited China and brought back with him the magnetic compass. The first great authority to investigate magnetism upon a commonsense basis was Faraday. He showed that every kind of matter was magnetic, and established the relationship between electricity and magnetism. Now, go where they would, they found all the practical developments of this period were the result of the application of electricity to the wants and comforts and to improve the health of man. Magnetism was sometimes called a fluid. There were two fluids according to some—a positive and a negative, a north and a south, or austral and a boreal, a red and a blue. But magnetism was not and could not be a fluid. It was no form of matter, and therefore must be some form of motion. If a piece of magnetic ore was broken up into the minutest fractions of a part that had dimension, the smallest part would still be magnetic. The laws of magnetism were absolutely uniform, absolutely sure. There were the same two poles of the same name, always repelling each other, and the two poles of different names, always attracting each other. Columbus used the magnet in his voyage across the Atlantic, and observed that it was not absolutely true, that it did not always point to the same north; but by keeping the stars in sight and using the stars to correct the compass, he found in crossing the Atlantic that there was considerable variation. The compass, continued the lecturer, pointed to a point considerably to the west of the north. That which we called the north pole pointed to a place somewhere to the north-west of Hudson's Bay, and the south pole to a point south of Tasmania—in each case a long way from the true geographical pole. The difference was variable, changing from year to year, and even from day to day, and it was most essential that accurate measurements should be kept by certain observatories of these variations. There were variations of the point of declination, and also the force with which the pole was attracted to the north. It was the absence of the knowledge of the variations of the compass that often led to serious disasters. The variation was bringing the needle nearer and nearer to the north pole. When he was in Falmouth, 25 years ago, that deviation of the compass was 24deg. Now, in London, it was 16½deg. In 1893, in Falmouth, it was 19deg. 6 minutes; it was now 18deg. 25 minutes, so it varied by about ¼deg. per year. In 10 years it would vary a whole degree, and the difference of a degree in a magnet would in the course of 60 miles make an error of one mile, so unless observatories were maintained right up to the hilt with accurate and careful observers, if the Admiralty did not correct their charts from time to time, if captains of ships did not make themselves acquainted with the different errors, then sooner or later they were doomed to meet with disaster. There was not only the periodical change, a change that was subtle, and unquestionably due to the movement of objects in space, but there were changes that took place every 11 years, caused by magnetic storms, which were always associated with the aurora borealis in the northern regions. There were also solar disturbances, monthly lunar disturbances, and daily magnetic tides. These tides were not serious, and those deviations were not serious in the days of the sailing ship. But the days of the sailing ship were past, and steel was now in every ship that was built, and active magnetism was there by the position in which it was built in the builders' yard. These were errors due to building, errors due to hammering, and errors due to other magnetic disturbances. Even the heeling and rolling of the ship and the hammering of the waves charged this magnetism, and even the existence of the electric light on board might disturb the compass. Fortunately we had got at the root of the evil, and all our nautical men, commercial as well as naval, were thoroughly taught all the rudiments of science, and no officer in the British Navy was allowed to call himself a navigating officer till he had received a certificate for knowledge in terrestrial magnetism, and the mode of correcting those errors in our ships. All causes of error, whatever they might be, came from without, and not from within. There were many reasons for believing that the earth was a highly charged body, and our thunderstorm disturbances and atmospherical electricity tended to lead to the conclusion that the earth really acted as a magnet. There was no doubt that there were currents circulating round about it, but he was bound to confess that the theory of terrestrial magnetism was still, in a way, in a fog. The scientific world was united in the opinion that more observatories were needed, not observatories supported by local people, but international and governmental institutions.

ELECTRICAL ENGINEERS (R.E.) VOLUNTEERS.

The following notice will be of interest to our readers:

The Electrical Engineers Volunteers have already sent out three detachments to South Africa and have carried out work of very great variety and importance. This work included lighting bridges during repair, lighting camps and hospitals, steam traction, bridge repairing, field telegraph and telephone work, and field and garrison search-light work. The third detachment (of 100 men) is now in South Africa, and a fourth (of 50 men) has just been enlisted in compliance with the direct request of the Commander-in-Chief of the forces in South Africa. A fifth detachment of about 100 men is now called for, and those wishing to join must send in their names not later than Dec. 5, as favourable consideration cannot be accorded to late applications. Men joining must be skilful tradesmen, mechanical or electrical engineers, including fitters, blacksmiths, engine drivers, carpenters, joiners, wiremen, and kindred trades, such as instrument makers and repairers. Telegraph and telephone hands are also wanted. Unmarried men are preferred. Applicants must be between the ages of 20 and 40, must be of good physique, at least 5ft. 3in. in height, and with a minimum chest measurement of 32in. for this height.

The conditions of enlistment and pay are as follows: Enlistment for the remainder of the war, but should the war terminate within one year men have the option of completing one year's service or taking their discharge at once. Pay varies according to rank and engineer pay according to skill, as follows: sapper, 1s. 4½d.; corporal, 2s. 9d.; sergeant, 3s. 6d. a day. Engineer pay in addition to above: fair tradesmen, 8d.; skilled, 1s.; superior, 1s. 4d.; very superior, 1s. 8d. a day for days employed. The following gratuities are payable on discharge: volunteer gratuity, £5; War Office gratuity, £5. The third-class railway fare of applicants is paid provided they obtain the written consent of the commanding officer of this corps to present themselves for approval. They must send sufficient particulars both as to phsique and trade qualifications to enable the officer commanding to form an opinion as to whether they are eligible for service in South Africa.

Applications should be addressed to the Officer Commanding Electrical Engineers (R.E.) Volunteers, Regency-street, London, S.W.

FORTHCOMING EVENTS.

SATURDAY, NOV. 23.

Manchester Association of Engineers.—At 7 p.m., ordinary meeting. Paper: "Electric Welding," by Mr. T. T. Heaton.

TUESDAY, NOV. 26.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper, "Train Resistance," by Mr. John A. F. Aspinall.

WEDNESDAY, NOV. 27.

Institution of Electrical Engineers (Birmingham Section).—At 7.30 p.m., ordinary meeting. Address by the Chairman (Prof. Lodge, F.R.S.), on "Self-Induction."

THURSDAY, NOV. 28.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Papers: "A Permeameter for Testing the Magnetic Qualities of Materials in Bulk," by Dr. C. V. Drysdale, D.Sc.; and "The Physical Properties of Certain Aluminium Alloys and some Notes on Aluminium Conductors," by Prof. E. Wilson.

SATURDAY, NOV. 30.

Institution of Electrical Engineers (Students' Section). — At 10.30 a.m., visit to the generating station of the City and South London Railway.

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LONDON TELEPHONES.

In the following words the Postmaster-General announces the subscription rates for the Post Office telephone system in London. In reading the same, it will be well to bear in mind the fact that an agreement has been made with the National Telephone Company whereby all competition as far as rates are concerned is avoided. The official documents read :

The Postmaster-General, with the sanction of the Lords Commissioners of his Majesty's Treasury, has now fixed the rates of subscription given in the following table for the public telephone exchange service which is being established by the Post Office in London and in the various adjoining towns and districts included in the London telephone area.

In fixing these rates, he has had chiefly in view the necessity of meeting the requirements of very varying classes of subscribers. The Select Committee of the House of Commons, which made a prolonged enquiry into the telephone service in 1898, reported that the system which had up to that date been in force in London, under which subscribers were entitled to an unlimited use of the service, was a fair one for those classes who were able to avail themselves of this privilege to a considerable extent, but that the system did not meet the requirements of numerous classes to whom a moderate use of the service would be of great advantage both for business and domestic purposes.

The system which the Postmaster-General has adopted as the standard mode of subscription to Post Office exchanges provides that the subscribers shall pay a moderate annual subscription of £5 a year for connections with exchanges in the county of London, and of £4 a year for connections with exchanges in other parts of the London telephone area. In addition to the annual subscription, a small fee of 1d. or 2d. will be charged for each call which the subscriber originates, and in order to cover the necessary cost of attendance and other expenses which must be incurred at the exchanges, whether the subscriber uses the service or not, he is to be required to pay a moderate annual sum as a minimum payment in respect of message fees.

The rates mentioned above cover the provision of a separate exchange line for the exclusive use of each subscriber, but an alternative "party-line" system will be offered to those subscribers to whom privacy is not so much an object as the right of access to the public system of communication. Where two subscribers can conveniently be grouped together on the same exchange line, the annual subscription will be reduced to £3 for a connection with any exchange in the area, except the central exchange in the City, where the pressure of traffic will be too great to allow of this system being adopted. In the districts outside the county of London a still cheaper service will be offered to those subscribers who do not object to sharing the use of a line with more than two others ; but in no case will more than 10 subscribers be connected with any exchange line. The annual subscription for this class of party-line connection will be only £2 a year, and it is believed that both of the party-line services will be of advantage to many persons, and especially to small traders. The message fees for calls originated on party-lines will be the same as for the calls made by message-rate subscribers, although a higher amount as a minimum payment for message fees is necessary. A party-line subscriber will therefore be able to make a much larger use of the system for the same total expenditure, than a subscriber who requires a line for his exclusive use.

It is hoped that one or more of the message-rate services will meet the requirements of a large number of persons who will in future become subscribers, but the classes who have hitherto used the service will probably, in many instances, still require the right of unlimited use. To meet these classes the Postmaster-General has adopted a rate which is proportionate to the service required. For the first line giving the right of unlimited use an annual subscription of £17 a year will be required, and for each additional line which the same subscriber may require, whether the premises and the exchange connected are the same or not, the annual subscription will be reduced to £14. Under this system subscribers will have the right of communication with any other subscriber in the London area without further charge.

The message-rate system is a novelty in its application to London, and it has only been introduced during the last two years in other parts of the United Kingdom, but it is well known in other countries where large telephone systems exist. It is stated that in New York no less than 45,000 telephones are worked on a system of payment according to the number of messages sent, and the number is rapidly increasing both in New York and in most of the other large cities in America as well as in Europe. The system is the only one under which provision can be made for the varying wants of subscribers, and its introduction is a necessary condition of the extension of the telephone system, so as to make it commensurate with the manifold commercial and social interests of the metropolitan area.

The rates of subscription now fixed for London are higher than those which the Postmaster-General has offered for exchanges in other parts of the kingdom, but this is rendered inevitable by the conditions under which the service has to be provided. It is a well-known fact that the cost of a telephone service increases more rapidly than the number of subscribers. This is due to the fact that the addition of every subscriber's line creates greater complexity in the equipment and working of exchanges. The London telephone area is probably the largest local exchange area in the world, and the provision of a thoroughly efficient service throughout this large area, which covers more than 600 square miles, is the most difficult problem which any telephone undertaking has ever had to solve.

The announcement that the Post Office was about to undertake the construction of a new telephone system in competition with the system of the National Telephone Company has given rise to some alarm in the public mind as to the inconvenience likely to be caused to subscribers if no arrangement were to be made for connection between the two systems. In order to meet this difficulty, the Postmaster-General has for some time been in negotiation with the National Telephone Company, and an arrangement has now been concluded under which subscribers on either system will have the right to full and free intercommunication. In other respects competition will still exist between the two systems, but as the company has agreed to charge the same rates as the Post Office, it is hoped that it will have no other result than to promote the efficiency of the general telephone service.

Rates of Subscription.

1. *Ordinary Message-Rate Service.*—(*a*) Charges for connection with any exchange in the county of London within two miles of the subscriber's premises : annual subscription, £5 ; message fees—1d. for each call to a subscriber on any exchange in the county of London ; 2d. for each call to a subscriber on any exchange outside the county of London. (*b*) Charges for connection with any exchange outside the county of London within two miles of the subscriber's premises : annual subscription, £4 ; message fees, 1d. for each call to a subscriber on the same exchange ; 2d. for each call to a subscriber on any other exchange. The minimum yearly amount payable by each subscriber for message fees is 30s.

2. *Party-Line Message-Rate Service.*—Annual subscriptions : (*a*) for connection with any exchange except the central exchange by means of a line used by not more than two subscribers, £3 ; (*b*) for connection with any exchange outside the county of London by means of a line used by more than two and not more than 10 subscribers, £2. Subscriptions at party-line rates cannot be accepted from subscribers on the central exchange, or at the lower party-line rate from subscribers on any exchange in the county of London. Message fees for calls originated by party-line subscribers will be the same as for calls by subscribers at the ordinary message rate, but the minimum yearly amount payable for message fees by each party-line subscriber is £3.

3. *Unlimited Service.*—Annual subscription for connection with any exchange within two miles of the subscriber's premises, together with an unlimited number of calls : (*a*) for the first line, £17 ; (*b*) for each additional line connecting any premises of the same subscriber with an exchange, £14.

4. *Call Office Fee.*—For any call from a call office to any subscriber in the London area, 2d.

5. *Additional Annual Charges.*—(*a*) Where the premises of any subscriber at the ordinary message rate or at the unlimited service rate are more than two miles from the exchange, for every additional quarter of a mile, £1. 5s. ; (*b*) where the main circuit of a party line exceeds two miles in length, for each additional quarter of a mile (for each subscriber), 10s. ; (*c*) for each extension line connecting two parts of the same premises of a subscriber, where the line is not more than 110 yards in length, 30s. : (*d*) for each additional 110 yards of such a line, 10s. : (*e*) for each extension line connecting separate premises of the same subscriber, and not more than a quarter of a mile in length, £3. 10s. ; (*f*) for each additional quarter of a mile of such a line, £1. 5s.

6. All agreements shall be for one year, and shall be terminable thereafter by three months' notice.

7. Post Office subscribers will have the right to communicate with subscribers of the National Telephone Company in the London exchange area at the same rates of charge as for communication with other Post Office subscribers.

In conjunction with the above, it is well to consider what the National Telephone Company have charged up to this week both for London and provincial services. In London only one system of charging a fixed fee for an unlimited number of calls has been in vogue, the scale being :

£20 per annum on a yearly agreement.
£17 per annum on a five years' agreement.
£15 per annum for a second connection to the same firm on a yearly agreement : and
£12 per annum for a second connection to the same firm on a five years' agreement.

As regards the provinces, the following details from Birmingham show what the company has provided on the party-line and message system :

Party-Line Service.

Ten-Party Line.—For this service a subscriber is one of 10 on the same circuit. He is not required to make any annual payment, nor is he charged anything for inward calls—that is to say, he can be called up by other subscribers free of any charge to himself. In respect of outward calls—that is to say, calls which the subscriber himself originates—the charges to him will be as follows : for each effective call to any subscriber on the same exchange, 1d. ; for each effective call to any subscriber on any other exchange in the area, 2d. Each subscriber on this service is required to guarantee to make or pay for calls to the value of at least 2d. per diem. [That is, £3. 0s. 10d. per annum for 730 1d. calls, or 365 2d. calls.—Ed. *E. E.*] The money will be collected by means of slot machines attached to the telephone instrument. For the purposes of this service the Birmingham (central and jewellers) and Edgbaston exchanges are deemed to be one exchange, and the West Bromwich, Smethwick, and Oldbury exchanges are also deemed to be one.

Two-Party Line.—For this service a subscriber is one of two on the

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same circuit. The same rules and regulations apply as in the case of the 10-party service, with the distinction that the subscriber must guarantee to make or pay for calls to the value of at least 4d. per diem. For this service the subscriber may, if he think fit, commute the payment per call by the payment in advance of the sum of £6 per annum, in which case he can have an unlimited number of calls throughout the exchange area.

INDIVIDUAL CIRCUIT SERVICE.

Message Rate.—For this service the subscriber is required to pay an installation charge of £3. 3s. per annum, plus the Government duty of 7s. (together £3. 10s. per annum), and in respect of this payment he can be called up by other subscribers free of charge to himself, but in respect of all calls which he himself originates he is required to pay 1d. or 2d., as the case may be, the scale in this case being the same as in the party-line service.

Unlimited Service.—For this service a subscriber is required to pay: for first connection, £10 per annum; for second and additional connections, £8. 10s. per annum. In respect of these payments he has the right to unlimited service throughout the whole exchange area. The exchanges now open in the Birmingham exchange area are as follows: Birmingham (central and jewellers) and Edgbaston (deemed for the purposes of charge per call to be one exchange), West Bromwich, Smethwick and Oldbury (also deemed for the purposes of charge per call to be one exchange), Redditch, Acock's Green, Bromsgrove, Halesowen, Barnt Green, Erdington, and King's Norton. All rates are based upon the subscriber's premises being within one mile of the exchange. Special rates for extra distances. All agreements are for one year.

With the Post Office scale in London the minimum charges per annum are as follows:

Ordinary message-rate service, £6. 10s., which provides for 360 1d. calls or 180 2d. calls.

Two-party line subscribers, £6, which provides for 720 calls of 1d. or 360 2d. calls.

Ten-party line subscribers, £5, which provides for 720 calls of 1d. or 360 2d. calls.

MANCHESTER SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address.

BY C. H. WORDINGHAM, M.I.C.E., M.I.MECH.E. (MEMBER), CHAIRMAN.

It is no formal or conventional thanks that I render to you this evening for the honour which you have done me in electing me chairman of this highly important Local Section of the Institution, for I appreciate most keenly this mark of your esteem and confidence. I can only say that during my term of office I shall look upon it as a great privilege to do everything that lies in my power to promote the success of the section. Our own local interests naturally first claim attention, and I think we may look back with satisfaction at last session, and forward with considerable confidence to the one now beginning, the second which has been held under the auspices of the Institution. Though so new under its present designation, this gathering of electrical engineers from the district of which Manchester is the centre, has a past of which we may well be proud. It dates back to 1893, and in its palmy days the papers read at its meetings were so excellent and the discussions on them so practical and so bright, that there were not wanting those who drew comparisons between the old Northern Society and our own Institution. There was, indeed, at one time actually danger of rivalry between the two. Happily, the possibility of such rivalry has been removed by the generous and wise policy adopted by the Institution, whereby the Council has recognised the legitimate desire of its members to hold meetings in the localities to which their work calls them, and to discuss with their immediate neighbours the problems with which they are confronted. This decision of the Council, the successful execution of which is so greatly aided by the tact and conspicuous ability of our secretary, Mr. McMillan, cannot fail to have far-reaching effects upon the fortunes of the Institution, raising its status, and increasing its importance far above anything that would have been thought possible a few years ago.

It is not only, however, from the point of view of the Institution as an institution that there is reason for congratulation; there can be no two opinions as to the great importance of having a single organisation resting on a broad and comprehensive basis to represent the electrical industry of the whole British Empire. It is a recollection of the early days of the Northern Society which makes me feel so confident of the success of our own Local Section, for we have the same men among us that we had then, and we have in Mr. Cowan an honorary secretary whose competence for the work and energy in carrying it out could not be surpassed, while the inducements to members now are much stronger than in the days of the Northern Society to prepare papers and take part in our discussions. Our proceedings form part of those of the Institution, and papers, if of sufficient merit, are printed in the *Transactions*, being equally with those read in London eligible for premiums. I trust, therefore, that members who are in a position to do so will come forward with papers, and that all will make a point of attending our meetings and taking part in our discussions. Especially do we want the young men, those who so far are unknown; for nothing is so painful as to hear only the same voices meeting after meeting, and, not the least so, to the speakers themselves, who often take part in the discussion solely because they do not like to see it languish altogether.

One of the great difficulties we have to contend with is the provision of a suitable place in which to meet. Through the courtesy and generosity of the authorities of Owens College this excellent theatre has been placed at our disposal, and I am quite sure that we all heartily appreciate their action. At the same time there are always some who will enquire into the age of a gift horse, and I have heard rumours of objections being raised, some saying that to meet at Owens is like going to school again, others that the college is too far from the railway stations, and so on. Good as the room is, one must recognise the fact that the college is a little far for some of the members to come who have trains to catch, and perhaps the physical comfort is not quite so great as is to be had, for instance, in the theatre of the Institution of Civil Engineers. Nevertheless, I cannot but think that there has been an enormous gain both as regards the comfort and dignity of our meetings through ceasing to hold them in an hotel, while the facilities for experimental demonstration are of no small value. It is quite hopeless for the section, unaided, to provide any accommodation of its own, for we have but a limited grant for current expenses from the Institution, and we could hardly expect the Council in London to make any effort to provide for a local section when the Institution itself is entirely dependent upon the hospitality of older and richer corporations for its own meetings.

There does, however, seem to me to be a way in which the difficulty might be solved if only the various engineering and scientific societies in Manchester would pull together. Manchester has long been prominent as an engineering centre, and it bids fair to eclipse all others as a seat of electrical enterprise. The local engineering and scientific societies are at least as important as any out of the Metropolis; they are numerous, there being upwards of 30 local sections or branches of London institutions, and some of them are extremely well provided for funds. At present all these societies meet in different places, many of them in hotels, and the aggregate rent paid in the course of a year must be very considerable. Surely all these institutions, which have this in common—that they are seeking to promote the interests of science in either its abstract or its applied form—might combine together and jointly provide or rent premises which should afford a suitable and convenient place of meeting, and at the same time accommodation for their respective libraries. Manchester, as a city, prides itself upon being in the van of municipal progress, and its citizens have provided funds for an institute of technology which has been planned to be as near perfection as money and thought can make it. With the opening of this institute there is being inaugurated a new era in the technical education provided in the district, and the standing to be taken by this new institute depends very much upon the line of action taken in the early stages. Already there are signs that the authorities desire it to be something more than a mere technical school, and it would seem that an effort is being made to secure this by making the status of the staff as high and dignified as possible. It appears to me that the opportunity exists at the present time of immensely adding to the dignity and of greatly improving the position of this institute by the authorities stepping in and bringing together under its wing the various societies, and affording them that material assistance which many of them lack, while receiving in exchange the support and weight of all that is best in the scientific and engineering circle of the district. I raised this question some six months ago at a meeting of the Society of Chemical Industry in Manchester, and judging from one or two paragraphs that have lately appeared in the newspapers, there seems some prospect of such a scheme being considered, and I sincerely trust that it will receive the hearty co-operation of all concerned. It is my intention to bring this matter before the committee of this section at the earliest opportunity, and I hope that by our united efforts some effect may be produced, and that we may be able to report to you that our negotiations have been successful.

I have referred to the libraries of the local societies, and I think that the want of a thoroughly good technical library is one severely felt in Manchester. In London there are the magnificent libraries of the Institution of Civil Engineers and the Institution of Mechanical Engineers, while for purely electrical work that of our own Institution is not to be excelled; but we in Manchester are cut off from the advantage of these libraries, and practically there is no place to which we can go and find the books that we should like to refer to from time to time. We cannot even find the technical papers at our disposal. Many of the local societies have libraries of considerable value, but they are locked away in book-cases in the public rooms of hotels, and are by no means readily accessible. The modest library of our own Local Section is at present housed in a book-case accommodated out of charity by one of our members. If only these books could be brought together in one place and each society would throw open its library to the members of all the others, the gain all round would be enormous, and there would be a strong incentive to improve and add to the joint library if it were felt that it were of real use to members. Closely allied to the subjects to which I have referred is one that has been mooted on more than one occasion—namely, the promotion of social intercourse among the engineers of the district. None of the existing clubs can at all be looked upon as being particularly affected by engineers, and such as are political are by their nature unsuitable. It has therefore been suggested that a purely engineering club should be formed, and the further suggestion has been made that accommodation for the holding of meetings might be furnished in connection with such a club. For my own part, while heartily approving of the idea of the club, I do not think that it would be found desirable to combine it with the engineering societies themselves. It would in my opinion be far better that the two problems should be dealt with each in its own way, and that the highest possible standing should be taken by the institutions charged with the furtherance of science and engineering, and I sincerely trust that some such way of promoting their common interests as I have indicated may be found.

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There is one other subject of local interest to which I desire to refer—namely, the question of students of the Institution. In the days of the Northern Society this class was practically non-existent, but now that we are a branch of the Institution there are naturally a number of student-members entitled to attend our meetings, and this class has been substantially augmented by the joining *en bloc* of a society promoted under the auspices of Mr. W. H. Gee in connection with the pupils at the technical school. There must be a large number of young fellows who are receiving their education in the important engineering works of the district, and considerable numbers cannot fail to be attracted by the new institute of technology, so that we may look forward to a substantial growth in numbers of this class of member. All of us who have been students of the institutions in London, particularly of the Institution of Civil Engineers, must have felt what an immense benefit was derived by us from attending the students' meetings organised by these institutions. It is, in my opinion, difficult to overestimate the educational value of preparing papers to be read at such meetings, and of the training in debate afforded by taking part in the discussions. I look forward to the committee being able to organise, even with the present numbers, meetings of the kind, and I hope that it may be found possible to make arrangements for visits to works of interest during the session.

Leaving now matters of merely local interest, I turn to the main object of my address, and I am bound to confess that I feel a difficulty, which it is some consolation to reflect is common to the writers of most inaugural addresses, in choosing a subject of interest. A review of engineering progress is only of use when undertaken by a master hand, and by a veteran who has borne the burden and heat of the day in the battle of engineering development, while it is not given to many of us to have the leisure or the opportunity for conducting scientific researches which may result in discoveries of a startling or epoch-making character. I have, therefore, thought that some slight comment upon one or two of the general questions which are agitating the minds of so many engaged in electrical enterprise might form perhaps the most suitable subject for this address, and I must rely upon the indulgence of my hearers in respect of my shortcomings, both as to completeness and novelty. We are now passing through an extremely critical period in the development of electrical engineering in this country, and much depends on the attitude assumed by every individual member of the profession. The stage in which electricity was untried and its usefulness has gone by, the day of small things is over, and we are entering upon a new phase of development in which the science is invading the domain of the heaviest class of mechanical engineering. Are we prepared for this development? Are we fit to step forward and say the demand exists in our country, we are prepared to supply it? If one may judge by common report, we are not. The undoubted fact is pointed to that contracts for large works are awarded to American and Continental firms, and the inference is drawn that English makers are unable to undertake them, and are either behind the times or incompetent. This charge is a serious one, and, if well founded, means not only that British electrical engineers are a failure, but that the decadence of the engineering industry of this country has set in, for what branch of engineering has not now been made electrical in some measure?

Let us examine a little more closely the common report. Whence does it emanate? Largely, no doubt, from the daily Press, which is so anxious to obtain a sensation that it does not pause to consider the mischief that may be wrought by propagating it. Unsupported, the Press would probably not do much real damage, but unfortunately electrical engineers themselves seem to be but too prone to lend colour to the story of their own incompetence, while the fact that their foreign competitors are successful in securing contracts is, to the lay mind, convincing proof of the latter's superior fitness to carry them out. It appears to me that, all unsuspected, the British nation is the most polite upon earth. When an English engineer goes abroad, he seems to feel it incumbent upon him to express amazement at everything he sees, to praise every detail of the plant or works he inspects if it differ from what he has been used to, without stopping to enquire whether it be better or worse, while he freely expresses his astonishment at some system of working that he is unfamiliar with, though it is more than likely that had he been called upon to solve the problem, his own old, despised methods would have afforded a solution twice as good as the one on which he lavishes his praise. When our Englishman comes home, he makes pessimistic speeches, eagerly reported by the daily Press, as to the marvellous advance made by foreign nations, belittling his own achievements and those of his colleagues, and for months he fills his technical papers with absolutely gratuitous, fully-illustrated advertisements of his rivals' works. Truly the politeness of the Englishman is magnificent, though some of us may think it is not trade, and that the words addressed to King Lear are applicable to him: "Thou gavest them the rod and put'st down thine own breeches." But the stay-at-home islander is not to be outdone by his travelled brother; he has specifications to draw and plant to purchase. What is the blackest crime in his eyes? A preference for native-made plant. The mere suggestion that he has such a preference at once raises the blush of shame. No, he is no spread-eagle or jingo; he does not think the nation whose name in foreign markets is a guarantee of genuineness and good quality is any better than others, and he will gladly waive his most cherished conditions in order to give an extra chance to the foreigner, and thereby show that he is a "citizen of the world," forgetting that

"That man's the best cosmopolite
That loves his native country best."

If, then, the engineers themselves eagerly praise their rivals, can we blame the man in the street if he assumes the inferiority of his own countrymen to be a fact, for he could never guess that their self-depreciation arises from politeness and modesty. But, you will say, why do the contracts go abroad? If the work can be done here, why is it not? That is a question which cannot be answered in a word, because the reasons are manifold and varied.

In many cases, no doubt, the work has been done for less money, and we will assume that it has been done as well as if the contract had been in English hands, though this assumption is, in many cases, far from the truth. Are we justified in drawing the deduction that because the machinery, or whatever it may be, is sold for less, therefore the foreign manufacturer has produced it at less cost than we, thereby showing that his practice is in advance of ours? By no means. It must be borne in mind that the English market is a comparatively new one to foreign makers of machinery, and the merest tyro in commerce knows that in order to push his wares he must advertise. Advertisement necessarily costs money, and the payment may advantageously take the form of a discount on the goods first sold. For not only are they thereby brought under the notice of possible future buyers by being got into the country, but the trade is actually begun by the very fact of lowering the price. It is an old device, but it never fails. Men always have sought for bargains, and always will. The Nemesis comes later.

Again, over-production and industrial depression in the producing country has undoubtedly had much to do with the low prices of some of the plant sent into the English market, manufacturers being ready to sell at almost any price rather than discharge their hands and admit the rotten condition of their trade. Low price is not, however, the only consideration that has determined the award of contracts for electrical machinery out of England; promises of early delivery have been almost, if not quite, as potent. The purchasers will procrastinate for months or years, allowing every trivial matter to delay them, but once they determine to go forward their lethargy is exchanged for panic and unreasoning haste. Here, again, over-production enables the foreigner to secure many of the contracts which in this case are often awarded to him regardless of price, because he can promise early delivery. The purchaser never considers that other contracts which must be executed first, cannot by their very nature be carried out in so brief a period, and he finds subsequently to his cost that the plant for which he has paid more than he would have had to pay to an English firm, who required a reasonable time for delivery, is on his hands deteriorating and costing him heavy sums for demurrage. Meanwhile, there has been the usual cry of the vastly superior resources of the foreigner, and the mischief has been done to the English manufacturer, mischief which is unremedied because the public never hears the end of the tale.

I ought, perhaps, to touch upon the question of the relative quality of the British and foreign made machinery. Let us at once grant that much of the latter is excellent, while, at the same time, it must in common fairness be admitted that much is unconscionable rubbish. Do we, who are in daily contact with British machinery, honestly believe that our manufacturers are in any one respect incapable of making as good machinery as any imported in this country? Do we not know that from British workshops is turned out machinery that it is impossible to better, whether in design, in workmanship, in finish, or in durability; and do we not know that our alleged inferiority is a delusion? In the past English engineers have been in the forefront. An Englishman—nay, a Manchester man—John Hopkinson, taught the whole world how to build dynamos. The earliest attempts at heavy electric traction were made in this country. An Englishman, Ferranti, first conceived and executed the idea of commercially working at high pressure, and devised the means whereby it might be done with perfect safety. An Englishman, Hughes, gave to the world the invention which made long-distance telephony possible. By the invention of an Englishman, Swan, domestic electric lighting became an accomplished fact, while English engineers have carried out almost the whole of the submarine cable work of the world. With this record behind us, is it likely that we shall cease to be in the van? Most assuredly not, unless our fellow-countrymen take the heart out of us by ceasing to believe in our capacity and by belittling our achievements.

I do not wish my remarks to be misunderstood. I do not for one moment seek to imply that good work is not turned out from foreign workshops, or that we as a nation have any monopoly of engineering skill. On the contrary, I yield to none in my admiration of the splendid achievements of our American brethren and of other nations more distant in blood, but nearer home, who are following in their steps. I have merely endeavoured to show that the position at the present time really is that English makers are fully equal to their competitors, but they are now being driven out of their home market, not because their rivals can produce better, more cheaply, or more quickly than they, but because these competitors are willing for a time to undersell them, while over-production enables them at present to forestall them. We have seen that no help is to be expected by English manufacturers from their colleagues. What then are they to do? I do not presume to suggest a remedy, but it does seem to me that whatever it may be, one thing is certain—they must join hands and combine, not, as has been done in many branches of commerce, to raise prices, but to lower them and so drive away the competitors who now menace their very existence, even though for a time they should be forced to face exceedingly lean times. Unless they do something drastic, and do it quickly, they will find themselves, to use a cant phrase, "frozen out," and the foreigner will be master of the situation. Then will the purchasing public in vain seek for the English competitor, and bitter will be the repentance of the present cupidity.

(To be continued.)

Paisley.—The Town Council have approved a recommendation by the Electric Lighting Committee to supply the tramways company with the electric energy required by them for the working of the tramways.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

431. What *kind* of measuring instruments are used in ship-lighting to read correctly when the ship rolls ?—S.

432. I am trying to make a micro-telephone to give the maximum loudness and distinctness of tone. What is the best form of microphone for the purpose, and what other means should I take to attain my object ?—W. A. T.

ANSWERS.

Question No. 425.—Feeder cables are used to keep up the voltage at a distant point. Why are they used instead of putting in a larger conductor with less drop in volts, for they are simply in parallel with the conductor, and take a proportion of the current ?

Best Answer to No. 425 (*awarded* 10*s.*).—The principal reason for using feeder cables is because we can use a higher current density in them than the Board of Trade regulations allow us to use in the mains. It is stated in the fourth of the Board of Trade regulations for securing a proper and sufficient supply of electrical energy, that the pressure at any point on the main must not vary by more than 2 per cent. from the standard pressure. Hence a total drop of 4 per cent. along any main is the maximum permissible, consequently, in order to avoid an excessive drop in volts, the current density in the main has to be kept very low, and hence a large quantity of copper is required. Now, in a feeding main we can use as high a current density as we please so long as the main does not heat excessively. By boosting the voltage at the central station, and having a 20 or 30 per cent. drop in the feeder, we can effect considerable economies in the amount of copper required.

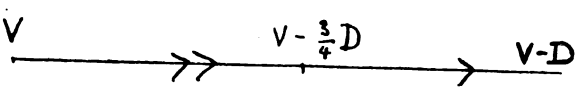

FIG. 1.

The statement in the latter part of the question is incorrect, for even without boosting the pressure at the station economies can be effected in some cases by using a feeder main. Consider the case shown in Fig. 1. Let V be the voltage at the station, and D the maximum permissible drop in the main; let C also be the current that gives this drop at the far end. The main is supposed to be tapped at equally distant points along its length, so that the current entering the main at the station is C, and rapidly diminishes until it is zero at the far end. It is evident that as we leave the station the potential will drop rapidly at first, and more slowly later on when the current gets less.

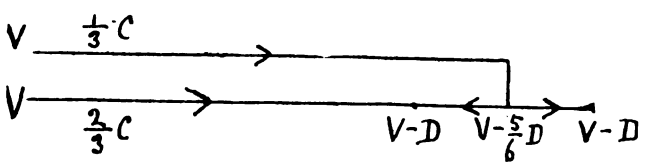

FIG. 2.

Now, instead of using this main, suppose we use another whose section is only two-thirds of it—⅔ S suppose—and a feeder whose section is only ⅓ S, and whose length is five-sixths of the original main Then the potentials will be as in Fig. 2, the feeder carrying one-third of the total current. Also, the total weight of copper will only be $(\frac{2}{3} + \frac{5}{6} \cdot \frac{1}{3})$—*i.e.*, $\frac{17}{18}$ths that of the original main—*i.e.*, there will be a saving of 5½ per cent. in the copper required. A study of Fig. 2 will show that the feeder cannot be accurately described as being in parallel with the main, as it is in series with two portions of it.—J. C. R.

Answer to No. 425 (*awarded* 5*s.*).—Perhaps the best way to answer this question is by an example. In Fig. 1 $x x_1$, $y y_1$ are mains fed by the feeders *a*, *b*, *c*, and *d*; the most convenient position for the feeders *c* and *d* being alongside the

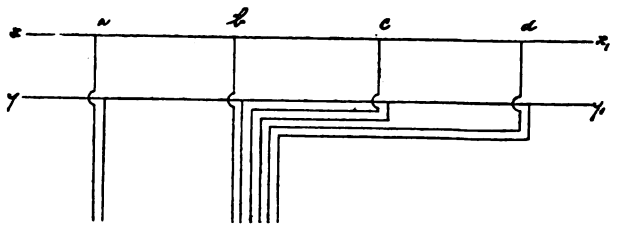

FIG. 1.

mains from *b* to $x_1 y_1$. We will suppose the current in mains to be uniformly distributed, being equal to C between the feeding points, and $\frac{C}{2}$ between $a - x y$, and $d - x_1 y_1$. The resistance of mains to be taken as equal to R between the feeding points, and $\frac{R}{2}$ between $a - x y$, and $d - x_1 y_1$; area of feeders to be twice that of mains. Maximum drop will then be equal to

$$\frac{R}{2} \times \frac{C}{4} = \frac{RC}{8}.$$

For the potential at feeding points to be kept equal, the resistance of each pair of feeders multiplied by the current carried by them must equal a prearranged amount; if this condition cannot be fulfilled, regulation must take place at station. (The maximum drop mentioned above is drop between feeding point and farthest lamp.)

In Fig. 2 we have the copper of feeders *c* and *d* put into

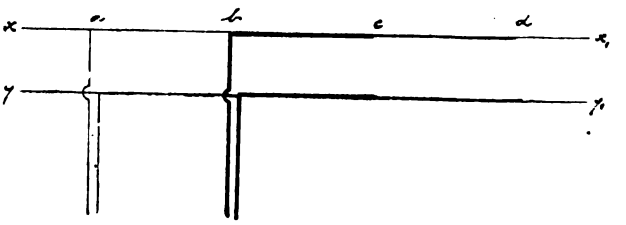

FIG. 2.

the mains, thus giving us a larger (tapering) conductor from *b* onwards. The *b* feeders must be enlarged, as now instead of carrying a current = C, they have to carry a current $= \frac{C}{2} + C + C + \frac{C}{2} = 3\,C$. Drop between *b* and *c* $= \frac{R}{5} \times 2\,C = \frac{2\,R\,C}{5}$. (For in place of the resistance, R, between *b* and *c*, we now have the original mains in parallel with two pairs of feeders—*i.e.*,

$$\text{Conductivity} = \frac{1}{R} + \frac{1}{\frac{R}{2}} + \frac{1}{\frac{R}{2}}$$

$$= \frac{1}{R} + \frac{2}{R} + \frac{2}{R} = \frac{5}{R}.$$

$$\therefore \text{Resistance} = \frac{R}{5}.$$

As the mains are uniformly loaded, we have average current between *b* and *c* + current between *c* and $x_1 y_1$

$$= \frac{C}{2} + C + \frac{C}{2} = 2\,C \Big).$$

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Drop between c and $d = \frac{R}{3} \times C = \frac{RC}{3}$, and between d and $x_1\ y_1 = \frac{R}{2} \times \frac{C}{4} = \frac{RC}{8}$.

$$\therefore \text{Total drop} = \frac{2RC}{5} + \frac{RC}{3} + \frac{RC}{8}$$

$$= \frac{48RC + 40RC + 15RC}{120}$$

$$= \frac{103RC}{120}.$$

$$\therefore \frac{\text{Maximum drop in I.}}{\text{Maximum drop in II.}} \propto \frac{\frac{RC}{8}}{\frac{103RC}{120}}$$

$$\propto \frac{15}{103} \propto \frac{1}{7} \text{ (nearly).}$$

—M.

Answer to No. 425 (*awarded* 5*s.*).—There are various reasons why feeder cables are used, and the different conditions and requirements need to be carefully considered when designing and laying down mains for any particular district. Suppose (as is evidently the case in the question) that the source of supply is outside and some distance away from where the current is needed, and the area of the supply is not very large, as, say, a building; there is no saving in copper by running a distributor and a feeder, provided they are both "'bused" together on the switchboard, and the route taken by each is identical. The saving in copper in this instance could only be effected by taking the feeder by a shorter route direct to the point of supply, or by having some arrangement on the switchboard to raise the voltage at the *station* end of the *feeder* independent of the distributor, thus working the feeder at a higher current density than would be permissible in the distributor, and so effecting a saving in the amount of copper required. The "drop" in the feeder would not affect the supply so long as the voltage at the far end was kept constant, which would be ascertained by pilot wire connected where it joined the distributor, and run back to a voltmeter in the station.

Taking, next, an ideal case, where the source of supply is in the centre of the district to be supplied, the value of feeders will be more apparent. A circle will illustrate this, the circumference representing the distributors, and the centre the source of supply, from which it will readily be seen that by running feeders at radii from the centre to the circumference at different intervals, a great saving in copper would be effected, as the current would travel direct from the station to the district requiring it, instead of travelling round the circumference, which would be the case were only one large conductor used. The main idea in using feeders is to equalise the voltage over the whole of the system with as little expenditure in mains as possible; and by using feeders so designed as to all give approximately the same "drop" on full load, and by taking them the most direct route, this object can be more or less realised. In addition to the economy in copper attained by using feeders, provision must be made for accidents, and, in a large system, for splitting up the different districts to facilitate testing, localising faults, etc. This could not possibly be done if only one large conductor was used, as any damage done to this cable would necessitate all the district beyond being cut off until the damage was repaired, whereas by using feeders the distributor may be disconnected for repairs or connecting new consumers, and the supply to the other districts still kept on by the feeders. The Board of Trade also state that in a public supply scheme the mains must be so arranged that not more than 80 consumers will be disconnected at one time. Should it be necessary to disconnect any portion of the mains for repairs or other causes, this would be impossible without feeders. Again, heavy cables are much more difficult to handle than lighter ones, and feeders are often put in to supplement the distributors where the demand has grown beyond their capacity, and where it would have meant a large amount of money lying idle had large conductors been put in before they were actually needed.—C. I. S.

Question No. 426.—Discuss the relative advantages and efficiencies of steam-driven and electrically-driven balancers for use on a three-wire direct-current system with batteries.

Answer to No. 426 (*awarded* 7*s.* 6*d.*).—The advantages are strongly on the side of the electrically-driven balancer in first cost, steadiness of voltage, and general convenience. The steam-driven balancer is, in fact, practically out of date, and would only be introduced into a modern station under special circumstances—in a case, for instance, in which, from motives of economy, a battery of too small capacity had been put in. Though quite capable of steadying the voltage of supply, this battery might be insufficient to satisfactorily deal alone with the day load, and a steam-driven dynamo or dynamos of small capacity would then be a great convenience in the station, as it could be run alone, fairly fully loaded, during the daytime, thus avoiding the necessity of running one of the large main generator sets inefficiently at times of light load. The steam driven balancer is essentially a hand-regulated machine, and for this reason could not be used satisfactorily as a balancer except in conjunction with a battery. The motor balancer, on the other hand, is automatic in its action, and maintains a practically constant voltage on the two sides of the system throughout its range. This automatic regulation is within 3 or 4 per cent. even when two shunt-wound machines are used, and can be made practically perfect by adding a few turns of series winding to the two fields, causing the machine on the heavily-loaded side of the system to act as a compound dynamo, and that on the other side as a differentially-wound motor.

With regard to efficiency, the two arrangements would not be very different. Thus, suppose the output on each side of the balancer is 15 kw. to 20 kw., the through efficiency of the balancer itself, $\frac{\text{KW. output}}{\text{KW. input}}$, would be about 82 per cent. running at about 1,000 revolutions per minute, and the combined efficiency of the main generator sets (say 500-kw. to 1,000-kw. sets) would be about 85 per cent. The two figures multiplied together, $\cdot 85 \times \cdot 82$, give 70 per cent. as the true through efficiency of conversion from indicated horse-power to electrical power delivered into the circuit. On the other hand, an engine direct-coupled to two small dynamos of 15 kw. to 20 kw. each, and running at about 500 revolutions per minute, would have a combined efficiency, $\frac{\text{E.H.P.}}{\text{I.H.P.}}$, of not over 72 per cent.

Turning next to the question of first cost, it is easy to see that the electrical balancer is far cheaper, for it not only saves the cost of the engine altogether, but also greatly reduces the price of the two dynamos, as though of the same power in the two cases, they can run at a far higher speed without than with the engine.—Q.

Answer to No. 426 (*awarded* 7*s.* 6*d.*).—In all-round efficiency and simplicity of working the steam balancer has not a look in with the motor balancer. Let us consider a system with a maximum out of balance of 50 amperes. Now, with the steam balancer each dynamo has to be able to cope with 50 amperes, but in the motor balancer either unit of the balancer has only to deal with 25 amperes, for it takes 25 amperes off the light side and puts it on to the other side; hence we see that a motor balancer is only half the size of a steam balancer (omitting the engine). A motor balancer also has a tendency to keep the voltage on the two sides of the system the same, since the shunts are connected to the opposite sides to the armature With a steam balancer, should one of the balancers break down, we can still use the other balancer to balance the system by putting it on the heavy side. Another advantage the steam balancer has is, that should a short occur between the middle wire and an outer, we can attempt to burn it out with the balancer. This is not the case with the motor balancer.

Now, as regards efficiency the motor balancer can be said to have an efficiency of 80 per cent. for ordinary station running. The steam balancer will have a much less efficiency than this. For engine and dynamo combined,

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running at about three-quarter load (which would be its average station load), we can expect an efficiency of 72 per cent. This low efficiency is due to the balancers generally being small units of between 60 h.p. and 100 h.p. A motor balancer needs hardly any repairs, only their commutators looking to a little. The steam balancer, on the other hand, seems always to be on the sick list; there are so many wearing parts on the engine, and a balancer in any station has to put up with rough handing, such as a varying load starting up at a moment's notice, which, by the way, a steam balancer cannot do. A steam balancer has the advantage in being able to charge the battery by putting balancer and battery on the spare bars should the booster break down.—WH.EX.

Answer to No. 426 (*awarded* 5*s.*).—I would first refer the questioner to an article in the current number of the *Electrical Engineer*, where he will see that for large stations such as Manchester electrically-driven balancers are the only kind that could be used, but I take it that the question refers to comparatively small stations, having balancers only at the station. There are two kinds of steam balancers—viz., one engine driving two dynamos, and two or three sets wound for the half voltage, and arranged to supply either side of the system. Both kinds are able to deal with large out of balance, owing to the fact that they can both or all be plugged on to the one side. With sets wound for the half voltage it is necessary to run at least two sets, which is not economical for small loads. Steam balancers, being comparatively large machines, are less likely to give trouble than the motor balancers; as the balance of a well-arranged system is never far out, quite a small set will do all that is wanted, and, in addition, will drive the boosters that are nearly always used for charging the battery. The balancer forms a very convenient motor for driving them, but there is one serious drawback to the booster-balancer set—that is, it places a great responsibility on a somewhat awkward and often troublesome machine—for instance, suppose that the boosters are connected up in the usual way in series with the 'bus bars, and charging the battery, and that there is not much load on, so that the battery forms a considerable part of the load, and something goes wrong with the set, you cannot get the set stopped till you have worked the load of the cells and put the battery in again to balance, which takes time, and often ends in disaster of some kind. The balancer booster is, however, exceedingly useful, and the number of duties it can perform are almost endless. It can motor-generate from one side to the other during small load when the battery is taking the load, so that if one side is run down more than the other, or the battery circuit is wanted to be opened for any reason, the half battery can keep both sides going. It is convenient, too, if the boosters are arranged in series with the 'bus bars in the usual way, and it is found that the top cells never get discharged, and are suffering from it, to put the cells in as to charge, and make them motor back on the boosters by cutting in all the cells, and regulate the shunt switches of the boosters to get the voltage right. This is much the same as the St. Helens system described by Mr. Highfield in his paper "Storage Batteries in Electric Power Stations Controlled by Reversible Boosters" (*Trans.* Inst. Elec. Eng., vol. xxx.). This paper sets out further uses of the motor balancer-booster. Boosting down only can be done with the ordinary system of connecting. Taking all into consideration, the electrically-driven balancer system should cost least, as the booster set would have to be installed to charge the battery, which are nearly always motor driven. There is not much extra cost in putting two motors in series (a balancer) instead of one of double the power, while two machines coupled to one engine cost considerably more than one machine of double the kilowatts. The all-round efficiency would in most cases be in favour of the electrically-driven balancer, as it is made use of for driving the boosters. The separate machines at the half voltage will be least economical; they are principally met with where stations have changed over to a higher voltage, and the smaller sets have been left as balancers, while the larger have been rewound for the new voltage across the outers.—C. L. E. S.

THE GLASGOW ACCIDENT.

The following is the full official report to the Board of Trade on the accident to John Stannage at Pinkston power station, which occurred on Nov. 19:

John Stannage, wireman's labourer, aged 23, residing at 20, Green-street, Bridgeton, received a high-pressure electric shock about 12.15 a.m. on Tuesday, Nov. 19, and died at 9.15 a.m. from the effects thereof. John Stannage had been employed at Pinkston generating station since Oct. 2 of this year, assisting with general wiring for the station lighting. For the past two days he had been acting as assistant to wireman McPhun. McPhun has been employed on some alterations to the high-tension connections at the back of the high-tension board since Oct. 27. Up till the 14th another labourer was working as assistant to McPhun. On the 14th and 15th this man was not present, and in consequence John Stannage was instructed to help McPhun by the chief wireman, who cautioned him at the same time about the danger of the high-tension 'bus bars as long as any of the large engines are working, and told him further that he would be notified each night by the charge electrician when the main engines were shut down, and when it would be safe for them to commence work. The charge electrician has invariably told all workmen when it is safe to begin work behind the switchboard, and he has further instructed them not to do anything behind the board until they receive such notice. On the two previous nights McPhun and Stannage were, as usual, warned by the charge electrician not to begin work till they received instructions from him. Shortly after midnight (18th to 19th) McPhun instructed Stannage to take a ladder up to the switchboard gallery, and there to wait for him. The charge electrician, having at 12.5 a.m. walked round the high-tension board on his usual inspection, had descended to the engine-room floor, and was preparing to throw over the load from the high-tension alternators on to the 500-volt auxiliary machines, and had as yet seen nothing of McPhun or Stannage. The assistant was on the high-tension gallery at the time, but did not observe anyone go behind the switchboard. The undersigned happened to be present that night in the power station, in order to witness a test on one of the auxiliary engines, and was at the time of the accident on the engine-room floor. His attention was attracted by a blaze of light behind the switchboard. He immediately mounted to the switchboard gallery, imagining that a voltmeter, transformer, or some such apparatus had gone to earth. Seeing the charge electrician in the act of cutting off the high-tension current, he ran in behind the switchboard to determine where the arc had started. On account of the blaze of light he could detect nothing for perhaps two seconds, after which Stannage fell at his feet. He saw at once that the man was badly burned at the back of the head and on the hands. He accordingly sent for a doctor, and started artificial respiration. An ambulance was also sent for. By the time the doctor arrived the unfortunate man was breathing distinctly, and soon afterwards the heart commenced acting very vigorously. The doctor stated, however, that he could not possibly live many hours on account of the terrible injury to the back of the head and the brain. He was then removed to the Royal Infirmary. John Stannage was always considered a steady, reliable man, and was never observed the worse for drink. The accident may, perhaps, be attributed to his over-eagerness. The length of time at night when the high-tension current is off is very short, and he wished, no doubt, to make the most of this time. He probably saw the auxiliary engines were working, and without further instructions, and disregarding the warnings repeatedly given to him, took for granted that the high-tension current was cut off. He must then have erected his ladder behind the switchboard, and have mounted the same. He appears to have lost his balance on the ladder, and, to steady himself, to have gripped with both hands a vertical iron bar to his left, which was part of the switchboard frame, to have then swung round, bringing his head in contact with one of the high-tension bars which was at a distance of 1ft. or 18in. to the left of the man as he stood on the ladder. The switchboard is closed off from the engine-room by two doors, Stannage entering at the one end, while the assistant at the switchboard was standing at the other end of the gallery. There is no high-tension metal work behind the switchboard lower than 7ft. 8in. from the floor level, and all such metal work is painted scarlet to distinguish it. Stannage, as far as can be ascertained, had no tools or anything in his hands when on the ladder, so that it is not known for what reason he ascended the ladder.

(Signed) M. B. FIELD, Electrical Engineer.
86, Renfield-street, Nov. 20, 1901.

LEGAL INTELLIGENCE.

ELECTRIC LIGHT SUPPLY.

In the King's Bench Division of the High Court, on the 14th inst., the Lord Chief Justice and Justices Darling and Channell, sitting as a Divisional Court, heard the appeal of the plaintiffs in the case of the London Electric Supply Corporation *v.* Priddis, from the judgment of the Clerkenwell County Court judge.

Mr. Bailhache, who appeared in support of the appeal, explained that the London Electric Supply Corporation sued the defendant to recover, under an agreement between that company on the one part, the National Electric Free Wiring Company on the second part, and the defendant on the third part. The agreement provided that the consumer should pay at a stipulated rate "for the use of the installation," and that the minimum payment per year should be a certain

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sum. Mr. Priddis, being dissatisfied with the current supplied to him by the Electric Supply Company, made an arrangement with a rival company, and when called upon to pay the minimum sum provided for in the agreement under notice for the quarter ended Michaelmas, 1900, he declined to do so. He was accordingly sued for the amount in the county court, and Judge Edge decided that the plaintiffs were not entitled to recover on the ground that as the defendant had not used the installation he was not liable to pay for it.

The **Lord Chief Justice** said he was unable to agree with the construction put upon the agreement by the learned county court judge, and held that there must be a new trial of the action.

Mr. Justice Darling and **Mr. Justice Channell** were of the same opinion.

The appeal was accordingly allowed and a new trial ordered.

ELECTRICAL METER PATENT.

In the Chancery Division this week Mr. Justice Swinfen-Eady concluded the hearing of the case of De Ferranti *v.* the British Thomson-Houston Company, which was an action for alleged infringement of the plaintiff's patent for an electric lighting meter by the defendant company.

Mr. Cripps, K.C., M.P., Mr. Astbury, K.C., and Mr. Colefax were counsel for the plaintiff, and Mr. Fletcher Moulton, K.C., M.P.; Mr. Bousfield, K.C., M.P., and Mr. A. J. Walter for the defendants.

In stating the case for the plaintiff, **Mr. Cripps** said that his client claimed in his specification certain improvements in motor meters which were used in electric lighting in order that the consumer might know the amount of current he had consumed, and that the supply company might know how much they had supplied. The patent granted to the plaintiff in 1887 for this specification had now run out, and therefore he was not in a position to ask for an injunction, although he was when the action was started. The action now was for an account of profits or damages. It was a very important question, because a very large number of meters now actually in use would be infringing meters if the plaintiff's view were accurate. He believed that when motor meters began to be generally used for measuring electricity, practically every manufacturer used the plaintiff's device. The defendants in their pleadings had raised the usual defences, besides denial of infringement, that the plaintiff was not the true and first inventor of the alleged improvement, that the alleged invention was not new, and that it had been anticipated not only by various previous patents, but by the common general knowledge of electricians. Defendants had also alleged disconformity in the specifications, and that the complete specification did not sufficiently describe the nature of the invention claimed.

Expert evidence was called to show that the plaintiff's invention was clearly defined in his specification, and that there was nothing like it in the alleged anticipations.

For the defence, evidence was given by **Mr. James Swinburne** and other witnesses to the effect that the devices claimed by plaintiff in his specification to be new inventions were well known to electricians previously, and that, therefore, the defendants had not been guilty of infringement.

On the conclusion of the speeches of counsel, his **Lordship** intimated that he would take time to consider his decision.

Judgment reserved.

COMPANIES' MEETINGS AND REPORTS.

BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING.

The directors' report for the year ended July 31, 1901, states that pending the completion of the Company's works at Manchester, orders have been executed at Pittsburgh on terms whereby the British company shares with the American company in the manufacturing profit. The British company's net profits for the year (including £10,000 not ascertained in time to be brought into last year's account) amount to £49,533. 4s. 6d. Out of this sum an interim dividend of £15,000 has been paid, and the directors propose to appropriate a further sum of £15,625, making the full 6 per cent. dividend upon the £750,000 preference shares as paid up on July. This will leave £18,908. 4s. 6d. to be carried forward. The British company therefore has no occasion to call upon the American company for its guarantee (that pending the erection of the works at Manchester the profit shall be sufficient to pay dividends upon the 6 per cent. preference shares). This guarantee extends to two more half-yearly dividends, payable May and November, 1902. The works at Manchester are rapidly approaching completion, and should be ready to receive tools and machinery by January next. Upon their completion British orders are to be executed in this country instead of at Pittsburgh. During the year there have been issued £250,000 preference shares and £250,000 ordinary shares, in order to combine the manufacture of large gas-engines with that of electrical machinery at the Manchester works. The £250,000 preference shares were duly offered to the proprietors by circular dated May 31, 1901, and fully subscribed and are now fully paid up. Orders for electrical machinery at the formation of the Company in 1899 amounted to £279,000, orders received during the year ended July 31, 1900, to £547,000, and orders received during the year ended July 31, 1901, to £738,000. By reason of recent improvements it is expected that gas-engines of greater horse-power will come into use for the operation of electrical generators. During the past year 12 important gas-engine installations, aggregating 3,000 h.p., have been sold, and negotiations are pending for over 10,000 h.p. of larger units. The Hon. R. C. Parsons, owing to the growth of his private practice as an engineer, retired from the Board prior to his departure for South America. Mr. John Wills Cloud (vice-president of the Westinghouse Brake Company, Limited) was appointed to fill the vacancy, and Mr. James Francis Mason (director of Mason and Barry, Limited) has been appointed as additional director.

NEW COMPANIES REGISTERED.

Telegraph Manufacturing Company (Colonial), Limited.—Capital, £2,000. Objects: to carry on in any British colony, dependency, or possession in South Africa or elsewhere, or in the United Kingdom of Great Britain and Ireland, or in any foreign country or State, all or any of the following businesses: electrical, mechanical, and general engineers and contractors, manufacturers, purchasers and sellers of and dealers in wires, cables, and all kinds of electrical appliances, materials, and apparatus; as electricians, machinists, suppliers of electricity for the purposes of light, heat, motive power, or otherwise, and the business of a telephone and telegraph company.

Monorail Syndicate (West Africa), Limited.—Capital, £70. Objects: to adopt an agreement with the Monorail Portable Railway Company, Limited, and to carry on the business of railway contractors, suppliers of plant for construction, locomotion, and transportation, railway and tramway engineers, etc.

Anti-Vibrator, Limited.—Capital, £3,010. Objects: to carry on the business of engineers, contractors, machinery manufacturers, electrical engineers, etc.

Belgian Electric Lighting Boards, Limited.—Incorporated under Belgian law at Brussels. Object: to work the parent syndicate's patent rights throughout Belgium and Holland.

Heatly-Gresham Engineering Company, Limited.—Capital, £20,000. Objects: to acquire the business carried on by H. Heatly, at Bassingbourn, Cambridge, as the Bassingbourn Ironworks, and to carry on the business of mechanical and electrical engineers.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Boyle.—The Guardians will shortly advertise for tenders for the lighting of the workhouse and hospitals by electric light.

Middleton.—The Corporation invite tenders for the free wiring of consumers' premises. Tenders by 26th inst. Details in our advertisement columns.

Brighton.—The Council invite tenders for the supply of meters for a period of one year from Jan. 1, 1902. Tenders by Nov. 25. Details in our advertisement columns.

Poplar.—The Electricity Committee invite tenders for one year's supply of continuous-current electricity meters. Tenders by Nov. 27. Details in our advertisement columns.

Greenock.—The Electricity Committee invite tenders for the supply of meters for a period of one year from Jan. 1, 1902. Tenders by Dec. 2. Details in our advertisement columns.

Dewsbury. — The Corporation invite tenders for the supply, delivery, and erection in the electricity works of two 100-kw. dynamos. Tenders by Dec. 2. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply and delivery, in complete running order, of rolling-stock (complete with electrical equipments). Tenders by Nov. 30. Details in our advertisement columns.

Hull.—The Electric Lighting Committee invite tenders for six rotatory transformers for continuous current tranformation, 2,000 volts to 220 volts, 90 kw. each. Tenders by Nov. 28. Details in our advertisement columns.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection of 12 water-tube boilers and superheaters, economisers, and feed pumps. Tenders by Dec. 4. Details in our advertisement columns.

Dublin.—The Dublin United Tramways Company invite tenders for electrical supplies during year ending Dec. 31, 1902. Information etc., can be obtained from the Secretary, 9, Upper Sackville-street, Dublin. Tenders by Nov. 25.

Coventry.—The Electric Lighting Committee invite tenders for the supply and erection of triple-expansion low-speed vertical marine type engine and 400-kw. direct-coupled alternator and exciter. Tenders by Nov. 27. Details in our advertisement columns.

Islington.—The Borough Council invite tenders for electric lamp columns, complete with crutches and bases. Specifications, etc., can be obtained on application to the Borough Electrical Engineer, 50, Eden-grove, Holloway. Tenders by Nov. 26.

Sheffield.—The Tramways Committee invite tenders for the supply of 400 steel-tyred tramcar wheels. Specification can be obtained from Mr. A. L. C. Fell, M.I.E.E., M.I.M.E., general manager, Tramway Department, Town Hall, Sheffield. Tenders by Nov. 25.

Bermondsey.—The Council invite tenders for the supply of the undermentioned articles up to March 31 next: ironmongery, arc lamp carbons, engine oils, indiarubber cables, and jointing material. Tenders by Dec. 3. Details in our advertisement columns.

Cleckheaton.—The Council invite tenders for the supply, delivery, and erection of Lancashire boilers, economiser, jet condenser, supply

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and feed pumps, steam. exhaust, feed, and drain pipes, and cast-iron water-tank. Tenders by Nov. 30. Details in our advertisement columns.

Brussels.—Tenders are invited for electrical installation at Royal Conservatory of Music. The deposit required is 800fr. Specifications No. 136 are to be obtained from, and tenders addressed to, Direction Générale des Ponts et Chauss es, rue de Louvain No. 38, Brussels. Tenders by Nov. 29.

Southampton.—The Director-General of Ordnance Survey invites tenders for the supply of motors, motor-generators, cables, switchgear, etc., and fixing and adapting the same to existing machines in the Ordnance Survey Office. Tenders by Dec. 14. Details in our advertisement columns.

Pontypridd.—The Urban District Council invite tenders for water-tube boilers, stokers, and economiser, three steam-engines, two 300-kw. and one 150-kw. dynamos, balancing set, switchboard and test-room, workshop, travelling crane, and arc lamps. Tenders by Dec. 14. Details in our advertisement columns.

Aberdeen.—The Tramways Committee invite tenders for the supply and erection of overhead linework, the supply and laying of cables, and the bonding of rails (bonds supplied by the Corporation for the equipment of their Union-street and Holborn-street tramways. Tenders by Nov. 26. Details in our advertisement columns.

Nantwich.—The Urban District Council invite tenders for the supply and erection of boiler-house plant: one water-tube tube and one Lancashire boiler, fittings, steam and exhaust pipes, etc.; engine-house plant: continuous-current steam dynamos, pumps, etc.; switch-board, etc., underground mains, lamp posts, etc., accumulators, meters, crane, etc., dust destructor. Tenders by Jan. 6, 1902.

Liverpool.—The South Lancashire Electric Traction and Power Company invite tenders for the overhead electrical equipment of certain tramway lines and car depot, the route length of the tramway lines being approximately 19 lines. Specifications, etc., may be obtained at the offices of the consulting engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster. Tenders by Nov. 25.

Lancaster.—The Corporation invite tenders for supply of tramway material and the execution of the following works—viz.: (Section A) supply of rails, fishplates, soleplates, tiebars, bolts, bonds, etc.; (B) platelaying, bonding, etc.; (C) supply and fixing of overhead trolley equipment; (D) supply of feed cables, pilot wires, cases, and draw boxes, etc.; (E) supply and erection of tramcars. Specification, etc., may be obtained from the borough electrical engineer, Mr. W. Tester. Tenders by Nov. 27.

Rockhampton (Queensland).—The Municipality invite applications from companies desirous of undertaking the construction and working a system of electric tramways under the Queensland Tramways Act of 1882 and the Amendment Act of 1890, within the municipality of Rockhampton aforesaid. Rockhampton, with a population of 15,461, is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882 and the Amendment Act of 1890, copies of which may be seen at the office of this paper. Applications to be forwarded to Mr. H. W. Johnson, mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31.

RESULTS OF TENDERS.

King's Lynn.—The tender of the British Insulated Wire Company for the supply of cable, at £412. 1s. 2d., has been accepted.

Swadlincote. — The Urban District Council have accepted the tender of Robottom and Perkins for the extension of the electric light at Stanton.

Taunton.—The Council have sealed contracts for the authorised electric lighting extensions with the British Thomson-Houston Company, Babcock and Wilcox, and Slatter and Co.

Stepney.—The Borough Council has accepted the tender of the New Century Arc Lamp Company, at £1,877. 4s. 6d., in connection with the supply and erection of 50 arc lamps and columns in Mile End and Cambridge roads.

Willesden.—The District Council have accepted the following tenders in connection with the erection of the electric light works: Pattinson and Son, main buildings, £29,933; J. E. Johnson and Son, chimney shaft, £5,364; Braid, Pater, and Co., sub-station, £11,300.

Ashton-under-Lyne.—The Corporation have accepted the tender of Macartney and McElroy for the supply, delivery, and erection of steel poles, bases, section boxes, and overhead line for the equipment of the first section of electric tramways, approximately 1½ miles long.

Ashton.—The Council have received a tender from Messrs. Chamberlain and Hookham for the supply of meters. They have also accepted the tenders of Messrs. Callender for cable on Manchester-road to Moss Lodge, and of W. H. Allen and Son for surface condensers and pumps.

Nuneaton.—The Electric Light Committee have decided to accept the tender of Messrs. Chamberlain and Hookham, of Birmingham, for the supply of electric meters for a period of 12 months, on the following terms: 3-ampere meters £2. 15s. each, 5 ditto £3. 5s. each, 10 ditto £3. 10s. each, 25 ditto £3. 15s. each.

London County Council.—The following tenders for the supply of stores during 1902 have been accepted: engineers' goods and electrical stores—Edison and Swan United Electric Light Company, Limited; Dorman and Smith; Heaton and Smith, Limited; india-rubber goods—Dermatine Company, Limited; Rubber Company of Scotland, Limited; St. Helens Cable Company, Limited; J. G. Ingram and Sons.

Wolverhampton.—The British Electric Traction Company have accepted the tender of Mr. Holloway, of Wolverhampton, for the construction of the new electric tramway from the boundary of Wolverhampton to Willenhall, the section from Willenhall to Bilston along the Willenhall-road, and also the section from the Wolverhampton boundary to Bilston and Moxley and to Bradley. The amount of the contract is between £75,000 and £80,000.

London.—The following tenders have been received for electric wiring and fittings at the fire stations in course of erection at West Hampstead, East Greenwich, Homerton, and Perry Vale for the London County Council:

East Greenwich station.

Ellis, Pollen, and Co.	102	11	0
National Electric Wiring Company, Limited	106	10	0
Handley and Shanks	130	12	11
Electrical and General Engineering Company	146	0	0
Nunn, Watts, and Co.	150	0	0
Troup, Curtis, and Co.	152	2	8
G. Weston and Co.	154	4	0
A. W. Penrose and Co.	155	0	0
G. Hignett and Co.	165	0	0
D. Firth and Son	167	0	0
T. Clarke	189	0	0
W. Simmons	190	0	0
F. A. Glover and Co.	203	0	0
Barlow Brcs. and Co	237	0	0
Tamplin and Makovski, Limited	253	0	0

West Hampstead station.

Ellis, Pollen, and Co.	£111	10	0
H. E. Gill	126	5	0
Handley and Shanks	145	17	8
National Electric Wiring Company, Limited	146	15	0
Electrical and General Engineering Company	156	0	0
Nunn, Watts, and Co.	159	0	0
G. Weston and Co.	165	8	0
A. W. Penrose and Co.	170	0	0
G. Hignett and Co.	170	15	6
Troup, Curtis, and Co.	171	10	6
D. Firth and Son	185	0	0
T. Clarke	190	0	0
F. A. Glover and Co.	220	0	0
E. Wight	250	10	0
Barlow Bros. and Co.	263	0	0
Tamplin and Makovski, Limited	277	0	0

Homerton sub-station.

Ellis, Pollen, and Co.	73	17	0
National Electric Wiring Company, Limited	95	15	0
W. Simmons	106	0	0
Handley and Shanks	107	0	0
Nunn, Watts, and Co.	108	0	0
Electrical and General Engineering Company	111	0	0
Troup, Curtis, and Co.	111	9	6
G. Weston and Co.	117	8	0
A. W. Penrose and Co.	119	0	0
G. Hignett and Co.	119	18	0
D. Firth and Son	122	0	0
T. Clarke	140	0	0
F. A. Glover and Co.	148	0	0
E. Wight	170	0	0
Barlow Bros. and Co.	190	0	0
Tamplin and Makovski, Limited	218	0	0

Perry Vale station—wiring and fittings.

Ellis, Pollen, and Co.	113	0	0
National Electric Wiring Company, Limited	129	6	0
Handley and Shanks	149	16	6
Electrical and General Engineering Company	165	0	0
G. Hignett and Co.	168	12	0
G. Weston and Co.	169	12	6
Nunn, Watts, and Co.	170	0	0
Troup, Curtis, and Co.	174	19	3
A. W. Penrose and Co.	175	0	0
D. Firth and Son	184	10	0
T. Clarke	206	10	0
F. A. Glover and Co.	226	0	0
Barlow Bros. and Co.	253	0	0
Tamplin and Makovski, Limited	287	0	0

Wiring only.

Ellis, Pollen, and Co.	89	0	0
National Electric Wiring Company, Limited	104	5	0
Handley and Shanks	126	6	6
Electrical and General Engineering Company	139	0	0
G. Hignett and Co.	142	12	0
G. Weston and Co.	136	0	0
Nunn, Watts, and Co.	138	0	0
Troup, Curtis, and Co.	143	19	0
A. W. Penrose and Co.	123	0	0
D. Firth and Son	156	10	0
T. Clarke	165	10	0
F. A. Glover and Co.	175	0	0
Barlow Bros. and Co.	214	0	0
Tamplin and Makovski, Limited	269	0	0

Note.—The Fire Brigade Committee recommend that the tenders of Ellis, Pollen, and Co., to execute for £111. 10s., £102. 11s., £113, and £73. 17s. the wiring, and to supply the fittings for electric light installations at the West Hampstead, East Greenwich, and Perry Vale stations and the Homerton sub-station respectively be accepted.

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Leeds.—The Corporation have accepted the tender of the British Thomson-Houston Company for the supply of 50 electric motorcars, at £25,951. 4s.

Northampton.—The Northampton Estates and Improvements Corporation, Limited, have received the following tenders for electric lighting of public portion of Emporium-arcade:

F. Watkin, Northampton	£171	0	0
Lea and Warren, Kettering	168	10	0
Mansell, Northampton	130	0	0
National Electric Wiring Company, London (accepted)	117	18	0

BUSINESS NOTES.

TRACTION.

Llangfelagh.—The Glamorgan light railway scheme has met with approval by the District Council.

Lancing.—The Parish Council have agreed to support the proposed extension of the tramway from Shoreham through Lancing.

King's Heath.—At the instance of King's Norton Urban District Council, the tramcar fare between Birmingham and this place has been reduced to 2d.

Ilkeston.—Last Tuesday the chairman of the Tramways Committee inaugurated the laying of the new tramway lines for the north end of the borough.

Bingley.—A scheme for the construction of electric tramways through this place is being considered by the Highways Committee of the District Council.

Brierfield.—Mr. W. A. Fraser, the borough electrical engineer of Nelson, has been appointed consulting engineer to the Council for the tramways and lighting.

Margam.—The Council have appointed a special committee to take into consideration the advisability of constructing an electric tramway from Taibach to Aberavon.

Lancaster.—The tramways company have offered to reopen the negotiations with the Corporation with reference to the acquisition of their undertaking by that body.

Hull.—In reply to a question at the last meeting of the Works Committee, the Chairman said the Corporation had in contemplation the building of their own tramcars.

Barrowford.—The Council have retained Mr. W. A. Fraser, the borough electrical engineer of Nelson, as consulting engineer to their schemes of tramways and electric lighting.

East Barnet.—In consideration of the opposition of the District Council, the Middlesex County Council have withdrawn their proposal to construct a light railway in this district.

Dublin.—A special committee is to be formed to consider articles of association, with a view to the formation of a company for the construction of an electric tramway to Slane.

City and South London Railway Extension.—The number of passengers carried on the new extension of this line to Islington, opened for the first time on Sunday, was 8,000.

Haslingden.—The Corporation are in favour of purchasing the whole of the undertaking of the local tramways company, in conjunction with the other local authorities concerned.

Leicester.—Announcement has now been formally made of the intention of the Corporation to seek parliamentary powers in the next session for the construction of electric tramways in the town.

Wrexham.—Notice has been given of an application to Parliament in the next session by the Wrexham and District Electrical Tramways Company for powers to construct electric tramways in this place.

Sandwich.—A committee of the Town Council has been appointed to confer with the Deal Town Council with regard to a proposal for a light railway communication between Sandwich, Deal, and Walmer.

South Wales Electrical Power Distribution Co.—This company have given notice of an intended application in the next session of Parliament for powers to acquire additional lands for generating stations, etc.

Birstall.—The District Council have resolved to obtain the sanction of the Board of Trade to purchase such portion of the Dewsbury, Batley, and Birstall Tramways Company's lines as are within the Council's district.

Hindley.—The South Lancashire Tramways Company have given notice of commencement of work in connection with the new tramways, and the District Council are appointing a man to supervise the work on their behalf.

Dover.—Official announcement has been made of an application in the next session of Parliament for powers to construct light railways to connect the municipal tramways at Dover with St. Margaret's Bay and several other villages.

Sheffield.—We understand that the "through service" in the working of the electric tramways will come into operation on Monday next. The object is to relieve the congestion of the tramway traffic in the centre of the city.

Greenock.—A petition for interdict has been lodged by Port Glasgow Town Council against the Greenock Corporation supplying the tramways company with electricity for use in Port Glasgow without the consent of the burgh.

Birmingham.—The city surveyor estimates the cost of the proposed new Edgbaston and Harborne tramway at £180,000. The scheme, which has received the approval of the City Council, has yet to be sanctioned by Parliament.

Twickenham.—The plans and drawings of the cars and rolling-stock, and also the design of the iron poles for carrying the overhead wires of the London United Tramways in the district, have received the approval of the local authority.

Eastbourne.—At the last meeting of the Town Council the proposal to include in the Corporation Bill to be promoted in the next session of Parliament powers to run a service of motorcars in the town met with considerable opposition, but it was eventually approved.

Wakefield.—The Wakefield and District Light Railway Company have decided to apply to the Light Railway Commissioners for authority to extend their lines to Dewsbury, Ossett, Rothwell, Oulton, Methley, Whitwood, Warmfield, Crofton, Sharlston, Featherstone, and Normanton.

Brighton Railway and Electric Traction.—Major Cardew and Mr. Philip Dawson have been retained by the London, Brighton, and South Coast Railway Company as consulting electrical engineers to advise generally on the subject of electric traction in connection with their system.

Hastings.—The Hastings Tramways Company have given public notice of their intention to apply in the next parliamentary session for powers to construct a system of electric tramways in the borough. The proposals of the company include a double-line tramway along the "Front line."

Colchester.—The Tramways Committee have reported to the Town Council that Colonel von Donop, R.E., Board of Trade inspector, has met the committee and inspected Queen-street. He explained certain modifications which he would be willing to recommend for acceptance by the Board of Trade.

Naples.—A Naples correspondent says that the great power station to supply the Neapolitan electric tramways and other industries with current has been opened, and two new lines of electric tramways have been inaugurated for public traffic. Three more routes were expected to be opened this week.

London and Brighton Electric.—The promoters of this scheme have given notice of intention to apply for powers in the next session of Parliament to construct an electric express railway between London and Brighton. The proposals of the company have already been published in this journal.

Aberdeen.—Formal notice has now been given of an application to the Secretary for Scotland before Dec. 17 next for a provisional order to be confirmed by Parliament under the Private Legislation Procedure (Scotland) Act, 1899, for a scheme of suburban tramways, as already announced in these columns.

Leicestershire and Warwickshire Electric Power Co.—This company announce their intention of making application to Parliament in the next session for powers to establish generating stations and works and supply electricity, etc., in parts of the counties of Leicester and Warwick.

Blackpool-Garstang Light Railway.—The negotiations in connection with this scheme are progressing very favourably. All plans and specifications and quantities have been completed by the engineers, and contracts are to be invited forthwith. The railway will, it is expected, be completed and opened by Easter, 1903.

Manchester-Liverpool Monorail.—Report states that the actual work of constructing this line will be commenced in the spring of 1902. It is not at all improbable that a start will be made simultaneously at the two extremities of the route—Liverpool and Manchester—and at Warrington, which is about halfway along the proposed route.

Cape Town.—A Central News message says that Prof. Morrison, of Victoria College, Stellenbosch, addressing the Philosophical Society on the 13th inst., caused a sensation by advocating a scheme for utilising the Orange River Falls to provide electric power for the Cape railways. Prof. Morrison urged the practicability of the scheme, but it is generally regarded as impossible owing to the huge mileage of the lines.

Sedgley.—It appears that the opening of the electric tramway between the Bull-ring, Sedgley, and the Fighting Cocks is being delayed through a dispute with the Post Office authorities, who have raised objections that the British Electric Traction Company have not given an undertaking of their wires. We understand that the dispute has been referred to arbitration, and that the Board of Trade are withholding the certificate for the running of the cars until the matter is settled.

Nelson.—The Corporation have agreed to supply the Burnley Corporation with current for the tramways on the Nelson and Brierfield lengths at 2d. per unit. The reconstruction of the tramways has been started, and the electric cars will probably be running early in the new year. The Corporation have received several applications for current for motive power for running looms which will give a load for 56 hours per week.

Plymouth.—The Plymouth, Stonehouse, and Devonport tramways, which have been converted to electric traction, were opened for public traffic by electric cars on Monday last. For the lines in Devonport and Stonehouse the electrical energy is supplied from the Devonport Corporation works at Stonehouse, while that part of the system which is situated in Plymouth is supplied with power from the Plymouth Corporation works.

North Metropolitan Tramways Co.—Notice has been given by this company of intention to apply in the next parliamentary session for powers to "use mechanical power on and adaptation to tramways in Middlesex of North Metropolitan Tramways Company for that purpose; construction of works for generating and supplying electricity or other motive power; working, traffic, and other agreements, and other provisions."

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Collision at Shepherd's Bush.—About nine o'clock in the morning last Saturday an omnibus collided with one of the electric cars proceeding in the same direction. It is stated that the accident occurred through the 'bus attempting to pull across the front of the tramcar. Both vehicles were full of passengers, but fortunately no personal injuries were sustained.

South Shields.—The proposal of the Town Council to extend the tramways to Harton Village has been abandoned on account of the Rural District Council having decided to support the application of the British Electric Traction Company for a system of light railways. The estimate of cost of the proposed conversion of the whole tramway system of the town to electric traction and the construction of new lines, together with new cars, is £300,000.

Sunderland.—The Corporation tramways are proving a very profitable undertaking. The accounts for the half-year ending the 6th inst. show that the receipts have been £35,341, an increase of £22,397 over the corresponding half of last year, when electric traction had only been adopted on one section. After allowing for interest and sinking fund, but not for depreciation, there will be a profit of about £10,000. The average weekly takings now are over £1,000.

Benwell.—At a special meeting of the District Council on Tuesday, the question of the proposed extension of the Newcastle tramways to Benwell was discussed. It was stated that the Newcastle Corporation did not consider it expedient, at present, to continue the tramways along Benwell-lane to the Fox and Hounds Inn, but the lines would be laid from Westgate-road into Benwell as far as the Charlotte Pit-lane, and along Elswick-road to the parish church.

Hackney.—The Works Committee of the Borough Council recommend "that with the object of effecting a considerable saving by the adoption of motor-vans as a means of transport for the collection of house refuse in the borough, the committee be empowered to make the necessary enquiries as to the cost, efficiency, etc., of the several systems, with a view to the purchase of one motor and three dust cars, to be used at the destructor works, as an experiment."

Beckenham.—Mr. J. A. Angell, engineer to the Urban District Council, has formulated a scheme for the introduction of municipal electric tramways for Beckenham, Penge, and Bromley. Altogether about 7 miles 6 furlongs of line are proposed, and the estimated total cost is put at £108,667. A local ratepayers' meeting has passed the following resolution: "That this meeting of ratepayers considers that tramways are unnecessary for Beckenham."

North Ormesby.—We understand that a syndicate of well-known manufacturers of this district has been formed to promote in the coming session of Parliament a Bill for an electric tramway to connect the important industrial areas on the outskirts of Middlesbrough that comprise North Ormesby, South Bank, and Grangetown. Mr. A. A. Campbell Swinton, M.I.C.E., Westminster, and Mr. W. P. Ingham, M.I.C.E., Middlesbrough, are the engineers for the scheme.

Deptford.—The Borough Council have passed a resolution of regret at the intention of the London County Council to seek powers for the acquisition of the vacant site in the New Cross-road known as Fairlawn, for the purpose of an electric generating station or tramway depôt, being of opinion that the prospective ratable value of the borough, the interests of the local tradespeople, and the value and comfort of the adjoining property would be very seriously affected thereby.

Darlington.—The purchase of the tramways by the Corporation from the tramways company having been completed, the Tramways Committee have arranged to carry forward the resolutions come to some time ago, to make application to borrow £100,000 to construct new tramways. The matter has been discussed as to whether the Corporation should work the tramways or lease them to a company, and the decision come to to recommend the Council that they should work them themselves.

Manchester.—A number of local gentlemen are considering a proposal to seek powers in the next session of Parliament for a "tube" railway in Manchester. The scheme provides for an inner circle running from Victoria Station to the London-road, Oxford-road, Central, and Exchange Stations, the circle being completed at Victoria. The cost is estimated at about £1,500,000. The Corporation have given notice of an intended application in the next session of Parliament for powers to construct additional tramways in the city.

Doncaster.—A special meeting of the Town Council has resolved to abandon certain portions of the light railways authorised by the Corporation light railways order. Since the Corporation got their order they have bought property which enables them to widen Sunny Bar, and instead of going through the cattle market the trams will run through Sunny Bar and along Nether Hall-road. The other deviation is to turn round at the race common towards the grand stand instead of finishing at the Belle Vue, near the horse pond.

New "Tube" Scheme.—According to a *Daily Mail* report, the District Railway Company, who obtained parliamentary powers to construct a "deep-level" railway below the existing lines four years ago, are now putting the plan into operation. It is even said that contracts have been signed for the construction of the new railway. The idea is to run a service of fast trains at a five-minute interval, making stops alternatively at the various stations according to the extent of the passenger traffic at different local authorities.

Tottenham.—An application to the Light Railway Commissioners for powers to construct a line of light railways from Tottenham to Epping Forest having failed, the North Metropolitan Tramways Company have now intimated to the District Council that they are promoting another scheme, which will unite Green-lanes with the High-road by a line running along West Green-road and Philip-lane, and with the Seven Sisters-road, by a line along St. Ann's-road. Application is to be made to the Light Railway Commissioners in the course of a few weeks.

Romford.—The Urban District Council are applying for powers to construct an electric tramway from the Ilford boundary to Romford. The Metropolitan Tramway now runs to Manor Park, while the East Ham electric tramway continues therefrom to Ilford. The latter District Council have decided to construct an electric tramway to Chadwell Heath, so that Romford's proposal will ultimately bring the old market town in direct tramway communication with the East-end of London.

Light Railway Orders Confirmed.—The Board of Trade have confirmed the following light railway orders: (1) authorising the construction of light railways in the county of Derby, from Derby to Ashbourne; (2) authorising the construction of light railways in the county of Somerset, in the city and county borough of Bath, and in the rural district of Bath; (3) amending the Tanat Valley Light Railway Order, 1898; (4) authorising the construction of light railways in the parish of Mitcham, in the rural district of Croydon, in the county of Surrey.

Wolverhampton.—A special meeting of the Town Council has been called to consider the advisability of applying for a provisional order to authorise the construction of a new tramway from Snow-hill to the present tramway in Piper's-row, at its junction with Bilston-street. The British Electric Traction Company have applied for the Council's approval of an alteration of the situation of the proposed tramlines in the Parkfield-road, from the centre of the road to the south side, so that the nearest rail should be an average of 4ft. 6in. from the kerb of the footpath.

Brighton.—On Monday the Lewes-road section of the new electric tramways will be officially inaugurated by the Mayor and Mayoress, the Board of Trade certificate having been granted for the opening of this portion of the system to the general public. Immediately after the completion of the opening ceremony the cars will be open to the public at the regular fare of 1d. for the whole distance from the north gate of the Pavilion to the borough boundary. The Board of Trade inspector is expected in Brighton again early next week to complete his inspection of the whole system.

Electric Motorcar's Success.—We learn from the *Daily Chronicle* that an interesting feature of the motorcar run to Portsmouth last Saturday, which has not been made public, was the excellent performance of an electric car which took part in the tour. Hitherto the average speed of cars driven by electricity has been something like 12 miles an hour, but on Saturday an average of 14 miles per hour was attained. This, under the conditions which prevailed, is a highly encouraging result to those who pin their faith to electricity as the propelling power for motorcars. At only one part of the journey were the conditions favourable for driving.

Bolton, Turton, and Darwen Light Railway.—This order came before Sir Francis Hopwood at the Board of Trade for confirmation. The Bolton Corporation opposed on the ground that the railway was likely to be a source of danger to their Belmont reservoir. Mr. Overend Evans explained that the Corporation were afraid if this line were constructed that it would bring heavy traffic, which would endanger the embankment, and might do untold damage to the neighbourhood if the reservoir gave way. Sir Francis Hopwood acknowledged that this was a most important question, and intimated that the Board would give their decision at an early date.

London "Tube" Schemes.—The following companies have given public notice of their intention to apply in the next session of Parliament for powers to construct underground electric tramways within the metropolitan area: the Great Northern and City; Great Northern and Strand; North-East London; Piccadilly and City; City and Old Kent-road; Brompton and Piccadilly; East London; City and Peckham; Victoria, Kennington, and Greenwich; Charing Cross, Hammersmith, and District; King's-road; City and Crystal Palace; and the Baker-street and Waterloo. The City and Brixton Railway Company give notice of the abandonment of the scheme.

Scarborough.—An influential local syndicate, with Mr. W. S. Rowntree as chairman, has been formed to promote in Parliament next session a Bill for a complete system of electric tramways in Scarborough, in accordance with an agreement that has been arrived at with the Corporation. In addition to some six miles of passenger route, which includes a line throughout the new marine drive, which is being constructed round the Castle rock, it is intended that the proposed tramways shall deal with the very large fish traffic that in the fishing season obtains between the harbour and the North-Eastern goods station. Mr. A. A. Campbell Swinton, M.I.C.E., is engineer for the scheme.

Barton-upon-Irwell Light Railway.—The County Council have withdrawn their objection to this scheme upon an assurance that granite setts will be used, unless some other kind of paving be directed by the Board of Trade, and the opposition threatened on behalf of the Salford Corporation has also been conciliated. The only outstanding point is whether payment of interest out of capital should be allowed during construction, as there can be no revenue earned until the light railway is made. The projected line is to run along part of the main road between Manchester and Bolton. The order, which has been issued by the Light Railway Commissioners, is awaiting confirmation by the Board of Trade.

Walsall.—The Town Council have approved the recommendation of the Tramways Committee, that, subject to satisfactory arrangements being made with the South Staffordshire Tramways (Lessee) Company, Limited, for working the extension of the tramways to Bell-lane, Bloxwich, for the remainder of the term of three years from Jan. 1 last, the Council proceed at once to construct and equip that portion of the line at an estimated cost of £6,000, and also to make such alterations and construct such new works as may be necessary for equipping the whole of the Bloxwich section of the tramways for taking a supply of current from the Corporation works at a further estimated cost of £3,140.

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Burton.—It was stated at the last meeting of the Town Council, with reference to the proposal to introduce electric tramways in the town, that no scheme would be launched without every consideration. There appears to be every probability of the scheme meeting with strong opposition in certain more or less influential quarters. A number of the protesting ratepayers, including several members of the Council, have held a meeting at which it was decided to send a petition to the Council asking that the ratepayers may be afforded an opportunity of expressing their opinions on the important question before any scheme is finally adopted. The opinion was expressed by some that it would be much better for the Corporation to permit a private company to step in and establish tramways, the Council retaining the necessary powers to purchase at any time from the company at a reasonable price.

Metropolitan Railway.—This company have given notice of intention to apply in the next session of Parliament for powers to enlarge and improve their Baker-street Station; to acquire lands for generating station; provisions as to running over, and electrical working of, railways of the company and joint railways of the company, and the Great Western Railway Company, etc.; powers and provisions for the Hammersmith and City Railway Joint Committee, the Metropolitan and District Railways (City lines and extensions) Joint Committee, and the East London Railway Joint Committee to work railways and traffic thereon by electrical power; laying of cables and apparatus on portions of other railways; use of water for purposes of undertaking; agreements as to dredging, etc., with the Company of Proprietors of the Grand Junction Canal and the Regent's Canal and Dock Company; confirmation of award or determination of Board of Trade under the Metropolitan District Railway Act, 1901, etc.

Parliamentary Bills.—Among the local authorities who have given notice in the *London Gazette* of the promotion of Bills in the next session of Parliament either for the construction of new tramways or the extension of existing lines are the following: the Corporation of Halifax, the Tipton Urban District Council, the Corporation of Sunderland, and the Corporation of Newport. The Corporation of Brighton announce an application to the Board of Trade for a provisional order for additional powers in connection with the electric tramways, and also the Corporation of Stockport; while the Cheltenham and District Light Railway Company and the Doncaster Corporation give notice of applications to the Light Railway Commissioners for powers to construct light railways in the county of Gloucester and in the borough of Doncaster respectively. The Mexborough and Swinton Tramways Company propose to apply to Parliament next session for powers to construct tramways in that district.

London United Tramways (1901) Co.—This Company was registered on Nov. 11 with a capital of £1,650,000 in £10 shares (82,500 5 per cent. cumulative preference), its object being "to take over and carry on the business of the London United Tramways, Limited, to acquire as a going concern the undertakings, tramways and light railways authorised by the London United Tramways Act, 1873 to 1901, by the London United Tramways, Limited (Light Railway Extensions), Order, 1898, and the rights, powers, and authorities thereunder as provided for and contemplated by Section 45 of the London United Tramways Act, 1901, or as otherwise authorised, and all or any other the undertaking, property, and assets of the London United Tramways, Limited, etc." The Company have now given notice of an intended application to Parliament in the next session for power to lay down and work additional tramways in the counties of London, Middlesex, and Surrey, reference to which has been made from time to time in these columns.

Salford.—The Pendleton section of the new electric tramway system has been inspected by Lieut.-Colonel von Donop on behalf of the Board of Trade, and opened for public traffic. Mr. A. P. Trotter, the electrical adviser to the Board of Trade, has intimated that he does not deem it necessary at the present juncture to make an inspection of the overhead equipment of the route. The official opening of those routes which have been completed for electric traction took place on Wednesday last, although on some sections electric cars have been running for public traffic for some time now. When the whole system has been completed the total mileage under the control of the Tramways Committee will be 35½ miles of single track, and to this should be added 12 miles in the borough of Eccles and the Swinton district, which have been leased to the Salford Corporation. The estimate of the cost was originally £414,753, but whether that amount will suffice remains to be seen. The electrical energy is generated in a new station in Strawberry-road, now in its last stages of completion. The Corporation have now given notice of the promotion of a Bill in the next session for powers to add to the tramways in the borough.

Newcastle-on-Tyne.—Active preparations are being made for the early running of the electric tramcars on some of the routes which have been converted. It was stated at the first meeting of the new Tramways Committee that the first route to be opened was from Byker, by way of Raby-street, Walker-road, City-road, Pilgrim-street, Northumberland-street, to Jesmond and Gosforth. The Board of Trade inspection was being awaited. Mr. Rossignol, the engineer, reported that 50 drivers had been engaged, and they would immediately be put into training. The question relating to the supply and consumption of coal was entered into. It was stated that when the power station and works generally were in full order, the consumption would be from 300 to 500 tons per week. The Corporation intend to apply to Parliament in the ensuing session for leave to bring in a Bill to enable them to "form, lay down, use, and maintain new tramways in the city and county of Newcastle-upon-Tyne, the borough of Wallsend, the urban districts of Walker, Benwell and Fenham, Gosforth and Westslade, the parish of North Gosforth and the rural district of Castle Ward, in the county of Northumberland." Sixteen tramways and a tramroad are included in the Bill, all of which will be constructed on a gauge of 4ft. 8½in."

Tramways in London.—Mr. J. Williams Benn, chairman of the Highways Committee of the London County Council, gave his views upon the question of the municipal control of the London tramways to a large audience at the Shoreditch Baths on Monday night. He claimed that there were many advantages of the control of tramways by the County Council, especially in the matter of lower fares and better conditions of labour. Referrring to the resolution of the London County Council to introduce shallow tubes for tramways and pipes under the streets, he stated that such a system was a great success in Boston, and he believed it would be a boon to London. It would stop the unbusinesslike and monstrous methods of constantly breaking up the streets by water and gas companies. They would have to go before Parliament with their scheme. There was a distinct connection between the housing and tramways problems, and if they obtained the necessary powers the electric cars would take passengers any distance for a penny. Rack-renting landlords could then be defied, as workers could get to the suburbs for 1d. instead of living in miserable slums. They might even look forward to County Council dwellings on the outskirts, with season tramway tickets thrown in.

Huddersfield.—The Corporation Tramways Committee are introducing a number of drastic reforms in order to put the undertaking on a sound commercial and paying basis. It has been decided, for instance, that all work other than that of the maintenance of the permanent way shall, wherever practicable, be let by contract, the Corporation dealing direct with the contractor doing the work. All surplus engines and cars are to be sold off. Notwithstanding a loss, aggregating to nearly £1,000 per annum, exclusive of depreciation, on the Newsome, Sheepridge, and Crosland Moor sections, the services of cars on those routes are not to be discontinued. No materials are to be purchased or work done above the value of £5 without the sanction of a finance, stores, and works sub-committee (consisting of the Mayor and six members of the Council), who shall meet at least once a fortnight. It is considered that the salaries and wages paid by the department are excessive as compared with similar undertakings elsewhere, and, accordingly, there is to be a reduction in the office staff, a revision of salaries, and rearrangement of duties, and the borough treasurer's office is to be the centre in which the substantial work in connection with the finances is to be done. It is further considered that the ticket system in place of fare collecting boxes should be adopted, and less elaborate offices could be obtained in one or other of the properties belonging to the Corporation.

Middlesex Light Railways.—Mr. W. King Baker, a member of the Middlesex County Council, has addressed a letter to the daily Press, in which he says: "Within a few months of the time when the Middlesex County Council took its first step in connection with the promotion of light railways, and before it had secured a single one of its projected lines, or had built a yard of them, it proceeded to dispose to a private company of the working of a number of these railways, including its great main arteries—the trunk roads out of London—Edgware-road and the Great North-road. Whether this action was wise or the reverse may be readily judged by the experience of a large number of the most important towns and cities throughout the United Kingdom, which, having previously tried this plan of leasing their lines, have discarded it and, with immense relief, have taken the more convenient and profitable course of promoting their own public transit on their own roads. In the face of these well-known facts is it credible that the premier county should continue and extend the obsolete and universally discredited policy of leasing its lines? The fatuity of such a course is intensified by the unusual conditions under which its light railway extensions are promoted. In them the County Council not only takes the cost of construction of the permanent way, but, in addition, the great expense of widening and paving roads and footpaths, and these exceptional items, not generally taken by tramway authorities, are supposed to be defrayed out of the uncertain profits to accrue under company management. How can less than half these profits repay such outlays? Under the Council's own working it would be entirely different. Further, notwithstanding the fact that the Council pays 75 per cent. of the original outlay, it will be obliged, when acquiring the lines, to pay the lessees for all their outlays, not according to the actual value (as would be required under any tramway agreement), but 'as a going concern,' which is something altogether different. What I would urge is that we should thoroughly investigate the matter, find out the actual earning value of our light railway property, and then, and not till then, with all the facts before us, decide on that policy which will give the best facilities to the travelling public, the best financial returns to our ratepayers, and which shall conduce to the interests of residents in our county, and to its successful development."

LIGHTING AND GENERAL.

Radcliffe.—Sanction has been obtained by the District Council to borrow £21,500 for electricity purposes.

Morecambe.—Estimates for extension of mains along Thornton-road are before the Urban District Council.

Bristol.—It is expected that the Corporation's new works for the generation of electricity will be opened within a fortnight.

Crompton and Co.—We learn that Mr. Lionel H. Hanbury, of 25, Mark-lane, E.C., has joined the Board of this Company.

Stepney.—The Borough Council have appointed Mr. W. T. Lynex to the post of accountant clerk in the electricity department.

Ormskirk.—The Guardians are still occupied with the question of introducing electricity into the workhouse for lighting and pumping purposes.

Epsom.—The lift at the grand stand, referred to in a previous issue, is being made by Messrs. Archibald Smith and Stevens, Queen's road, Battersea.

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Whitby.—The Urban District Council have arranged to draw up to £26,000 for the electric lighting undertaking. This includes £9,000 already expended.

Brush Electrical Engineering Co.—Mr. Edward H. Tyler has been appointed chief engineer to the Brush Electrical Engineering Company, Limited.

Llangollen.—At an extraordinary meeting of the Urban District Council on Tuesday proposals to light the town by electricity were considered in committee.

Finchley.—An enquiry will be held shortly into the application of the Urban District Council to borrow £700 for land for an electric lighting generating station.

Blaydon.—Application is to be made for a provisional order authorising the Council to supply electricity under the Electric Lighting Acts, 1882 to 1889.

Margam.—The Council have decided to proceed with the application for sanction to borrow the sum of £7,000 for works provided for in the Margam Electric Lighting Order, 1898.

Hebburn.—The District Council have asked the County of Durham Electrical Power Distribution Company to send their representatives at an early date to discuss the whole question of electricity.

Barnsley.—Application is to be made to the Postmaster-General for a license to establish municipal telephones in the borough. It is proposed to extend the mains of the Corporation and to supply electrical energy to the workhouse.

Bradford.—The following appointments have been made in the electrical engineer's office: chief assistant in meter and motor department, Mr. R. Briggs; shift engineer, Mr. J. Y. Mackensie, assistant at Fleetwood and District Light and Power Syndicate.

Telegraphists for South Africa.—In addition to the draft of specially enlisted telegraph operators to be dispatched by the Royal Engineers at Aldershot on the 26th inst., two complete field telegraph companies are to be prepared to embark for the Cape on Dec. 5.

Electric Lifts.—Messrs. Easton and Co., Limited, Westminster, have received from the London County Council the contract for the supply of the large electric lifts for the Greenwich Tunnel. The lifts on the Islington extension of the City and South London Railway were also manufactured by this company.

Stafford.—At the last meeting of the Town Council, a resolution was brought forward to the effect that the time had now arrived when a separate committee should be appointed to each department of the gas and electricity works. The fact that the motion was rejected by 19 votes to 3 sufficiently indicates the feeling of the Council.

Morley.—The Electric Lighting Committee have reported that during the four weeks ending Oct. 19 there was an increase in the output from the electricity works of 2,570 units as compared with the same period last year, or 36·7 per cent. The increase for the last three months was 6,000 units over the same period of last year.

Carnarvon.—As in the opinion of the parliamentary agents the insertion of a transfer clause in the draft provisional order for supplying the town with electricity would weaken the Corporation case before the Board of Trade should Mr. Peterson renew his application, the Council have resolved that such clause be omitted from the draft order.

Harrogate.—The Lighting Committee have resolved that 16-c.p. and 8-c.p. lamps be put in the lanterns in Mornington-crescent as a trial, and to instruct the engineer to ascertain the lowest cost at which he can fit up street lamps complete for electric lighting, and also to prepare particulars of extras of the proposed boiler extension at the electric light works.

Ealing.—Mr. B. F. Jenkinson, C.E., A.M.I.E.E., in his report on tests of the comparative results of mechanically-stoked and hand-fired boilers, states that the actual difference in the cost of producing 500,000 units for fuel alone was £520. 16s. 3d. under the old coal contract, and £304. 3s. 4d. under the present coal contract, both in favour of boilers fitted with mechanical stokers.

Ilford.—The County Council have asked the Urban District Council what they proposed to do with regard to the removal of the electric light and tramway posts from the centre of the main road, so as to prevent obstruction. The posts have been up several months, and a copy of the resolution to have the posts placed in the middle of the road is to be sent to the County Council in reply.

London Electrical Contractors' Association.—A meeting of electrical contractors under the auspices of this association will be held at Anderton's Hotel, Fleet-street, on Wednesday, Nov. 27, at eight o'clock. We have been asked to state that important questions of trade interest will be discussed, and representatives of all electrical contracting firms are particularly requested to attend.

Robert W. Blackwell and Co.—Mr. Philip Dawson, M.I.Mech.E., M.I.E.E., A.M.I.C.E., has severed his connection with Robert W. Blackwell and Co., Limited, and will practice as a consulting engineer at Lennox House, Norfolk-street, Strand, London, W.C. Mr. Edgar R. James (late secretary) succeeds Mr. Dawson on the Board. Mr. W. J. Bailey (late assistant secretary) succeeds Mr. James as secretary.

Coventry.—At the last Town Council meeting the chairman of the Electric Light Committee confirmed the statement that the new manager had recommended the committee to double the capital expenditure, that was, to practically raise the capital expenditure from £70,000 to £140,000. He added, however, that no date had been given as to when that increase should take place. Sanction to the borrowing of £22,800 has been received.

Cottingham Telephones.—The Town Council of Hull having enquired whether the Urban District Council would grant facilities in regard to wayleaves in the village, and for the erection of the necessary poles in connection with the proposed municipal telephones, the Council have replied that they had passed a resolution three years ago offering to grant the Hull Corporation every reasonable facility in the event of Cottingham being included in the telephone area.

Aylesbury.—The last report of the Electric Lighting Committee adopted by the Urban District Council showed that the committee met just prior to the Council meeting and considered a letter from Mr. Pieterson, and in view of his having declined to give particulars relative to the firm he represented, the committee recommended that Mr. Medhurst be asked to forthwith send in his report.

Electric Power in Northumberland.—Application will be made to Parliament in the ensuing session for leave to bring in a Bill to incorporate a company for the purpose of establishing and carrying on electric works and generating, producing, using, and supplying electric energy or power in certain parts of the Castle Ward, Tynemouth, Morpeth, and Alnwick Unions, in a triangle bounded by Lesbury in the north, Tynemouth in the east, and Heddon in the west.

The Recent Storm.—One of the effects of the recent storm was that telegraphic communication from Hull was seriously interfered with. Scotland was entirely cut off, and considerable delay occurred on telegrams to all parts of Cumberland, Durham, and Northumberland; also to Belfast and the North of Ireland generally. In consequence, great inconvenience was caused to the trading community, whose experience of the trunk telephone lines was also very trying.

Rotherham.—Mr. A. A. G. Malet has held an enquiry into the application of the Town Council for sanction to borrow £12,000 for the following purposes: (1) extensions of generating plant, £3,336. 12s.; (2) feeders and mains to Masborough, £2,150; (3) extensions and mains in Rotherham, £4,300; (4) street-lighting, £600; (5) service cables, £700; (6) meters, £600; extras, £313. 8s. The Corporation originally had not anticipated so large a demand for the electric light.

Brighton.—On Friday the ceremony of switching on the installation of electric light at the Brighton Workhouse was performed by the Mayor of Brighton (Alderman J. E. Stafford). The work has been executed by Mr. H. J. Galliers, of St. James's-street, Brighton, whose tender was the lowest—viz., £688. 16s. It has been referred to the Sites and Works Committee to consider the question of the improved lighting of the Pelham-street schools by electric light or otherwise, and report thereon.

Dundee.—A breakdown occurred at the electric station last week, but the supply of electric energy for lighting and tramway purposes was only interrupted for about 20 minutes. The Gas and Electricity Committee are proceeding to remove the electric light standards in High-street, the lamps attached to which are not now in use. It was remitted to the electrical engineer and gas engineer to consider and report as to the feasibility of dispensing with electric light standards in Reform-street by attaching the arc lamps to the trolley standards.

National Electric Wiring Co.—We are informed that the order for the electric lighting of the new Emporium Arcade, Northampton, has been secured by the East Midlands centre of this company, and the work is being carried out by Mr. Barham, district engineer. Amongst other orders in hand, this centre has obtained the contract for lighting the School Board offices and Waller-street Schools for the Luton School Board; and is also engaged on a large and complete bell and telephone installation at Hughenden Manor, the residence of the Hon. Coningsby Disraeli, M.P.

Stockport.—At a recent meeting of the Town Council the Mayor drew attention to the fact that he had directed the attention of the Council to the desirability of establishing a municipal telephone service, and a preliminary step in this direction had been taken by appointing a committee to consider the matter and report thereon. He hoped as a result of the investigations of this committee an efficient service of municipal telephony would ensue, and that the charges would be brought down to such a reasonable figure as to facilitate the fuller use of the telephone for commercial and general purposes.

Stock Exchange.—The Stock Exchange Committee have ordered the Charing Cross and Strand Electricity Supply Corporation's £250,000 4 per cent. debenture stock (redeemable), in lieu of the provisional certificates now quoted, to be quoted in the official list. Application has been made to the Exchange Committee to appoint a special settling day in and grant a quotation to Edmundson's Electricity Corporation's 10,000 ordinary shares of £5 each (issued at 5s. premium), £3. 5s. paid (of which £3 is capital and 5s. premium). The committee have also been asked to appoint a special settling day in Edmundson's Electricity Corporation's further issue of 10,000 6 per cent. cumulative preference shares of £5 each (issued at 5s. premium), £3. 5s. paid (of which £3 is capital and 5s. premium).

Hackney.—The borough electrical engineer (Mr. L. L. Robinson) has made the following appointments: Shift engineers—Mr. Morgan W. Holmes, of Leeds; Mr. Bernard Sankey, of Middlesbrough; Mr. Thomas Baxendale, of Coventry. Testing engineer—Mr. L. H. Andrews, of Brighton. Assistant testing engineer—Mr. Eugene Matthews, of Clapton. At last night's meeting of the Borough Council it was reported that the contract with the British Insulated Wire Company, Limited, for electricity mains provided that the company should make a certain number of house service connections at a fixed schedule rate per service, including making good the surface of the road or pavement disturbed. At the present time this work was being carried out by the contractors, but later on they thought it would be more convenient for them if the Borough Council would undertake the work on their behalf.

London Gazette.—Application is to be made to the Board of Trade for orders as follows: Electric lighting—East and West Molesey (U.D.C.), South Bank-in-Normandy (U.D.C.), Mytholmroyd (U.D.C.), Hindhead and District (John Dover, Woodberry Down, Finsbury Park), Springhead (U.D.C.), Otley (U.D.C.), Tipton (U.D.C.), Newburn (Newcastle and District Electric Light Company.—A final meeting of the Leyland Rubber Company (in liquidation) will be held

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on Dec. 18 at the Golden Hill Works, Leyland.—It is proposed to apply for a Bill to alter and adjust the existing areas of supply of electricity in London and parts detached therefrom. This affects all the previous London electricity supply orders.

Alnwick.—The Council have passed a plan submitted by the Northern Counties Electricity Supply Company for electricity works proposed to be erected in Morpeth-road, adjoining the gasworks. The company stated that all the contracts are let for the machinery. The proposed site is at present leased to the Shilbottle Coal Company, and forms part of their depot, but the electricity company have arranged to purchase it outright from the Duke of Northumberland. A certain quantity of town water will be required daily—from 300 to 400 gallons up to 2,000 per diem. Further notices will be sent as soon as the consent of the Board of Trade has been received to the proposed system of supply.

Leeds.—The Corporation Lighting Committee have resolved, with regard to extending the area of central Leeds which is lit by arc lamps, to erect a line of ornamental standards some 16ft. in height on the causeway side from East-parade along Infirmary-street, and up Park-row, Cookridge-street, and Woodhouse-lane to the corner of Blackman-lane. Every standard will support an arc lamp, and the height will be about 11ft. lower than that of the standards which occupy the centre of the road in Briggate and Boar-lane. The distance between each will be about 40 yards, and the current will be obtained from the electricity works in Whitehall-road, instead of from the tramway power station, as is done in the case of the present arc lamps.

Esh Winning.—Last week saw the inauguration of electric lighting for both street and private purposes in this district. The power station is situate at Esh Colliery, where two of Robey's horizontal engines, running at 120 revolutions a minute, drive two 220-volt dynamos at 137 amperes. The dynamos are by the British Schuckert Electric Company, Limited. The switchboard is of polished slate. If necessary one machine can supply the whole of the lighting required, or each machine supply part. When the whole is completed, including the west ward of Brandon and Byshottles Urban District Council, there will be 100 lamps under the jurisdiction of the Esh Parish Council and the aforementioned Urban District Council, 500 lamps of varying powers to private consumers, and 200 in and about Esh Colliery.

Camberwell.—The Borough Council are considering the municipalisation of the electric light undertaking in their district. There are at present three companies in the district. We understand that the London Electric Company are prepared to sell their orders at £25,000 and wayleaves. The County of London and Brush Company, according to the purchase clause in their order, would be entitled to an advance of 33 per cent. of their cost, or about a quarter of a million sterling. In addition the sites of both these companies would have to be purchased. A small interest is also held by the Crystal Palace District Electric Supply Company. On Wednesday night the Council decided to supply electricity for public and private purposes within the borough, and to purchase the existing rights of the London Electric Supply Corporation, Limited, for £25,000.

King's Lynn.—The engineer's last report states that the total number of applications from private consumers was equal to 9,453 lamps of 8 c.p., being an increase of 178 lamps during the month, and that one additional street lamp had been fixed in Cresswell-street. He also reported that the working expenses for September, 1900, were £179. 3s. 2d.; September, 1901, £138. 16s. 4d; units generated, 23,241 (24,867); units sold to private customers, 4,942 (6,252). During September it was necessary to run the gas plant every night, except Sundays, to help the steam plant, owing to the late delivery of the second steam-engine, which fact made the expenses £25 to £30 more than they ought to have been. A third engineer-in-charge is to be appointed at a salary at the rate of £78 per annum. The second steam set is now erected, and has worked on the town mains, but has not been taken over from the contractors. It has been agreed to lay an electric light cable at South Lynn at a cost of about £35. A return is to be prepared showing the cost price per unit for private consumption, and the cost price per unit for public consumption.

Surbiton.—The Town Clerk reported at the last meeting of the Council that, by instruction of the Kingston Sub-Committee, he had communicated with the National Telephone Company and the Post Office in respect of telephonic communication between the two fire stations, with extensions to superintendents' houses. The Telephone Company tendered the price of £22. 10s. per year for five years, and £26. 10s. per year for three years. The Post Office had replied stating that they hoped to have their exchange completed early next month, and the connection of subscribers would then be vigorously undertaken; probably intercommunication with the National Telephone Company's local system would be opened in January. The cost of the service for the two fire stations, with connections to superintendents' houses, would probably be under £20, to cover any number of calls from the public and a considerable number of originated calls from the fire brigade. At present the stations were connected by an overhead private wire by the General Post Office at a cost of £38. The calls are furnished by the National Telephone Company. It was decided to give three months' notice to terminate the agreement for the private wire, and await a letter from the secretary to the Post Office before deciding which system to adopt.

London County Council.—Notices under Electric Lighting Acts and Orders have been agreed to as follows: From the Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Order, 1897, intention to lay low-tension mains along and across Burnt Ash-road and along High-road, Lee; County of London and Brush Provincial Electric Lighting Company, under the Camberwell Order, 1896, to lay low-tension mains along both sides of and across Stradella-road, also, under the Wandsworth Order, 1892, to lay mains of high and low tension along and across Replingham-road. The Notting Hill Electric Lighting Company has given a notice, dated Nov. 5, 1901, under the Notting Hill Orders, 1889 and 1895, to lay mains along portions of High-street, Notting Hill, and Silver-street; the St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, of intention to lay mains along Midford-place. Notices have been received as follows, served under orders granted to local authorities, and under which the Council has no power of approval or disapproval of works: (*a*) from the Hampstead Borough Council, under the Hampstead Order, 1893, to lay mains along portions of Finchley-road and Fordwych-road; (*b*) from the same Council, under the same order, to lay mains along portions of Finchley-road, Eton-avenue, and High-road, Kilburn; (*c*) from the Hammersmith Borough Council, under the Hammersmith Order, 1893, to lay mains along Mall-road; (*d*) from the Islington Borough Council, under the Islington Order, 1893, to lay mains along and across Tollington-park; and (*e*) from the same Council, under the same order, to lay mains along North-road and New Wharf-road.

Islington.—At the last meeting of the Borough Council, the Lighting Committee reported that the electrical engineer had informed them that 25 30-kw. transformers were required for the purpose of meeting the demands of new consumers. The total estimated cost of the transformers complete with switch boxes, tanks, indicating devices, etc., and including the laying of them down, was £4,125. The committee recommended that the estimate be approved, and that application be made to the London County Council for their sanction to the borrowing of this amount, and that the committee be authorised to purchase the transformers, etc., when such sanction has been received. This was agreed to. At the same meeting the Lighting Committee reported that they had carefully considered the means by which a saving could be effected in the cost of the water required at the electricity works, and have had before them several reports on the subject. They were of opinion that the works should, as far as possible, be independent of a company's supply, and that the best means of accomplishing this end was by sinking a tubular well on the premises, which would save the department a large annual charge now paid to the New River Company. The bill for water during the current year was estimated at between £700 and £800, while the cost of boring a well to a depth not exceeding 450ft., capable of supplying 5,000 gallons of water per hour, and providing all necessary pumping or other gear, was estimated at £1,700. The committee therefore recommended that the estimate of £1,700 be approved, and that application be made to the London County Council for their sanction to the borrowing of this amount, and that they be authorised to obtain tenders and carry out the work when such sanction has been received. This was also agreed to.

Walsall.—The Electric Lighting Committee's report adopted at the last meeting of the Council states that the total number of consumers supplied on Oct. 31 last was 207. During the past month the total units generated at the station was 52,194. The total output from the main generators was 50,440 units. The total units from the transformers was 39,079 (estimated). The total units registered on the meters was 39,097. The machinery was run for 521 hours. The wages paid amount to £86. The committee have approved of the principle embodied in a clause in the Bury Corporation Act of last session, under which a person is not entitled to demand a supply of electric current to premises having a separate supply unless he agrees to pay such a sum as will give the Corporation a reasonable return on the capital expenditure and other charges incurred to meet the demand of such person, and they are of opinion that, if practicable, it is desirable that similar powers should be conferred on the electric lighting authorities. The committee also recommend that, providing the South Staffordshire Tramways (Lessee) Company, Limited, agree to take a supply of current from the Corporation works for working the whole of the Bloxwich section of the tramways, including the proposed extension to Bell-lane, until the expiration of their lease for three years, at a price to be settled by the committee, the Council proceed at once to lay the necessary mains and to construct the necessary works, at an estimated cost of £6,371. 10s.; and that additional generating plant, including engine, boiler, dynamo, and condensing plant, be provided at the generating station, at a further estimated cost of £8,800, to meet the probable demand for current for tramway purposes at the end of 1902; and that the cost be defrayed out of the moneys to be borrowed by the Corporation for the tramway undertaking under the provisions of the Walsall Corporation Act, 1900.

Sheffield.—An unopposed enquiry was held on Tuesday by Mr. A. A. C. Malet into the application of the Corporation to borrow £500,000 for the purposes of the electric lighting undertaking. The Town Clerk explained that a site had been obtained for a new electric light station, inasmuch as the increase in the number of lamps had rendered the accommodation at present available altogether inadequate. In 1893, when the undertaking belonged to a company, the number of units sold was 131,752 per annum; in 1897 the number had increased to 747,061; and in 1898, the first year of the Corporation managing the business, the number reached 978,088 units, while for 15 months in 1900-1 the figures were 2,381,708 units. There were 1,616 consumers who were connected with the mains, representing 149,748 8-c.p. lamps. There were about 90 consumers waiting to be connected, representing about 10,000 8-c.p. lamps. The land proposed to be purchased was situate at Old Park Wood, Neepsend. One plot was to be bought from the Duke of Norfolk, containing 7 acres 2 roods 15 perches, at a cost of £3,037. 10s., to which should be added about £100 for vendor's costs and law expenses. Two plots were to be bought from Burgoyne's trustees, one comprising 2 acres and 17 perches, and the other 3 roods 21 perches. The cost of these would be £1,195, to which should be added about £100 for expenses. The whole site was an admirable one for the purpose, being bounded on one side by the Great Central Railway, which would enable the Corporation to take coal close to the side of the station. On the other side a perpetual supply of water could be obtained from the River

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Don. The various items in the application for the loan were then gone through, and the amount actually applied for was stated to be £496,004 A statement was handed to the inspector showing that a sum of £238,422. 10s. was for works, etc., at the new station; a new arc lighting scheme, including 100 lamps, involved an expenditure of £10,500; the obligations at the present station amounted to £134,000, and it was stated that there had been an unauthorised expenditure of £83,237, while contingencies were estimated at about £30,000. Mr. Fedden having explained the system of electric lighting in detail, and the new machinery which is to be erected, pointed out that they would commence with about 4,500 h.p.

Ashton.—Mr. Appelbee, borough electrical engineer, has reported upon the recent visit of a deputation to the works of the London and North-Western Railway Company, at Crewe, to view a surface-condensing plant by the Klein Engineering Company, of Manchester. On Tuesday, Oct. 7, the deputation visited the Millbank-street generating station of the Westminster Electric Supply Company, where two large surface condensers and pumps, by Allen and Sons, of Bedford, are fixed, but have not been put to work owing to structural alterations, and no material information was obtainable. The next place visited was the generating station of the West Ham Corporation. Here there are two sets of surface condensers and pumps, by Allen and Sons; each is of the type tendered for Ashton, and roughly of the same size. One was at work and two were at rest at the time of the visit. The one at work was running very smoothly, and keeping a good vacuum. The engineer expressed himself as perfectly satisfied with them, and that they gave no trouble whatever. The first set had been at work for about three years. The engineer expressed the opinion that Messrs. Allen and Sons would be the only firm asked to quote for the extension plant. The deputation then visited the power station of the London Docks, and saw another of Allen and Sons' surface condensers and pumps. This plant was practically exactly the same as that offered for Ashton, and was working very well indeed. It had been down about three years, and the engineer here also expressed himself as entirely satisfied with it. Learning that there was a large modern slow-speed vertical engine by the same firm in Woolwich Arsenal, an inspection was made of it. It was found to be in every way a first-class job, and giving entire satisfaction. The deputation, from what they have seen and heard, are of the opinion that the Allen plant is preferable to the Klein for Ashton, and, therefore, recommend the Electricity Committee to accept Messrs. Allen and Sons' tender. The deputation report further that, being then in the vicinity of Messrs. Siemens Bros. and Co.'s works at Woolwich, they called there also to see what progress had been made with the two new small generating sets on order. They found good progress had been made, and the first machine was to be ready to send to the engine builders in about two weeks' time from the date of the visit. The deputation, in returning, called at Messrs. Belliss's works in Birmingham to see the engine parts, which were well advanced, but not so forward as the dynamos. The material and workmanship on the parts appeared satisfactory. The question of obtaining an adequate water supply from the gathering ground in the vicinity of the electricity works has been referred to the Works Sub-Committee. The committee have also decided to recommend the Council to seek powers in the ensuing session of Parliament to enable them to supply electricity outside the borough, and to supply electric fittings.

NEW COMMITTEES.

The following new committees have been selected:

ABERDEEN.—*Gas and Electric Lighting*: Councillor Kemp, convener; Bailie Maitland, Treasurer Bisset, Councillors Bain, Boddie, G. Brown, W. Coutts, Esslemont, Laing, Watson, and Wilkie.

ACCRINGTON.—*Electricity, Legal, and Parliamentary*: Aldermen Haywood, Lee, Hindle, Rawson, and Whittaker; Councillors Bunting, J. W. Cunliffe, J. S. Higham, T. E. Higham, W. Lupton, Nuttall, Slinger, Sprake, and Welch.

ASHTON.—*Tramways*: The Mayor; Aldermen Hilton and Siddall; Councillors Andrew (chairman), Bainbridge, Barlow, Boardman, Hall, Hallam, Newton, Oldham (deputy-chairman), Wilson (Gloucester-place), and Yoxall. Day and hour of meeting as before, Tuesday, at 5.45 o'clock. *Electricity*: The Mayor; Alderman Marland, Shaw, and Siddall; Councillors Andrew, Barlow (chairman), Barrett, Boardman, Catlow, Hall, Kelsall, Newton (deputy-chairman), Oldham, Phillips, and Yoxall. Day and hour of meeting as before, Thursday, at 5.45 o'clock.

BARROW.—*Electricity*: Aldermen Bradshaw, Lee, Little, and Townson; Councillors Ashburner, Chapman, Cox, Fisher, Hardy, Heath, Hewetson, Peacock, Postlethwaite, Smith, Tootill, and Townsend.

BASINGSTOKE.—*Public Lighting*: The Mayor; the ex-Mayor; Alderman Edney; Councillors Hillary, Gerrish, Stark, and Wheeler.

COVENTRY.—*Electric Light*: The Mayor; Aldermen Booth and Hill; Councillors Bethell, Gardner, Hewitt, Johnson, Liggins, McGowran, Slaughter, Statham, Tickner, Watson, Webster, West, and Wood.

DEWSBURY.—*Gas, Electricity, and Water*: The Mayor; Aldermen Beattie, Oldroyd, and Rhodes; Councillors Cartwright, Machell, McCann, Newsome, and Pearson.

DUKINFIELD.—*Electric Lighting and Traction*: The Mayor (chairman); Alderman Pickup and Pratt; Councillors Ashworth, Bardsley, Cooke, Grime, Heathcote, Kenyon, McFarlane, and Hibbert.

HECKMONDWIKE.—*Electric Lighting, Traction, and Tramways*: Aldermen Hirst and North; Councillors Akeroyd, Ineson, and Ben Turner.

HEYWOOD.—*Electric Lighting*: The Mayor; Aldermen Hoyle, Maden, and Marlor; Councillors Ashworth, Chadwick, Cockerill, Coupe, W. Healey, Ingham, Jackson, and Smith; one vacancy.

LANCASTER.—*Electricity*: The Mayor; Aldermen Kitchen and Smith; Councillors Heald, Huntington, Kershaw, Threlfall, Towers, Dixon, Till, Cardwell, Seward, Wright, and Bell.

MACCLESFIELD.—*Lighting*: The Mayor; Councillors Davenport, Trotter, Hordern, J. Mellor, Shaw, Isherwood, Harrison, Wilson, and Heath.

MANCHESTER.—*Telephones*: Chairman, Mr. Alderman Southern; deputy-chairman, Mr. Alderman Briggs. *Electrolytic Action upon Mains and Pipes*: Chairman, Alderman Sir John Harwood.

MORLEY.—*Light Railways*: The Mayor; Aldermen Glover, Binks, and Horsfall; Councillors Haigh, Marsden, Jowett, Buttery, Smith, Tetley, Rhodes, and Scatcherd. *Electric Lighting*: The Mayor; Aldermen Foster, Glover, Horsfall, and Binks; Councillors Baines, Oakes, Scholes, Tetley, Haigh, Smith, Hirst, Craven, Jowett, and Buttery.

NEWBURY.—*Watch and Lighting*: Alderman Lucas; Councillors Jackson, Davis, Stradling, Wigington, and Pitman.

PERTH.—*Electric Lighting*: Ex-Bailie Wright, chairman.

RAMSGATE.—*Gas, Water, and Electricity*: The Mayor; Messrs. Bannister, Barnett, Bear, Blackburn, Coleman, Cook, Dowling, Emett, Gwyn, Hacker, Hart, Hawkes, Hope, Hunter, Martin, Ougham, Poole, White, and Wood.

ROTHERHAM.—*Electric Light and Tramways*: The Mayor; Aldermen Gummer, Hickmott, and Woodhouse; Councillors Cox, Clarke, Copley, Fieldsend, Gichard, Hirst, and Jenkinson.

SCARBOROUGH.—*Tramways*: Aldermen Land, Sanderson, and Eaman; Councillors Pirie (chairman), Fletcher, J. W. Rowntree, Taylor, Hopwood, and Maynard.

SHREWSBURY.—*Lighting*: Aldermen Cross, Herbert, Deakin, and How; Councillors Brace, Crump, Downes, Froggatt, and Withers.

STIRLING.—*Lighting*: Mr. Cowane in place of Mr. Reynolds.

STOCKPORT.—*Gas and Electricity*: The Mayor; Aldermen J. G. Johnson, Lister, and Henry Turner; Councillors Allcock, Aldred, Barrodale, Brelsford, Grundy, Lloyd, James Lomas, Jacob Lomas, Mackenzie, Pollitt, Webb, and Welsh. *Tramways*: The Mayor; Aldermen Atherton, Brentnall, Lister, Ramscar, Torkington, and White; Councillors Barnett, Broadhurst, Hollis, Leigh, Jacob Lomas, Richardson, Rowbotham, Traynor, Ward, and Webb.

WARRINGTON.—*Electricity*: Aldermen Bolton, Fairclough, Heaton, and Monks; Councillors Bennett, John Evans, Pierpoint, Sampson, Smethurst, and Tinnion. *Tramways*: Aldermen Fairclough, Francomb, Heaton, Monks, Roberts, and Sutton; Councillors John Evans, Greening, Plumpton, and Smethurst.

WORKINGTON.—*Electric Lighting*: Messrs. M'Aleer, Walls, Milburn, Dodgson, Holmes, Highton, M'Mullen, Harding, Pool, Walker, and Yeowart.

PROVISIONAL PATENTS, 1901.

Nov. 11.

22682. Improvements in the construction of carbon filaments for incandescent electric lamps. Johannes Amtician Calantarients, 8, Alma-square, Scarborough.

22710. Improvements in telegraph and telephone systems. Luigi Cerebotani and Carl Moradelli, 111, Hatton-garden, London. (Complete specification.)

22711. Improvements in apparatus for reversing motion transmitted by electric current impulses through a single line to a body with the aid of motive power acting in a definite direction. Luigi Cerebotani and Max Bernstein, 111, Hatton-garden, London. (Complete specification.)

22742. An automatic fork to facilitate the bringing into contact of trolleys, or other means of making contact as used in connection with electric trams of the overhead system, with the overhead leads. Francis James Bretherton, 29, Castelnau-mansions, Barnes.

22760. Improvements in moulding glass vessels suitable for accumulator cells. Ernst Muller, 24, Southampton-buildings, Chancery-lane, London. (Ladiges, Greiner, and Co., Germany.)

22767. Improvements in primary batteries. Arthur Edwin Greville, 27, Chancery-lane, London.

Nov. 12.

22795. Improvements in electric tramcar and other trolley heads. Walter Featherstone, 40, Victoria-buildings, Manchester.

22808. Improvements in means for working signals and points on railways electrically. Edgar William Timmis, 2, Great George-street, Westminster, London.

22844. Improvements in and relating to apparatus for perforating the tape used on automatic telegraphic instruments. John Gell, 45, Southampton-buildings, Chancery-lane, London.

22851. Improvements in or relating to electric signalling for railways. Thomas William Gornall, 6, Lord-street, Liverpool.

22887. Improvements in switches for telephone systems. Max Byng and Francis George Bell, 165, Queen Victoria-street, London.

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22888. Improvements in and pertaining to electric railways. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Maschinenfabrik Oerlikon, Switzerland.)

Nov. 13.

22898. Improvements in the lapping heads used in electric cable-making machines. Ernest Alexander Claremont and John Britton Hyde, 70, Market-street, Manchester.

22899. Improvements in wattmeters. William du Bois Duddell and Thomas Mather, 47, Hans-place, London.

22914. Improved recording block telegraph instruments. Charles Underwood, 21, Regent-street, Harrogate.

22921. Improvements in selective systems for electrical communication. Sylvanus Albert Reed, 55, Chancery-lane, London. (Complete specification.)

22924. Improvements in means or apparatus for electrically transmitting and receiving messages. Arthur Thomas Metcalf Johnson and George Guyott, 46, Lincoln's-inn-fields, London.

22937. Improvements in electric relays. Siemens Bros. and Co., Limited, and George Forrest, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

22938. Improvements in electrical apparatus worked by the axle of a vehicle. Horace James Jordan Hummel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Partly communicated by Johann Heinrich Ludwig Onken, Germany.)

22948. Improvements in magnetic mechanical movements. John Otto Heinze, jun., and William Herbert Rollins, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22953. Improvements in or relating to electromagnetic cut-outs. Edward Lionel Joseph and George Gardner, 322, High Holborn, London. (Complete specification.)

22978. Improvements in electric meters. Evershed and Vignoles, Limited, and Sydney Evershed, 1, Queen Victoria-street, London.

Nov. 14.

22983. Improvements in cut-outs for Nernst lamps. Eustace Graham Sheppard and Nernst Electric Light, Limited, 18, Southampton-buildings, Chancery-lane, London.

22984. Improvements in series resistances for use with electrolytic glow-bodies. Maurice Solomon, Sydney Gowan, and Nernst Electric Light, Limited, 18, Southampton-buildings, Chancery-lane, London.

22985. Improvements in the manufacture of heaters for incandescent lamps of the Nernst type. Gilbert Scott Ram and Nernst Electric Light, Limited, 18, Southampton-buildings, Chancery-lane, London.

22990. Novel or improved insulating composition for electrical purposes, and a method of applying the same. John William Sankey, Prince's-chambers, Wolverhampton.

22997. Improvements in reversing gear for internal-combustion or electric motors for propelling vehicles or traction engines. Charles Burrell and Sons, Limited, and William Campbell Wilson, Thetford, Norfolk.

23030. Improvements in or relating to apparatus for automatically switching electric current on or off, turning gas or water on or off, and the like. James John Stockall, jun., 10, Clerkenwell-road, London.

23035. Improvements in brakes for electrically-driven vehicles. Louis Edward Forster and Harry Horton, 55, Chancery-lane, London.

23038. Improvements in or in connection with electric arc lamps. Frederick Woodward Branson, 30, Park-row, Leeds.

23044. Improvements relating to shades for electric incandescent and other lamps. Otto Mayr, 27, Chancery-lane, London.

23046. Improvements in or relating to electromagnetic cut-outs. Edward Lionel Joseph and George Gardner, 322, High Holborn, London. (Complete specification.)

23047. Improvements in means for adjusting the conductor in conduits of electric tramways on the slot conduit system. William Albert Heindle, 322, High Holborn, London. (Complete specification.)

23054. Improvements in electrical measuring instruments. Rudolf Ziegenberg, 18, Buckingham-street, Strand, London.

23059. Improvements in and relating to electricity meters. William Morris Mordey and Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

Nov. 15.

23097. The electric lamp exchanger for expeditiously renewing lamps in chandeliers without using a ladder or scaffolding. John Woods, 77, Prince Edwin-street, Liverpool.

23114. Improvements in controllers for electric motors. Frank Clarence Newell, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 18, 1901, being date of application in United States.)

23115. Improvements in windings for electrical machines. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 17, 1901, being date of application in United States.)

23116. Improvements relating to the regulation and distribution of electric currents. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 17, 1901, being date of application in United States.)

23131. An improvement in surface contact for electric traction. George F. M. Cornwallis-West, 35A, Great Cumberland-place, London.

23152. Improvements in electric ignition for motorcars. Charles William Scott Crawley and John Marshall Gorham, 121, Victoria-street, Westminster, London.

23153. Improvements in or connected with electrical demand or rebate indicators. Arthur Wright and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

Nov. 16.

23166. Improved devices for use in electric wiring. James Archibald Robertson, 62, St. Vincent-street, Glasgow.

23214. Improved manufacture of a material for incandescent electric lamp filaments. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (The Siemens und Halske Actien-Gesellschaft Germany.)

23215. Improvements in electrical accumulators. Victor Cheval and Joseph Lindeman, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 22, 1901, being date of application in Belgium.) (Complete specification.)

23225. Improvements connected with incandescent or open electric arc lamps. Louis Carl Henry Mensing, 166, Fleet-street, London.

23230. Improvements in and relating to electric batteries. Kazimierz Szwede and Michael Norvicki, 27, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 7.

1900.

20982. Construction of coin-freed electric meter. Moore.

21860. Electric meters. British Thomson-Houston Company, Limited. (Thomson.)

22378. Dyeing apparatus for use in the manufacture of electrical insulating materials. Claremont.

22662. Process for the manufacture and repair of electrical glow lamps. Blau Scharf Löti Löti and Latzko.

22775. Arrangement of cut-outs and apparatus for the better protection of electric cables and generators. Callender's Cable and Construction Company, Limited, and Callender.

22933. Combined electrical transformers and choking coils. Eckstein and Angold.

22972. Electric lighting of railway and other vehicles. Preston.

23146. Electricity meters. Schattner.

23422. Controllers for use with electrically-driven capstans and for analogous purposes. Scott.

23593. Method of and apparatus for actuating devices on public electric supply or distribution systems. Wright and Reason Manufacturing Company, Limited.

23986. Regulating device for electric motors. Soc. d'Etudes "Voitures Electriques de Paris." (Date applied for under International Convention, June 25, 1900.)

1901.

275. Electric switches. Crawley and Madgen.

724. Polarized electric bells. Brander.

740. Call-lines in telephone exchanges. Oppenheimer. (Actien-Gesellschaft Mix und Genest.)

916. Means for supplying electric energy to railway vehicles. Hill.

973. Electrically-illuminated portable travelling case for holding carriage clocks or watches. Roswell.

1788. Alternate-current motors. De Lignieres.

2523. Means for the distribution of electricity on the three-wire system for electric traction on rails. Blackburn and Moore.

2853. Electric batteries. Johnson. (Soc. Paul Chapuy et Cie.)

3207. Telephone installations having a central microphone battery. Siemens Bros. and Co., Limited. (Siemens und Halske Actien-Gesellschaft.)

3488. Electric ignition apparatus particularly applicable to explosion engines. Wellington.

13024. Magnetic compasses. Reynolds.

18332. Electric rheostats. British Thomson-Houston Company, Limited. (Case.)

19068. Process for electrolytically precipitating and simultaneously amalgamating metals. Henneberg and Pape.

19227. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Erben and Knight.)

20664. Signal telegraphs. Lavens and Lavens.

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TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Nov. 16	605	596	+ 9	19,387	17,518
Birmingham Tramways	,, 16	4,365	4,387	- 22	207,866	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 16	498	418	+ 80	20,640	23,252*b*
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 16	153	157	- 4	19,998	19,413*b*
Bolton Corporation	,, 17	1,262	1,282	- 20	66,911	54,858*b*
Bradford Corporation	,, 17	1,029	747	+ 282	41,669	21,124
Bristol Tramways Company	—	—	—	—	—	—
British Electric Traction—						
Croydon	,, 15	542	246	+ 296	15,036*b*	13,687*a*
Devonport	,, 15	366	—	—	8,393*c*	—
Dudley-Stourbridge	,, 15	653	499	+ 154	30,392*b*	14,683
Gateshead	,, 15	602	—	—	16,196*i*	—
Greenock-Port Glasgow	,, 15	406	—	—	1,376*e*	—
Hartlepool	,, 15	207	186	+ 21	10,497*b*	9,186
Kidderminster	,, 15	102	93	+ 9	5,668*b*	4,990
Merthyr	,, 15	197	—	—	8,175*f*	—
Oldham-Ashton	,, 15	477	468	+ 9	23,023*b*	19,819
Poole	,, 15	197	—	—	9,358*f*	—
Potteries	,, 15	1,465	1,247	+ 247	64,428*b*	45,453
Southport	,, 15	120	145	- 25	7,617*b*	10,360†
South Staffordshire	,, 15	758	724	+ 34	35,736*b*	33,306*a*
Swansea	,, 15	412	385	+ 27	20,321*b*	16,077
Taunton	,, 15	59	—	—	1,117*g*	—
Tynemouth	,, 15	160	—	—	9,741*h*	—
Wolverhampton District	,, 15	80	50	+ 30	3,015*b*	2,331
Carlisle Tramways Company	—	—	—	—	—	—
Central London Railway	,, 16	6,808	5,406	+ 1,402	120,784	—
City and South London Railway	,, 17	2,476	1,866	+ 610	39,646	32,108
Cork E. T. and L. Company	,, 14	398	351	+ 47	21,404	18,995*b*
Darwen Corporation	,, 15	192	170	+ 22	8,692	7,129
Dover Corporation	,, 16	181	170	+ 11	10,113	9,600*b*
Dublin & Lucan Electric Railway	,, 17	85	69	+ 16	2,446	2,104
Dublin U. T., electric cars	,, 15	3,356	3,319	+ 37	—	—
Dublin S. District, Electric	,, 15	675	687	- 12	—	—
Dundee Tramways Company	—	—	—	—	—	—
Glasgow Corporation	,, 16	10,446	9,057	+ 1,389	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 16	1,601	1,360	+ 241	35,012	27,671
Liverpool Corporation	—	—	—	—	—	— *b*
Liverpool Overhead Railway	,, 17	1,391	1,553	- 162	32,116	33,549
Portsmouth Corporation	,, 16	752	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 18	3,393	—	—	—	—
Southampton Corporation	—	—	—	—	—	—

a Part. *b* From Jan. 1. *c* From June 21. *d* From April 1 *e* From Oct. 3. *f* From April 5. *g* From Aug. 21. *h* From March 22. *i* From May 8. * Fortnightly. † Reconstructing.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £378 decrease.
Barcelona Ensanche y Gracia, £10 decrease. Barcelona, £258 increase.
Brisbane, £206 increase (month of Oct., £943 increase).
Buenos Ayres and Belgrano Electric, £156 increase.
Calcutta, £23 increase.
Cape Town (month of Oct.), receipts, £14,063; expenditure, £6,817.
La Capital Traction and Electric, Buenos Ayres (month of Oct.), £1,350 increase.
Mexico Electric (month of Oct.), receipts, £17,400; expenditure, £10,100.
Perth Electric, £128 increase.
Port Elizabeth (month of Oct.), receipts, £3,240; expenditure, £1,960.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅜-½
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅜-½
—— Ordinary, 1-125,000	1 ..	9 16-11/16
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-5⅝
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5-5½
Brush Electrical Engineering, Ordinary	2 ..	1⅝-1⅞
—— Non. Cum., 6 per cent. Pref.	2 ..	1⅞-2⅛
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	112-116
—— Ordinary	5 ..	16-17
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	1-1⅛
—— 5 per cent. Debentures	5 ..	1⅞-2⅛
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1⅞-2⅛
—— 7 per cent. Cumulative Pref.	2 ..	2⅛-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10⅛
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	23-24
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10¼-11½
—— 5 per cent. Cum. Pref.	5 ..	5⅛-6⅛
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6⅝
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-102
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	7⅞-8¼
—— 7 per cent. Preference	5 ..	8¼-8⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7⅛-8⅛ xd
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10½ xd
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5⅛-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5-5½
—— 40,501-50,936	5 ..	4⅜-5⅛
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9½-10½
—— 6 per cent. Cumulative Pref.	10 ..	11½-12½
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	8½-9½
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	104-107
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5½-6
—— 6 per cent. Cum. Pref.	5 ..	5½-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4⅜
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5⅜
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10½
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	3¼-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	113-116
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7⅜-8¼
—— £4½ Shares, New	4½ ..	7-7½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-2⅜
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11½-12½
Electric Railways.—		
Central London, Ordinary	100 ..	108-111
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	107-110
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	59-62
—— Ordinary	10 ..	5¼-6
—— 4 per cent. Debenture Stock	100 ..	112-116 xd
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	3¼-4⅛
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-128
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2⅜-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅜-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6-6¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9-9½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14⅜
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11⅜-12⅛
—— 5 per cent. Perpetual Debenture Stock	100 ..	121-124
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅞-2⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
—— Prov. Cert., all paid	100 ..	100-103
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅛-2⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11½-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	104-106
New General Traction, Ordinary	5 ..	2⅜-3¼
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	98-102
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10⅜
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11¼-12⅜
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-10¼
—— 4½ per cent. Debenture Stock	100 ..	106-109 xd
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8a. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Telephones.—		
National Telephone, Ordinary	5 ..	4⅛-4⅜
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-4½
—— 4 per cent. Deb. Stock, Red.	100 ..	96-99
—— 3½ per cent. Deb. Stock, Red.	100 ..	96-99
Oriental Telephone and Electric Company	1 ..	15/16 1 1/16

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NOTES.

Western Society of Engineers.—The current number of the *Journal* of the above society contains some interesting papers on engineering matters, among which may be mentioned "Electrical Oscillations of High Frequency," by Mr. A. V. Abbot.

Pan-American Exhibition. — The Pan-American Exposition at Buffalo has closed, but in striking contrast to the Glasgow International Exhibition, which shut its doors on a profit of £100,000, its receipts have been about £700,000 short of expenditure. If not a financial success, however, it is generally agreed that the American Exhibition will live in history for its wonderful electrical displays both in connection with its exhibits in the electrical section and its splendid illuminations at night-time.

Primitive Telephone Line.—Monrovia, the capital of the nigger republic of Liberia, on the West Coast of Africa, has, we hear, enjoyed for the last five months a public service of telephone. The line and apparatus, which are very primitive, were put up by a coloured gentleman from the States. Besides joining the different Government offices, there are six subscribers, a greater number being debarred from availing themselves of the telephone, it is said, by the high price of subscription, which is equivalent to £12 per annum. The line goes inland for about 20 miles.

Electric Railways in Mexico.—We understand from our American contemporary *Electricity* that in Mexico a company is proposing to construct an electric railway which will be the longest of all the roads now in operation there. It is intended that the new railway shall start from Tuxpan and proceed across a great part of the States of Vera Cruz, Hidalgo, and Puebla, as far as the capital. The mountainous nature of the ground will offer great difficulties in the construction, but it is expected that these will be finally overcome. As a compensation there are many rivers and torrents which will furnish hydraulic power to develop the electric force necessary for the operation of the line.

American "Transactions."—Among the papers appearing in the October number of the *Transactions* of the American Institute of Electrical Engineers are the following: "Some Fundamentals of Electric Meters," by Mr. Caryl D. Haskins; "Metering of Electrical Energy," by Mr. Harry P. Davis; "Theoretical Investigation of Some Oscillations of Extremely High Potential in Alternating High-Potential Transmissions," by Mr. Charles P. Steinmetz; "Angular Variation in Steam-Engines," by Mr. P. O. Keilholtz; "Angular Velocity in Steam-Engines in Relation to Paralleling of Alternators," by Mr. Walter I. Slichter; and "Parallel Running of Alternators," by Mr. Ernst J. Berg.

Variable-Speed Direct-Current Motor. — An inventor of the name of Ziehl has recently published on the Continent some particulars of a device of his by which the speed of a direct-current motor can be varied in wide limits, while the efficiency is only slightly changed. It seems that he has succeeded in accomplishing this by producing a special counter E.M.F. in the armature, and thereby diminishing the voltage of the current received. Thus, according to the value of the special counter E.M.F. in the armature, the speed of the direct-current motor is varied without influencing the efficiency to any material degree. A special armature winding is required for producing this special counter E.M.F., and this consists of several parts, of which any may be made active or inactive in order to adjust the speed of the motor. It would seem that this device differs little from a double-wound armature with a series-parallel control.

Granite as an Insulator.—A special committee of the Franklin Institute which has been studying the question of the use of granite as an insulator for electrical purposes, has just issued its report. It appears that the process followed by the committee in their experiments was this: Granite chips were reduced to powder and calcined felspar and kaolin added with water to make a plastic mixture. After the moulded objects had been heated to 3,000deg. F., they were glazed. The product crushed at 7,000lb. pressure per square inch, and showed a tensile strength of 900lb. per square inch. The sample tested showed an insulation resistance of eight megohms, but the size of the sample is not stated.

Royal Meteorological Society.—The opening meeting of this society for the session was held on Wednesday evening, the 20th inst., at the Institution of Civil Engineers, Mr. W. H. Dines, B.A., president, in the chair. A paper by Mr. A. Lawrence Rotch on "The Exploration of the Atmosphere at Sea by Means of Kites" was read by the secretary. Mr. Rotch proposes the employment of kites carrying meteorographs on steamships, especially on vessels cruising in tropical oceans. He has himself demonstrated the practicability of this scheme, as on Aug. 22 last he raised a kite to an elevation of half a mile from a towboat in Massachusetts Bay, when the velocity of the wind at sea-level varied between six and ten miles an hour. At the end of the same month, when crossing the North Atlantic from Boston to Liverpool on the steamship "Commonwealth," he was able to raise kites carrying a meteorograph to an altitude of 1,600ft. on five days out of the eight. The chief feature of these records was the rapid change of temperature with height. A paper on "Meteorological Phenomena in Relation to Changes in the Vertical" was also contributed by Prof. J. Milne, F.R.S.

Paris Underground Railways.—While the new line which extends the metropolitan electric railway of Paris from the Porte Dauphine to the Place de la Nation is waiting to be opened, particulars of another important extension of the line are being circulated. The proposal is to start the projected line from the Palais-Royal to the Place du Danube, following the line of the Avenue de l'Opera, the Rue Lafayette, and other important thoroughfares. The distance covered will be about 4½ miles, and there is proposed to be 14 stations, which seems to us to be rather many having regard to the length of the projected extension. According to the special correspondent of the *Pall Mall Gazette* in Paris, the existing line from the Porte Maillot to the Porte de Vincennes is merely the trunk of a system that will eventually push its branches into every part, which seems to indicate that many more extensions of the system are being considered by the authorities. The load of passengers carried daily on the Paris "underground" as it is to-day, with its 8¼ miles of line, is 140,000, or about 7,000 per mile. The receipts, it is said, show an astonishing regularity, and even race days in Paris do not have any very great effect on the number of tickets sold. From the statement, however, that the company have just received sanction to run more trains, it is to be concluded that the traffic is on the increase. It is expected that the completed extension from the Porte Dauphine to the Place de la Nation, will be opened at the beginning of the new year.

Electrically-Driven Printing Press.—The *Electrical Review* of New York illustrates a successful electrically-driven printing press which has recently been perfected by

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the Sprague Electric Company. Shortly put, the equipment consists of a Lundell 4-h.p. standard-speed, compound-wound motor, belted to a flat-bed press. The motor is controlled by one of the Sprague Company's standard rheostatic rotary controllers used in connection with armature and shunt field regulating resistances. The pulley on the motor is 4½in. diameter and 6in. face, and the pulley on the main driving shaft of the press is 22in. in diameter (6in. face). The transmission of the power from the motor to the press is obtained with a medium thickness perforated endless belt 5½in. wide, which ensures noiseless operation and reduces slippage to a minimum. An idler or belt tightener is used which, together with the motor brackets, is furnished and attached by the press manufacturer. This method of equipment is said to have merit, owing to the impossibility of sudden strains being put on the gears of the press or the motor by the rapid manipulation of the controller. With this equipment, if the controller suddenly throws the full power upon the motor, it causes a slight slippage of the belt until the press has attained its speed. The motor is attached to a removable bed-plate which permits the motor, in case of accident, to be withdrawn and another substituted while repairs are being made. The equipment has also the advantage of being an economical installation.

Electric Lighting in the States.—Our contemporary, the *Electrical Review* of New York, has presented to its readers this month a very complete table of figures regarding one of the most important applications of electrical engineering—*i.e.*, electric lighting in the States. To give shortly the result of our contemporary's study of the question which has enabled it to compile the table in question, we find that in the whole of the United States there were on Sept. 1 last a total number of 2,842 electric lighting stations, representing a capital of nearly 134 millions sterling. In counting the number of stations given in this total isolated plants of all sorts were absolutely neglected, and only those actually doing business in public electricity supply in the States were included. And similarly, of course, the "capital" given does not represent the actual sum in cash expended on the equipment of the stations. It is estimated, however, that the total sum of money expended in the construction of the electric light plants, as represented in the table, is between 60 and 80 millions sterling. A study of the table reveals the fact that the largest number of separate electric light stations in any State is in Illinois, while the largest capital invested is in Pennsylvania, which also possesses the second largest number of stations. It is further apparent that where consolidation has been active, the number of stations is comparatively small in relation to the total capitalisation. For example, California, with only 93 stations, shows a capitalisation of nearly 2½ times as much as Ohio with 188 stations, or more than twice as many. While in some measure this may point to over-capitalisation in the Western State, it is also the fact that the Californian companies control larger territory, and by the liberal use of power transmission make one station serve a considerable area, which probably accounts for the widely different conditions in the two States mentioned.

Electrical Turntables.—The question of obtaining suitable power to facilitate the turning of locomotives has been brought to the front in the last few years by the decided increase in the size and weight of locomotives. The matter has recently formed the subject of a report of a committee of the Association of Railway Superintendents of Bridges and Buildings, of America, in which the conclusion is drawn that electric power, generally speaking, is the most economical for the operation of heavy-service turntables. We gather that the arrangements usually followed in tables driven by electric power are as follows: The electric motor through which the power is transmitted is mounted on a cast-iron, wrought-iron, or steel frame, properly geared to a friction wheel which runs on the circular rail of the turntable. This part of the apparatus is commonly called the "donkey." It is attached by a pin joint to one end of the turntable in such a way that the friction wheel runs concentric to the table on the circular rail. The current wires are either brought to the motor by way of an overhead switch or by means of contact rings—one ring fastened to the centre bearing, the other to the centre cross girders of the table. The "donkey" and motor are usually covered by a small house for the use of the operator. The current is controlled by a regular street car controller. Generally the power apparatus is provided with an appropriate brake to stop the table at a given point. In some cases sand-boxes are provided in the operator's house to sand the circular rail to prevent slipping of friction wheel. The committee are of opinion that if electric power can readily be obtained from the railway company's plant, or from outside parties, electricity should be employed for this purpose, as it requires least machinery and is economically maintained. Where special engine and electric generator would have to be provided, however, they recommend that a steam or gasoline apparatus will no doubt be more economical and preferable, on account of the first cost of installing the plant, as well as the additional help required to run the engine and generator. It is estimated that the cost of a gasoline engine or steam-engine plant is just about a third of that of an isolated electrical installation.

The World's Wireless Telegraphy.—Lieutenant L. R. Steigner, of the United States navy, has compiled many interesting facts relating to the use of the various systems of wireless telegraphy in different parts of the world, which are published in the naval annual, issued a short while ago. The lieutenant's conclusions are digested in the *Electrical Review* of New York, and they present a concise idea of what is being done in the introduction of wireless telegraphy by the different countries. Systems of wireless telegraphy have been and are now being installed on the war vessels of many nations, and the steamships of several commercial lines have also been so equipped. Chili is the latest country reported to have made contracts to have its naval stations equipped with the Marconi system. Some 36 ships of the British navy have already been installed with the Marconi apparatus, while 10 or 12 more have been fitted with what is known as Captain Jackson's system. The French have used the Popoff-Ducretet apparatus on the ships of the Mediterranean and northern squadrons, and in the coast lighthouses. Great progress has also been made in developing wireless telegraphy for use in the navy by Lieutenant Tissot and M. Rochefort, and they are said to have succeeded in making many improvements. The German navy has adopted the Slaby-Arco system. Prof. Slaby has worked with the object of giving the navy an efficient and reliable system, and one less expensive than that of Marconi. He appears to have solved the questions of syntonic and multiplex telegraphy, and the results of his experiments have been very satisfactory. The Italian Government has been investigating the project of connecting its outlying islands with the mainland by means of the Marconi system, and thus doing away with the submarine cables previously used; while Japan is equipping some of her men-of-war with wireless telegraphy outfits. The Japanese Government are also carrying on experiments on shore for the use of wireless telegraphy in the army. Many ships and stations on shore have been equipped by the Russian

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Government with Mr. Popoff's system, and one of the Russian infantry regiments which has experimented with this system, has succeeded in obtaining very successful results. With the Popoff system, however, a great disadvantage was the weight of the apparatus, but it is thought possible to make considerable improvement in this direction by the use of lighter materials. The Swedish Admiralty is said to be to be taking on the Slaby-Arco system for its vessels, and also for shore stations, but up to now Spain has devoted little attention to wireless telegraphy. The Government, however, are carrying on experiments with a system invented by Colonel Cervera, of the Spanish Engineers. The above all goes to show that the many advantages of wireless telegraphy have been readily appreciated by the different nations of the world, and although its introduction on an approved method is only of very recent date, its progress has been remarkably rapid.

Telegraphs and Telephones in British South Africa.—Some good information relating to telegraphs, telephones, etc., is to be gleaned from the latest report of the directors of the British South Africa Company, which deals with the position of the company for the two years ended March 31, 1900. The report also records the principal events which have occurred since this date. It is a noteworthy fact, for instance, that notwithstanding the reduction in the cablegram rate between Southern Rhodesia and Europe from 4s. 2d. to 3s. 8d. a word on Jan. 1 this year, and the adoption of a penny internal postage for Southern Rhodesia, the postal and telegraph revenue for the year ending March 31, 1901, was greater than in any previous year. Similarly, the revenue for the four months April to July, 1901, shows a decided increase over that of the corresponding months of 1900, and was greater than in the corresponding period of any previous year, with the exception of 1899. The telegraph system in South Africa has shown rapid expansion during the two years under review, the lines under the control of the Postmaster-General now extending from Mafeking to Lake Tanganyika, a distance of 2,031 miles. There were 81 telegraph offices open on March 31, 1901, including those belonging to the African Trans-Continental Telegraph Company, Limited. At that date the Rhodesia telegraph system consisted of 3,554 miles of line, with 5,214¾ miles of wire. With regard to telephones, the exchanges at Bulawayo and Salisbury have continued steadily to expand, and new exchanges have been opened at Umtali and Selukwe. The police telephone system has also increased, and consists at the present time of 478 miles of line. In spite of transport difficulties steady progress has been made with the construction of the African Trans-Continental Telegraph line, and it has now been carried for a considerable distance along the eastern shore of Lake Tanganyika, together with the branch line from Domira Bay to Fort Jameson, which has been completed. The total length of the line constructed on March 31 last was 1,308 miles. It is gratifying to read that since the line crossed the Anglo-German frontier the German officials have rendered valuable assistance, and have supplied most of the labour required for construction. The traffic receipts for the year 1900 amounted to £3,188, a decrease of £159 as compared with the previous year. The revenue obtained from the internal traffic increased by nearly 30 per cent., and from the traffic passing between African Trans-Continental Telegraph offices and Portuguese East Africa by nearly 150 per cent.; but, owing to the interruption of traffic between Southern Rhodesia and Cape Colony, the amounts paid to the British South Africa Company and the cable companies show a decrease of £495. The last item of interest given in the report with regard to this subject is that a service of silver plate was presented by the company in June this year to Sir Somerset R. French, K.C.M.G., Postmaster-General for the Colony of the Cape of Good Hope, in recognition of the valuable services rendered by him in connection with the Rhodesian postal and telegraph systems.

The Diesel Motor.—The merits or demerits of the Diesel motor, which is an improved engine of the "internal combustion" class, has recently formed the subject of investigation by the Committee on Science and Arts of the Franklin Institute, and the results of this investigation have just been made public. To sum up shortly the principal features of the Diesel motor, as recognised in the report which the committee has prepared, they are these: The sub-division of the combustile is secured by delivering it into the combustion chamber through a pulveriser, employing air under a great excess of pressure, by means of which each particle is surrounded by fresh air. The preheating of the air is secured by the previous compression to a degree greater than any attained by the subsequent combustion. Any previous vaporisation or gasification of the combustile is entirely avoided, the fuel being introduced cold in its normal condition, and the pulverisation is entirely mechanical. No contact between the combustible and the cooler walls of the combustion chamber occurs, the fuel being injected into the midst of the proviously compressed air, with which it is completely consumed before it can come in contact with the walls. This is verified by the complete absence of any coating of carbon upon the cylinder walls, even after continuous runs of several months. There being no previous admixture of air and combustible, there can be no propagation of flame whatever, each particle burning of its own ignition due to the high temperature of the air with which it is in contact. The most important feature of the Diesel engines is that the pressure is raised by the compression to a higher degree than is subsequently attained at any point in the stroke by the combustion. At the Mechanical Congress at Paris, Mr. Diesel reported that the latest trials with his motor had realised an indicated thermal efficiency of 40 per cent. under full load and 50 per cent. under half load. At the first attempt, even, the Diesel motor gave an efficiency of 28 to 30 per cent., which added 50 per cent. at once to the best previous results with other types of internal-combustion motors then in use. The committee considers that what Mr. Diesel has done in this matter is worthy of the highest commendation, and the institute has accordingly awarded the inventor the Elliott Cresson medal for his improvements in internal-combustion motors and for his practical application in actual work of the fundamental principles of thermo-dynamics.

Electric Traction.—A paper on this subject was read before the Civil and Mechanical Engineers' Society on Nov. 7 by Mr. B. Pontifex, in which the author gave a general *résumé* of the up-to-date practice of electric traction both for railways and tramways, together with his views on the same. Commencing with the power-house, Mr. Pontifex expressed his opinion that any well-made type of boiler would work satisfactorily, but that the water tube type had an advantage where tramways were concerned, in which sudden demands were likely to arise in consequence of changes in the weather. After dealing with the coal and feed arrangements in modern power-houses, the author went on to the question of the steam-engines. On the point of governing, he explained the various types which have been successfully used, and also the need for good governing in traction work. We think, however, he was rather incorrect in one respect—in suggesting that the maximum variation of speed

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should not be more than 1¼ per cent. for direct-current generators, and half this when the engines are required for driving alternators to be worked in parallel. Half the trouble in parallel working of alternators has been due to the fact that the engines have been governed too closely, and in consequence the load has fluctuated violently from one to the other. The 600-h.p. engines to be used for the New York electrical tramway station, with their vertical low-pressure and horizontal high-pressure cylinders, were next described. With these engines the pistons for the high and low pressure work on to the same crank. After a general review of the modern practice in the design of direct-current and alternating-current generators, the plant used on the Central London Railway was given in detail. The paper then referred to the rotary converter as a necessary adjunct to large traction schemes in which a high voltage distribution is required. As regards the rolling-stock, the author considers that both locomotives and the multiple-unit system will be required in the future, and that where a large amount of foreign traffic has to be handled on a line locomotives will be essential. The Central London Railway locomotives were then described, and also the controllers in use on the same. Speaking of the Liverpool Overhead Railway equipment, attention was drawn to the fact that while the first locomotives with gearless motors have been successful, satisfactory results have recently been obtained with enclosed motors of the single-reduction type. Four of these, each of 125 h.p., are required per train. We understand that the paper was well received by the society.

Electrical Tabulating Machine.—The use of electrical machinery for the tabulation of the statistics of population in the eleventh census of the United States had such successful results, that similar machinery is again being used in that country in connection with tabulations of the statistics of agriculture. Whereas, however, tabulating machinery for population statistics need only be capable of counting, for agriculture it must add. The machinery invented by Dr. Hollerith, and adopted for use in the Division of Agriculture of the twelfth census, is said to meet all requirements. Mr. H. T. Newcombe, editor of the *Railway World*, has just published a pamphlet in which he gives a description of the general principle involved in such tabulating machinery. It seems that in the case of agricultural statistics the perforated tabulating cards control the machinery, which is actuated by means of an electrical current passing through the perforations. The transmission of this current is effected by feeding the cards successively into a device not unlike the bed and platen of a small job printing press. The bed of this device consists of a non-conducting material with perforations corresponding to each possible perforation in the card. Each perforation in this bed is the opening over a cup of mercury, which is separately connected, electrically, with the proper portion of the adding machinery. The platen holds an arrangement of pins set in springs, which are compressed by light pressure, one pin corresponding to each perforation in the bed and to each possible perforation in the card. Thus, as adapted for tabulating the data that are transcribed on the "farm" cards, each bed contains 345 cups of mercury, each electrically connected with the adding machinery, and each platen consists of 345 pins, each separately and similarly connected. A properly-prepared card being fed into the machine, and the platen similarly depressed, only those pins which correspond to perforations in the card remain sufficiently extended to enter their reciprocal cups of mercury, while the others, striking the card and meeting with its resistance, are pushed backward upon the springs in which they are set. The "adding" machinery consists of a series of adding devices electrically controlled as above described, and sufficient in number separately to add the amounts of each character contained on the cards used. The tabulating machine in the form adopted for aggregating the data from the "farm" cards comprise 10 of these adding devices, and in one of its adjustments, for a particular purpose, carries also 21 separate counting machines. Each tabulating machine is in charge of a single operator, whose work consists of feeding and removing the cards, depressing the lever so as to make the electrical connection through each card, and recording the totals from the dials. Records show that the average number of cards run through each machine of this class daily when the highest speed had been attained was 8,130. We understand that the Division of Agriculture of the United States now employs 12 of these large machines for tabulating the "farm" cards, and 86 smaller machines for tabulating the "crop" cards, and that these are giving every satisfaction.

London Telephones.—Mr. J. Williams Benn, the chairman of the Highways Committee of the London County Council, spoke on the above subject at the City Liberal Club on Monday last. Unfortunately for him the event was arranged one day too soon, and he was, therefore, unable to deal with the terms of the agreement between the Post Office and the National Telephone Company, which were only made public on Tuesday last. Mr. Benn's remarks were, therefore, based chiefly on the tariff which has now been arranged for both of the competing telephone systems in London. He claimed that these charges were some 50 to 75 per cent. too high. After a brief *résumé* of the history of the telephone question, Mr. Benn referred to the application of the London County Council for a telephone license, which was not granted. The report then of the advisers of the Council was to the effect that for £10 per annum an unlimited service could be given, and that after five years' working this could be reduced to nine years. Sir Alexander Binnie's estimate of the capital cost for each subscriber connected was £38. The speaker went on to quote Mr. Hanbury, who had said in the House of Commons that £40 was an outside figure for a connection. In Glasgow the cost had actually come out at under £19. Again, in 1892, when the New Telephone Company was formed, under the chairmanship of Mr. J. Staats-Forbes, the capital of the company, divided by the number of subscribers to be provided for, worked out at £38. The next step in the argument was a statement that when the National Telephone Company bought out the various other companies which it amalgamated, the price paid was as high as £102 per subscriber. It was due to this that such a high price had to be paid by London telephone subscribers for the use of their instruments. He claimed that the other large towns had got reductions, and that in consequence the London subscribers had to pay the dividends on the watered capital. With regard to the Post Office charging the same rates, Mr. Benn accused the Postmaster-General with trying to save the telegraphs at the expense of the telephones, and that the high rates were looked to to make good the large annual deficit of the telegraph system of the country. As a final argument of how favourable the proposed amalgamation rather than competition was to the Telephone Company, their shares had appreciated £295,000 since Sept. 19. He advocated that the business men of the city of London, who were hampered in their competition with merchants in other towns by the high telephone rates, should combine in sending a deputation to the Government urging that reduced rates should be arranged. The meeting concluded with a vote of thanks

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to Mr. Benn for his address. It would have been interesting to hear what the chairman of the London County Council's Highways Committee would have had to say had he known that the agreement also provides for the buying up of the National Telephone Company's plant in 1911, and that the Post Office are obliged to provide for the company all the underground wires they require at a moderate rental. The agreement thus gives the company those facilities which the London County Council have strenuously refused for a large number of years.

"The Practical and the Ideal."—Under the above title Sir John Leng, M.P., presented a thoroughly interesting address to the Dundee Institute of Engineers on the 21st inst., a copy of which we have received through the courtesy of the secretary, Mr. Donald Porteous. Practically speaking, the address consists of a criticism of English and American methods in regard to novelties and innovations. Of two ways of doing a thing, or of two things, one old and one new, the American prefers the new as invariably as the Britisher prefers the old, and as the latest instance of this, Sir John refers to the "slowness of John Bull and the swiftness of Jonathan" in the movement initiated by Mr. Yerkes, of Chicago, to electrify the underground railways of London on the same system as the "twopenny tube." Whoever has travelled on the Continent, he asserts, knows that we have been years behind Continental cities in the adoption both of electric power and locomotion. Sir John Leng then goes on to mention "one reason why the Americans especially are so much ahead of us in inventions." It is because they have had the good sense to make their Patent Office a great help, instead, as ours long was, a great hindrance to inventors. As compared with the patent system of the United States, ours is still too expensive and discouraging to the poor inventor. That of the United States excels in three important respects—*i.e.*, it is cheap, it is for a satisfactory number of years, and it follows upon an examination for originality. The duration of a patent in this country is 14 years, and protection for the first four years costs £4. The fifth year the patentee must pay £5; the sixth year £6; and so on until the fourteenth year, £14—making a total of £99 for the 14 years. Now, in the United States the duration of a patent is 17 years, and it costs about £8 to take out. There are no subsequent renewal fees, so that for £8 a patent is obtained for 17 years, as against £99 required for only 14 years in this country. Not only is this so, but the American Patent Office makes a fairly thorough examination, and, if required, the applicant is assisted to put his application into proper shape. The result is, says Sir John Leng, that far more patents are applied for in the United States than in the United Kingdom. Irrespective of the cost of a patent, the most important point is the examination for originality, so that applicants may not waste their money in taking out patents which have been previously granted for similar inventions. Taking a still wider outlook, the author urges that we should have an imperial patent office, so that a British patent would hold good throughout all our colonies, dominions, and possessions. Or that we should go a step further, and endeavour to arrange an international patent system, so that the same patent should hold good the world over. In closing his address he strongly advised the members of the Dundee Institute to cultivate open minds. He was not wholly destitute of practical knowledge, and the result of his observation and experience was that, after all, the most important element in devising, constructing, and controlling all machinery was the human element. Every engineering, mechanical, and scientific improvement must proceed from an observant and thoughtful brain. Every inventor was an idealist to the extent of his invention. Hence, therefore, he urged them not to be content merely with the practical, but inform, animate, and elevate it by the pursuit of the ideal.

Electrical Convection.—In a long communication to the current number of the *Physical Review* Mr. Harold Pender claims to have shown conclusively by experiment that electrical convection does produce magnetic action. The research which the author asserts has given the required proof was undertaken by him with the assistance of the late Prof. Rowland and Prof. Ames in the fall of 1900. He explains that a further investigation of this important question was considered desirable in view of the fact that Mr. M. V. Cremieu, as the result of experiments, has come to the conclusion that a moving electrified body produces no magnetic effect, which conclusion is in direct opposition to the classical experiment performed by Prof. Rowland in Berlin in 1876, subsequently repeated in the physical laboratory by Prof. Rowland and C. T. Hutchinson in 1889, and confirmed by the experiments of Röntgen and Himstedt in Germany. The method which was employed in the present research to put in evidence the existence of the magnetic action of electrical convection, was identical in principle with that used by Cremieu in his first experiments—viz., the measurement of the current induced in a coil on reversing the convection current due to rotating charged discs. The author, in his article, gives full particulars of the design of the apparatus he used in order to avoid the pitfalls which are open to experimenters with this type of apparatus. In fact, the galvanometer employed was such a sensitive one that it could only be worked during the night, when the ordinary street traffic, and especially the electric tramcars near the laboratory, had been suspended. The reverser and commutator of the charging apparatus are also described. Each of these were driven by independent electric motors so placed as not to affect the galvanometer. All the high-potential wires were suspended by silk threads in order to avoid leakage, and the result was so good that no readings were ever taken on the galvanometer when there was any perceptible deflection with the discs at rest. Before describing the results obtained, the author develops a theoretical calculation as to results which were to be expected with an apparatus of the dimensions of the type employed. This calculation is too long to give here, but it is interesting to find that in the tables of results the difference between the observed deflection and the calculated deflection is in every case small. For instance, with a calculated deflection of 60·1, the observed deflection was 63·7; with a calculated deflection of 65, the observed deflection was 68·2. In the same way, with the smaller deflections the percentage difference between the calculated and the observed deflection is little. In order to prove that the charge was actually carried round on the disc, and hence was acting in the way described, the conducting surfaces of the discs and the condensing plates were each divided into six sections by radial scratches ·75mm. wide. The internal edges of the condensing plates were then connected together by a ring of tinfoil 1mm. wide. If, then, the effects observed had been in any way due to conduction currents in the metal surfaces, this arrangement would certainly have greatly altered the magnitude of the deflections. Observations showed that this was by no means the case. The author rightly concludes, in our opinion, from the results obtained, that moving charges of electricity do produce magnetic action. We understand that further experiments are to be made in order to ascertain how Prof. Cremieu was misled in the experiments made by him.

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CITY AND SOUTH LONDON RAILWAY.

Since the completion in 1890 of the first section of the City and South London Railway Company's system, not only have several further and important sections been added, but the arrangements generally for generating and supplying power to the system have also undergone considerable change. Under these circumstances, it may not be out of place here to briefly trace the progress of the undertaking down to the present time. So far as the railway itself is concerned, the accompanying map (Fig. 1) should help to convey an idea of the growth of the undertaking up to date. As originally constructed, the line extended from Stockwell to the Monument, but in February, 1900, an extension from London Bridge to the present City terminus in Moorgate-street was opened, the Monument Station being at the same time abandoned, and in June of the same year an extension from the opposite or suburban end as far as Clapham Common was inaugurated, the trains running in each direction at intervals of 2½ minutes morning and evening, and every four minutes during the rest of the day. The further extension of the railway to the Angel at Islington, inaugurated on the 17th inst., establishes a direct and important link in the communication between North and South London. The distance by rail from Moorgate-street to the Islington terminus is 1½ miles, the total length of the line with this section amounting to 6½ miles. Between Moorgate-street and Islington, stations have been opened at Old-street and City-road, the journey over the whole length of the line being performed in 27 minutes. Subway connections with the new Great Northern and City Railway will be provided at Moorgate-street and at Old-street. There is already a subway from the Bank Station to the Central London Railway, and also one at London Bridge giving direct access to the London and Brighton Company's station. It will thus be seen that the company have by no means neglected the question of intercommunication, so essential to the usefulness of such a system. The new terminus at the Angel, Islington, is contained in an iron-bound tunnel of the same diameter as that at Clapham Common—namely, 30ft.—claimed to be the largest in the world—and the long island platforms make ample provision for trains consisting of four coaches. The traffic over the line already amounted before the Islington extension was inaugurated to a daily average of 40,000 passengers, while the trains running in and out of Moorgate-street Station numbered 600 daily. In the first instance the generating station at Stockwell contained four 400-h.p. vertical engines, belt coupled to a corresponding number of 125-kw. dynamos, which supplied energy direct to the line at a pressure of 500 volts. Steam to these engines and to the engines working the hydraulic lift pumps, was furnished by eight Lancashire boilers. The rolling-stock then consisted of 10 three-coach trains and 14 electric locomotives.

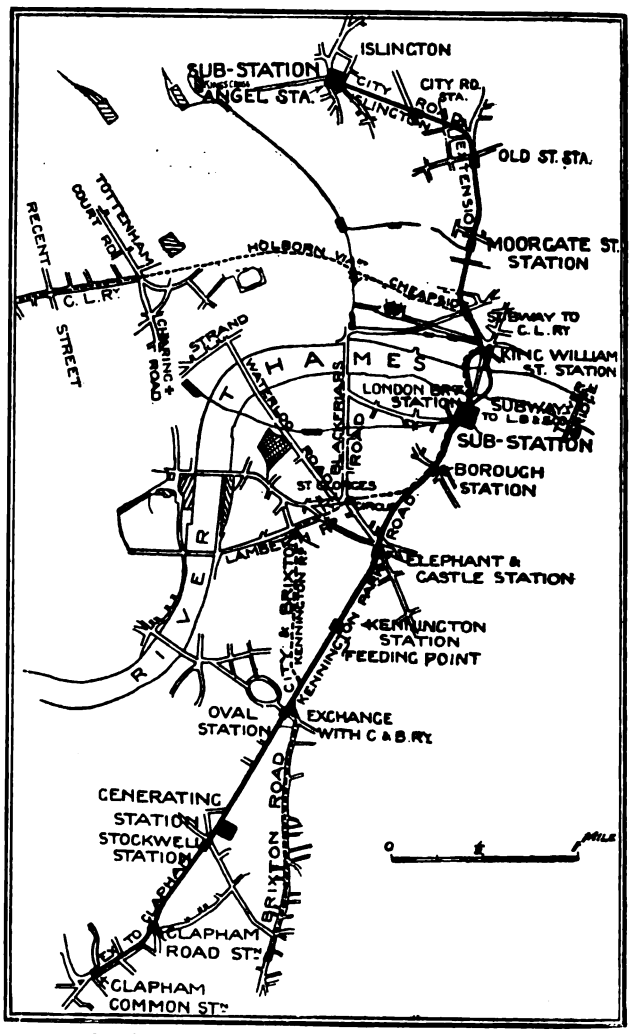

FIG. 1.—Map of Route, City and South London Railway.

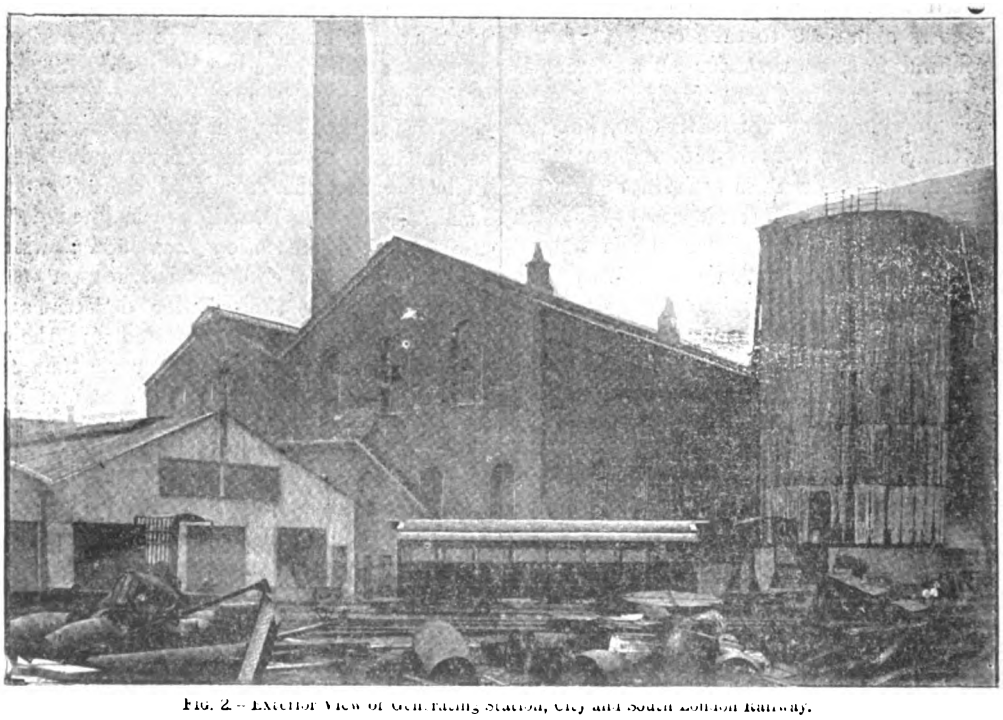

FIG. 2.—EXTERIOR VIEW OF GENERATING STATION, CITY AND SOUTH LONDON RAILWAY.

The extensions of the railway to Clapham Common and Moorgate-street, and the then contemplated further extension to Islington, entailed the necessity of making a change also in the system of working the line, since the ordinary

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two-wire system originally employed was rendered unsuitable by the increased length of the route, both on account of the return drop in the rail and also the loss in the feeders. Alternative methods were carefully considered, and the possible systems ultimately reduced to three—namely (1) the three-phase system with sub-stations; (2) an extension of the then existing two-wire system with feeder and return boosters; and (3) the three-wire system with balancers. Criticisms adverse to the adoption of the latter system for traction work had been expressed in America and elsewhere, but after going very carefully into the matter the company's engineer, Mr. P. V. McMahon, saw no reason why, with proper arrangements for balancing, this system could not be made to fulfil all the conditions incidental to the efficient working of the line, and experience has proved the choice to have been entirely justified.

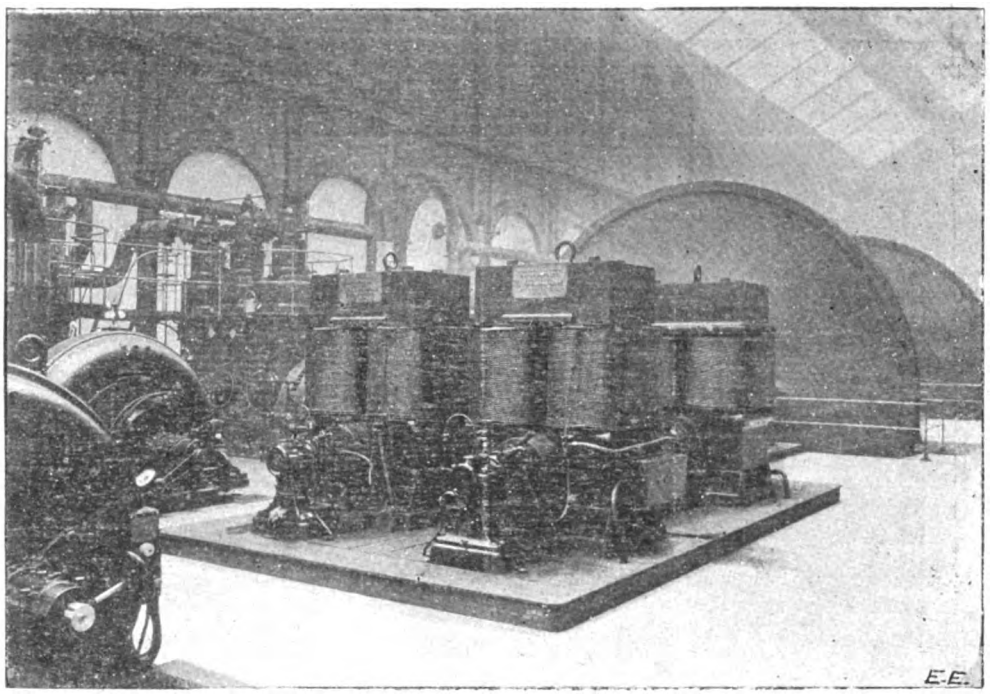

FIG. 3.—Interior View of Engine-Room, City and South London Railway.

In order to provide for the increasing demands of the line, a piece of land adjoining the original generating station at Stockwell was secured, and upon this the present station (Fig. 2), together with additional car-sheds, etc., were erected, the old station being utilised for the tool and repair shops required in connection with the railway. The new generating station consists of a steel and brickwork structure with slated roof, and is capable of being extended to double its present capacity. As it now stands the building is 150ft. long by 90ft. wide, the boiler and engine houses being practically under the same roof, whereby the length of the steam-piping is reduced to a minimum. The boiler-house contains 12 Davey-Paxman "Economic" boilers 15ft. 6in. by 8ft. 9in. diameter, capable of evaporating 8,000lb. of water per hour each, the working pressure being 160lb. per square inch. It may be mentioned that the "Economic" boiler is of the dry-back marine type. Each boiler is fitted with Vicars's mechanical stokers. Over these boilers the coal is stored on a steel and concrete floor in wrought-iron bunkers, having a passage down the centre. The bunkers afford capacity for a total of about 1,000 tons of coal, which latter is delivered by carts to a hopper outside the boiler house. From this hopper it is elevated and conveyed to the bunkers by an elevating and conveying plant, erected

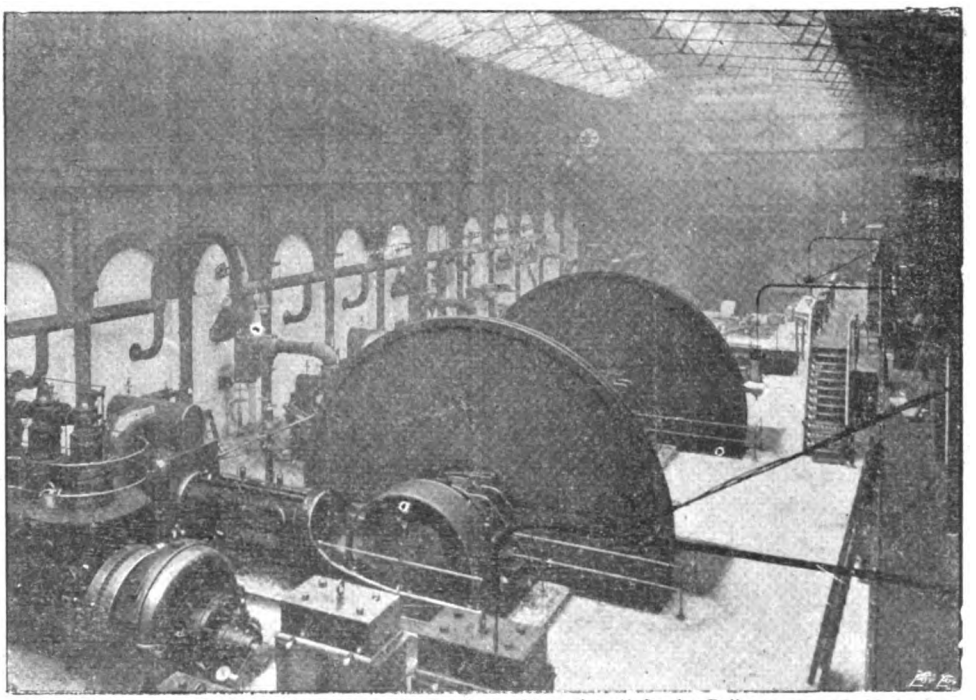

FIG. 4.—Interior View of Engine-Room, City and South London Railway.

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by the New Conveyor Company, of Birmingham. The coal is subsequently delivered from the bunkers by measuring shoots to the hoppers of the mechanical stokers below. As regards the steam-piping, the main steam range is duplicated, and consists of lap-welded pipes provided with valves controlled from the engine-room floor.

engines (seen in Figs. 3 and 4) are 24ft. in diameter. All the generators are compound wound to maintain a constant potential of 500 volts at the switchboard 'bus bars. The shunt regulating resistances are operated from the switchboard platform. The main engines exhaust into a 32in. diameter main running the entire length of the engine-house,

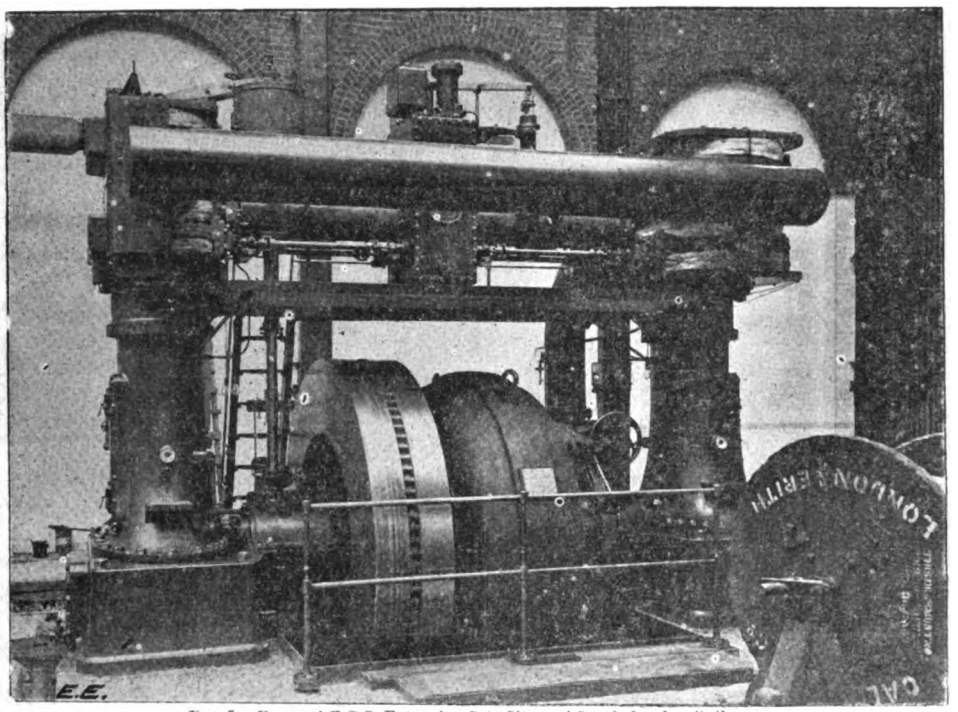

FIG. 5.—Ferranti-E.C.C. Extension Set, City and South London Railway.

The generators shown in the views of the engine-room (Figs. 3 and 4) are all direct coupled, their respective outputs being arranged to suit the demand at various times of the day, depending, of course, upon the number of trains running at any given time. With the exception of the original Siemens-Willans set of 125 kw. removed from the old power-house, all the generators are of the E.C.C. type,

a surface-condensing plant by Cole, Marchent, and Morley being coupled to one end of the main below the level of the engine room. The air-pumps are of the Edwards type. The cooling water is passed over two Klein's cooling towers (see Fig. 2) by two centrifugal pumps, one steam-driven and the other by an E.C.C. motor of 60 b.h.p. The other end of the exhaust main rises above the building, and has

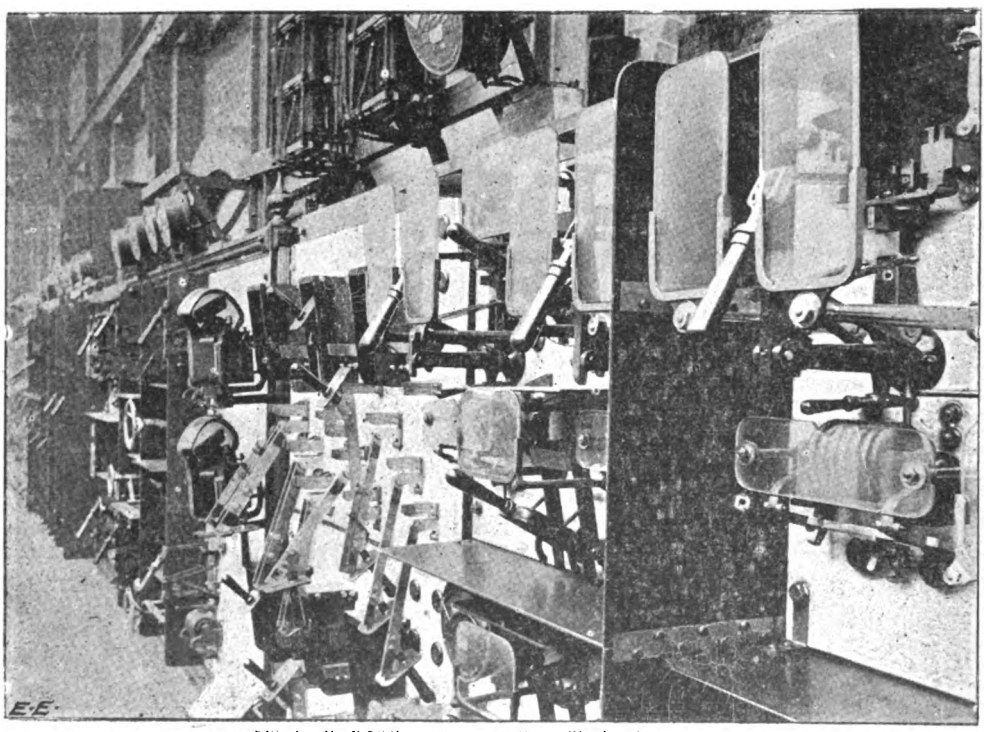

FIG. 6.—Main Switchboard, City and South London Railway.

and consist of one 125-kw. generator coupled to a high-speed Willans engine; two 300-kw. sets, also coupled to Willans engines; and two 800-kw. sets direct-coupled to two Corliss compound engines, built by Cole, Marchent, and Morley. Each of the above sets is capable of taking an overload of 33 per cent. without excessive sparking or heating. The heavy flywheels belonging to the Corliss

an automatic valve which opens when the pressure rises slightly in the main. Fig. 5 shows an extension set now in course of erection. This set consists of a Ferranti standard type engine coupled to a 300-kw. E.C.C. dynamo.

The distribution of power to the line from the main switchboard (Fig. 6) is carried out on the three-wire system, with the running rails as the middle wire and the working

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conductor in each tunnel as the outers, the difference of potential being 1,000 volts—*i.e.*, 500 volts between the working conductor and the running rail in each tunnel. Part of the electrical energy is supplied to the line direct at 500 volts by copper cables, but in order to ensure the equal distribution of electrical energy along the line, which is necessary for a quick service of trains, their steady lighting, and the efficient lighting of the stations, two sub-stations, one at London Bridge, and the other at the Angel, Islington, have been erected. At each sub-station, and at the main station, large storage batteries are either erected or in course of erection. The object of these batteries is to steady the load on the dynamos, and to supply current to the line in the event of a temporary interruption in the supply from the generating station. Moreover, the station lighting and current for working the electric lifts will be supplied from these batteries by independent cables, thus ensuring well-lighted stations and power for working the lifts should the main supply be interrupted.

Besides from the main switchboard at Stockwell and the two sub-stations at London Bridge and Islington respectively, the working conductor in each tunnel is fed at Kennington (see Fig. 1), where the feeder is coupled through a booster to compensate for the drop in the feeder, while at London Bridge and Islington the batteries and reducers maintain a constant line potential.

The sub-station at London Bridge is fed from the main board at Stockwell on a five-wire system—*i.e.*, a motor-generator is placed between the 'bus bar and the high-tension feeder, adding 500 volts to the feeder. The high-tension board, situated on the right of the main board (Fig. 6), is connected by means of Callender's armoured cables with this sub-station, where the voltage is reduced to 500 volts per side by reducers on the Electric Construction Company's patent high-tension continuous-current system. In addition to the reducers, the London Bridge sub-station contains a battery of 556 No. 49 H.B. 11 type Tudor accumulators of the following capacity: 450 ampere-hours when discharging at 150 amperes for three hours, 350 ampere-hours when discharging at 350 amperes for one hour, together with the necessary charging transformers.

(To be continued.)

TESTS OF NERNST LAMPS.

(*Concluded from page 728.*)

D. *Behaviour of a Nernst Electrode at Different Voltages.*—A bare electrode constructed for 165 volts was placed in a 220-volt circuit. The excess pressure was choked off by means of a graduated resistance, so that the electrode became incandesced at pressures between 132 and 168 volts, the pressure being regulated by cutting out successive resistances until the pressure across the electrode terminals attained 168 volts. Then the pressure was alternately increased and decreased by cutting out or inserting resistance to represent violent fluctuations in the line potential. The current and light intensities for each pressure were noted. The values given in Table VI. are represented graphically in Fig. 13.

TABLE VI.

E.	J.	E/J.	A.	K.	A/K.
132	0·1	1,320	13·2	1·19	11·1
133	0·109	1,220	14·5	1·65	8·8
136·4	0·122	1,119	16·6	2·73	6·08
137·8	0·134	1,028	18·5	3·83	4·83
142·4	0·149	956	21·2	5·2	4 08
102·0	0·185	822	28·1	10·4	2·7
156	0·202	772	31·5	13·8	2·28
159	0·222	717	35·3	17·5	2·02
165	0·271	608	44·7	29·7	1·5
167	0·32	522	53·4	42·9	1·24
168	0·37	454	62·2	63·6	0·978
167·4	0·44	381	73·6	90·1	0 817
167·6	0·372	451	62·3	64·0	0·973
167·4	0·405	413	67·8	75·2	0·902
166	0·445	373	73·8	90·0	0·82
165·6	0·484	342	80·1	111·5	0·718
163	0·55	297	89·7	144	0·623

Since electrodes for the Nernst type of lamp are made for specified current strengths similarly as in the case of arc lamps, it is advisable to regard the variable values as functions of the current strength and not of the pressure. We obtain the different curves shown in Fig. 13. It is seen that the pressure in Curve E (Fig. 13) attains a maximum of 167·8 volts ⌒⌣ 168 volts for a current strength of ·38 ampere. Commencing at the left-hand end of the curve, the normal pressure of 165 volts is soon

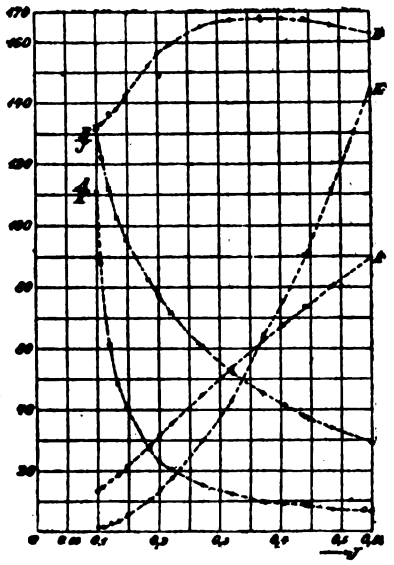

FIG. 13.

reached. It will be seen that, if through the fluctuation of pressure the critical value of 168 volts is exceeded, the electrode immediately falls in resistance and takes a large current. Thus, at the right-hand end of the curve, the electrode takes 0·51 ampere at 165 volts instead of 0·27. It would be able to withstand this excessive strain only for a short time. At the same time the intensity of the light has greatly increased. The growth of the light intensity above the same abscissa, J, is shown by the Curve K (Fig. 13). It is seen that the light intensity curve slopes up much more rapidly after the normal current of 0·27 ampere is exceeded. The apparent resistance, E/J, decreases at first rapidly and then more slowly. This occurs in an even more marked degree with the specific consumption, A/K, which appears to approach a minimum. It will, of course, be endeavoured to approximate to this minimum, but at the same time the critical point of the pressure curve must not be exceeded. Hence at the present stage of the lamp's development, and with the material now employed, a

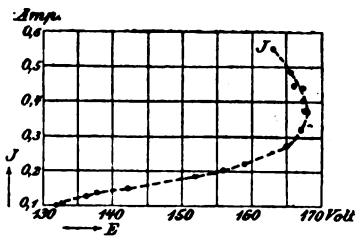

FIG. 14.

specific consumption of 1·5 watts per candle-power is still considerably removed from the consumption of 0·7 watt striven for. The same remarks apply equally to the incandescent glow lamp, in which case a specific consumption below three watts has not yet been obtained in a commercial lamp.

If we regard the individual values as functions of the pressure, we obtain, under certain conditions, a still clearer impression of the behaviour of the electrode at the critical point. For this reason these curves are also given in Figs. 14, 15, and 16. From the curves (Figs. 13 to 16 inclusive) are apparent the great difficulties which have to be overcome in manufacturing the lamp. Quite apart from the difficulties entailed by the manufacture of a lamp with a low specific consumption, satisfactory life, simple and cheaper construction, the correct resistance to insert in the

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circuit of the lamp has also to be determined, this resistance being a very essential feature of the Nernst lamp. The conditions for the resistance are shown in Curve E (Fig. 13). Having regard to the unavoidable fluctuations which occur in the line pressure, the resistance must be designed to ensure constant current strength. Under no circumstance

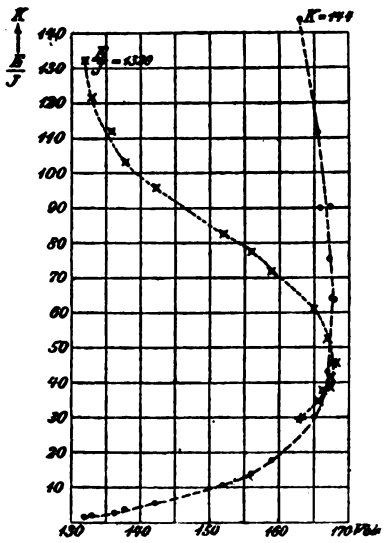

Fig. 15.

must the critical point of the curve in Figs. 13, 14, or 15 be exceeded. The electrode would otherwise be quickly destroyed.

The behaviour of a choking coil designed for a 220-volt lamp of the A type was tested by subjecting the coil to different pressures and currents. It is clearly indicated in

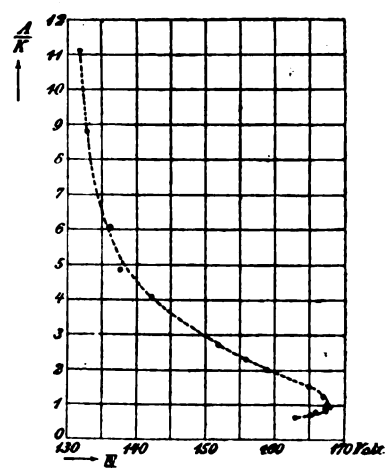

Fig. 16.

Table VII. and Fig. 17 that the current strength was maintained constant. From 17·5 volts to 29 volts and upwards the choking coil adapts itself so quickly that the current strength is maintained at a constant value.

while under K the light intensities at these points are given.

Table VII.

E.	J.	E.	J.
1·3	0·16	11·6	0·440
1·6	0·141	13·4	0·447
2·0	0·182	15·4	0·456
2·4	0·213	17·5	0·461
2·9	0·246	19·3	0·465
3·5	0·284	21·6	0·462
4·3	0·324	22·4	0·462
5·9	0·375	24·8	0·463
6·95	0·396	26·1	0·462
8·0	0·409	27·2	0·460
9·9	0·427	29·0	0·461

Table VIII.

a.	2·5 m. K.	3 m. K.	4 m. K.
0	5·6	3·89	2·19
0·5	6·43	4·39	2·48
1	7·18	4·95	2·62
1·5	7·21	5·16	2·77
2	6·3	4·92	2·90
2·5	5·09	4·81	2·75
3	3·91	3·54	2·58
4	2·34	2·24	1·99
5	1·46	1·48	1·42
6	0·96	1·01	1·03
7	0·67	0·71	0·76
8	0·47	0·52	0·57
9	0·35	0·39	0·44
10	0·26	0·297	0·34
12	0·154	0·189	0·217
15	0·083	0·085	0·121

In the accompanying diagram (Fig. 18) the diffusion of the surface illumination for the three different heights of suspension is plotted. It is seen from these three curves how the position of the maximum is displaced with increasing elevation from 1·25m. to 2m. distance, and how a more uniform diffusion of the light

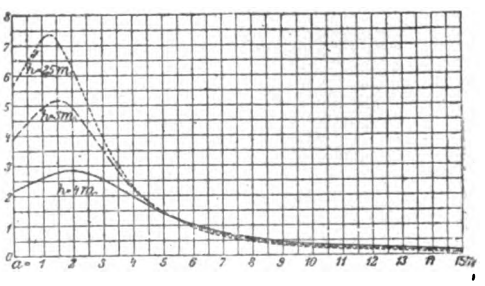

Fig. 18.

over the surface results from the increased height When in practice a height of 4m. is allowed, it is apparent that with an interval between two lamps of 12m. the illumination rises to 2 c.p. for each interval of 6m.

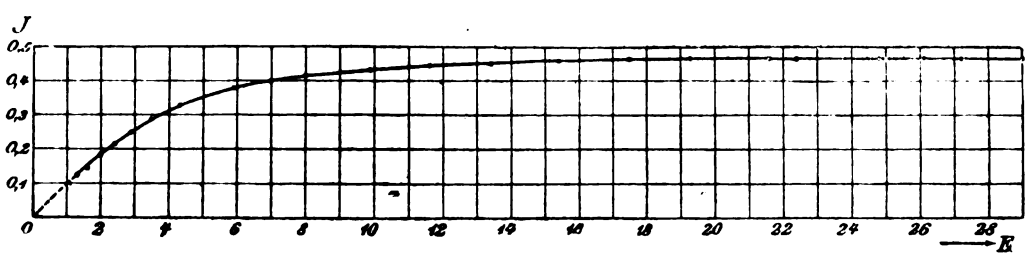

Fig. 17.

The Useful Illumination from a 200-Watt Nernst Lamp without Reflector.—By using the values given in Table V and Fig. 10, we may determine the illumination of a horizontal surface with the lamp (192·5 watts) hanging at three different heights (2·5m., 3m., and 4m.) above an even horizontal surface In Table VIII. the distances of the points to be illuminated on the level surface from the point immediately below the lamp, up to 15m., are stated under (*a*), in the centre between the two lamps, while the maximum reaches 3 c p. The diffusion is, therefore, fairly uniform. We do not obtain the rapid decrease from the maximum in the close proximity of each lamp to the minimum between two lamps, as in the case of ordinary arc lighting; and even if the total illumination obtained is less under certain conditions, the impression made on the eye is in favour of the Nernst lamp by reason of the more uniform diffusion

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of the light. This result is solely attributable to the superior diffusion of the light emitted by the individual lamps. For instance, while in the case of an arc lamp the maximum light rays available for illuminating the surroundings are generally emitted at an angle of less than 45deg., the Nernst lamp, on the other hand, gives its maximum intensity of light in an almost horizontal direction, whereby a very satisfactory illumination is obtained at the limits of the area to be lighted. The result may be further improved by employing a suitable reflector to utilise the light rays emitted upwards.

HOWARD ASPHALT CONDUITS AND TROUGHING.

The protection of electric cables to be placed underground requires the serious consideration of all electrical engineers. In the earlier days of electric lighting it was the failure of the insulation of the main which was the most frequent cause of breakdown. This failure of insulation in many cases could be traced to the way in which the cables were laid without protection in the soil. The protection required is twofold—*i.e.*, electrical and mechanical—and we know of cases where a most efficient mechanical protection has been the actual cause of the breakdown of cables through electrical troubles. These troubles have arisen in consequence of electrolytic action on the lead sheathing of the cable. The Howard asphalt conduit described below avoids entirely this trouble, and has other claims for advantages which merit the careful attention of electrical engineers. These asphalt conduits and troughing for use on the solid filling-in system are manufactured by the Howard Conduit Company, of Trafford Park, Manchester.

In considering this system, it is necessary to emphasise the difference between asphalt and bitumen, a difference which is often not appreciated. Asphalt is a natural rock formed by volcanic action, and consists of a mixture of bitumen and limestone. The proportions vary from 7 per cent. bitumen and 93 per cent. carbonate of lime to 20 per cent. bitumen and 80 per cent. carbonate of lime. Bitumen is a semi-fluid substance, sometimes supposed to be of organic origin, which flows freely when heated, and even at ordinary temperature will yield under pressure. Asphalt is particularly suitable for pipes or conduits; it is impervious to water and air, resists fire and acids, is an electrical insulator, and repels vermin. The makers claim also that it is durable and easily repaired, and so ductile that it will yield to any ordinary pressure without cracking. It is unaffected by frost, and though softened by heat at about 125deg. F., does not disintegrate even at 350deg. F., and upon returning to its normal temperature has lost none of its qualities. The difficulties in manufacture have hitherto prevented the use of this material for pipes, as it does not become fluid with heat, but only acquires a pasty consistency, and will not readily flow into moulds. It also requires pressure to make it cool into a solid mass. The process of manufacture consists in placing the hot asphalt in a mould or sheet-iron pipe and revolving it rapidly. Under the influence of centrifugal force the asphalt spreads out into a cylinder of uniform thickness, and is compressed into a solid mass. The heavier constituents are left on the outside of the pipe, forming a strong outer skin, and the lighter matter forms a smooth inner surface. The pressure developed by centrifugal force is considerable; thus a 3in. pipe revolving at 500 revolutions per minute subjects every pound of asphalt to a pressure of 10·6lb., and the result is a solid pipe with a smooth inner surface. The machine for making these asphalt pipes is shown in Fig. 1.

Pipes formed of asphalt only if subjected to unequal pressures in various parts might alter their shape. In order to prevent this a spiral of galvanised iron wire, or a covering of sheet iron, is combined with the asphalt so as to maintain its shape. The coil of wire (Fig. 2) is embedded in the material, and is consequently thoroughly protected against oxidation. Asphalt pipes are especially suitable for conduits for electric cables, as the material is an insulator and so prevents an earth contact if the insulation of the cable fails. There will also be no trouble from electrolysis, which eats away the lead covering of the cables. The inner surface is smooth, and allows cable to be drawn through with a minimum of friction, and the joints between successive lengths are of the same size as the pipes themselves, so that a number of conduits can be run in the same trench, occupying the smallest possible space. The labour in making joints is very slight. A cast-iron block of suitable shape (Fig. 3) is heated in a portable fire and applied

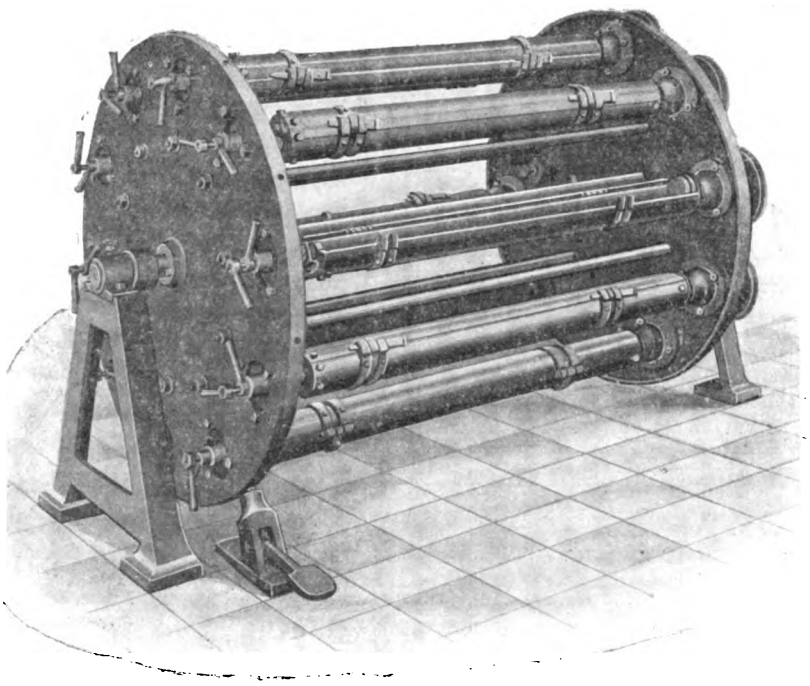

FIG. 1.

FIG. 2.—Conduit.

FIG. 3.—Jointing Iron for Square Troughing.

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between the two ends to be joined As soon as the asphalt is sufficiently warmed, the two ends are then pressed together firmly and left to cool, and a thoroughly welded joint is made of the same strength as any other part of the conduit or trough; an expanding

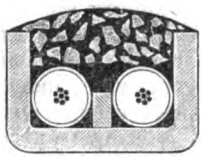

FIG. 4.—Square Troughing with Asphalt Cover.

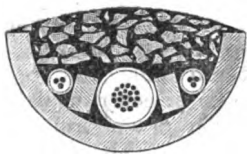

FIG. 4A.—Semi-Circular Troughing with Asphalt Cover.

mandril is inserted (in the case of conduits) to prevent any projection on the inside. The entire process takes about two minutes, and no skilled labour is required. The troughing for use on the solid system is made on the same principle as the conduits, but without the spiral, and

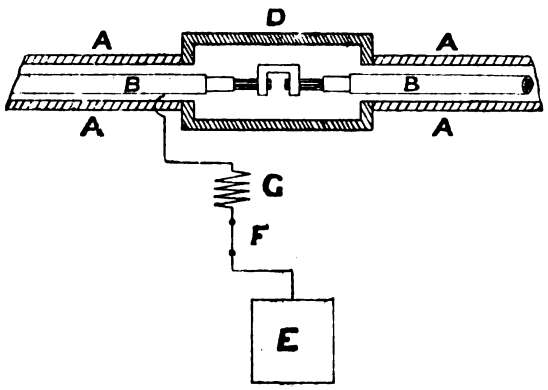

FIG. 5.

pressed into a rectangular shape (Fig. 4). The cable is laid direct in the bottom of the trough without supporting clips, as these are rendered unnecessary by the insulating properties of the asphalt. This method of laying saves the large amount of bitumen compound necessary to fill in the

FIG. 6.—Laying Howard Conduit at Windsor.

insulating space in a cast-iron or carthenware trough, and also lessens the size of trough, and consequent excavation. A small quantity of melted bitumen is then poured into the trough only just sufficient to cover the cables. The remaining space is filled in with asphalt rock, which can be arched, as shown in the drawing, thus forming a solid cover, efficiently protecting the cable from external damage. By this method of laying the cable is so thoroughly insulated from earth, that it is possible to use this protection as a safeguard against breakdowns in case of a failure of the insulation of the cables.

The arrangement for effecting this purpose is shown diagrammatically in Fig. 5. (D) represents an iron joint-box lined with asphalt connecting two lengths of lead-covered cable (B) laid in the asphalt trough, (A); the lead of the cable is insulated from the joint-box by the asphalt, and the lead covering of the cable is connected to earth at (E) through a resistance (G) and a fuse (F). The lead of the cable is divided up into sections by the method of laying. The only path to earth is through the resistance (G) and fuse (F). In case of a failure of the cable causing a short-circuit to the lead and so to earth, in the ordinary case the cable is burn out, or the circuit breakers opened, causing considerable trouble, especially in tram circuits. In this system of laying the fuse (F) in the section in which the fault occurs is blown, and the lead covering is then insulated from earth by the asphalt troughing. The cable can still be utilised until a convenient time for repairing the fault, and the position of the fault is easily found by an inspection of the fuses in the various street boxes without the necessity of making tests or interrupting the supply. The resistance (G) is intended to prevent the flow of any electrolytic currents in sufficient strength to injure the lead. The flexibility possessed by asphalt is an important point in a system of this kind, as any ordinary subsidence of the ground will not cause a fracture, but will leave the conduit or trough intact, where an earthenware or iron trough would be broken. Fig. 6 shows some of these asphalt troughings being laid at Windsor.

THE CONFUSION OF TERMS AND UNITS.

BY W. CRAMP.

It is astonishing to find how few men are willing to take the trouble properly to understand the everyday terms used in mechanical and electrical work, and what confusion may follow from a lack of appreciation of their value. The terms more particularly referred to are those used to express physical quantities, such as "work," "power," "energy," etc. To one who spends much time in explaining to students the value of such terms, and their relationship to the fundamental units of length, mass, and time, the carelessness shown by writers in technical journals is appalling, and leads one to think that these writers themselves often cannot understand the language they use and the value of checking the accuracy of an equation by reducing it to its fundamental units.

Of the many blunders which occur without any attention being drawn to them by those responsible for their publication, one example will suffice to illustrate what is here meant and put the reader on his guard. Take, for instance, the following paragraph, which appeared lately in one, and, we believe, more than one, well-known electrical paper: "The best-known method of testing an electric motor for efficiency is to put an artificial or frictional load on the machine by means of some form of brake dynamometer, measuring the mechanical torque in pound feet delivered to the dynamometer and the electrical power in watts delivered to the motor from the supply circuit; multiplying the pound-feet by the revolutions per second and dividing by the watts gives the percentage of intake that the motor is able to convert into useful work. This method is simple enough, and if one has a reliable Prony brake and is experienced in the use of it, there is nothing more to be desired."

To a student who understands the units he works with, such a paragraph as the above should be almost incomprehensible. Take it piece by piece. We are told to measure the "mechanical torque in pound-feet." Now, the term *torque* (so often misunderstood) is used to express the *moment of a force* tending to produce rotation or twist about a given centre. Thus, if we have a motor whose armature is caused to rotate, the torque which causes the

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rotation may be measured by the product of the radius of the armature, and a force acting tangentially at the periphery of the armature and perpendicularly to the axis of rotation. We see, then, that the term *torque* has the same dimensions as *a couple*, or *the moment of a force about a point* It is the product of a length and a force.

We are told to multiply this quantity by the revolutions *per second*. Since nothing has been said about the *distance through* which the force acts, we shall now have an expression which is neither torque, nor power, nor work, but which is to be immediately divided by the "electrical *power in watts* delivered to the motor." What the result of this will be is hard to guess, but we are told that it will be a "*percentage* of *intake* that the motor is able to convert into useful *work*. Hence we have

$$\frac{\text{a couple} \times \text{revolutions}}{\text{power} \times \text{time}} = \text{a percentage of "intake."}$$

Obviously such a ratio cannot be a "percentage," nor can the word "intake" have any meaning at all. Further, it is misleading to speak of a motor as converting "intake" into useful *work*. Notice, too, that by the writer's own statement a product of "*pound-feet" and revolutions per minute* is to be divided by watts—*i.e.*, by a number of *dyne centimetres per second*. This is a mistake like that of the child who divides pounds by pence, and tells you the answer is in shillings.

Seeing, then, how meaningless is the language of such a technical article, let us now rewrite the paragraph, attributing to it the meaning which the writer probably meant to convey, and using as far as is possible his own form of expression.

It will then read as follows: "The best-known method of testing an electric motor for efficiency is to put an artificial or frictional load on the machine by means of some form of brake dynamometer measuring the mechanical torque, expressed as a product of feet and pounds, exerted by the motor on the brake, and the electrical power in watts delivered to the motor from the supply circuit; multiplying the torque by 2π and by the revolutions per minute gives us the *power* exerted by the motor in foot-pounds per minute. Bringing the foot-pounds per minute to watts by multiplying by $\frac{746}{33,000}$, and dividing by the power in watts delivered to the motor, gives the fraction of the power put in that the motor is able to give out usefully."

This is probably now not expressed as well as practised writers would do it, but there is at all events no great mistake in the terms used or the dimensions of the units employed. It should be noticed that throughout the weight of 1lb. is used as a unit of force.

INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address.

BY WILLIAM LANGDON, PRESIDENT.

(Concluded from page 736.)

The work of the railway engineer is to construct railways; and if the opportunity arises he will not be deterred from doing so by any consideration of the injury his work may inflict upon existing interests. The way to prevent him from doing so is to make it clear that there is no profitable need for any such addition; and this can only be accomplished by the existing systems showing that they are prepared to avail themselves of the same means—to afford as far as possible the same facilities and advantages as are to be derived from independent electrically-worked lines. It has been advanced that the existing lines of railways are unsuitable for higher speed; that the stock is cumbrous and that the system is generally unsuitable. This has to be proved. Railways have to face the fact that electricity as a motive power is before them; that if it is not applied to the existing systems—if they do not elect to avail themselves of it, it will come independently, and in competition with existing interests.

To attempt to approach the subject in a piecemeal fashion by dealing with a branch line here or there may be of service, but it can scarcely affect the main issue. While a small branch line is being converted, new lines between important centres will be constructed, and the passenger traffic between those centres will at least be split between the old and the new service. No one doubts the ability to apply electrical energy to branch lines, but many will doubt whether the traffic of a branch line can be so regulated as to form a continuous and remunerative service throughout the day. With main lines there can be no doubt of a regular demand, while most branch lines can with convenience be dealt with from the main-line power station. Manifestly, however, if the trunk lines are eventually to be operated electrically, whatever may be done in relation to branch lines should be done with a view to harmonise with that system which will be ultimately employed on the main line. I do not presume to indicate what that system may be—whether alternating, or direct current, but it is clear that for main lines an overhead electric service is inadmissible; and equally, to my mind, is a rigid or semi-rigid rate of speed. With a line carrying one class of traffic, this latter question may not be so important, but on lines carrying a mixed traffic this cannot be so, for the power to vary the speed is a factor which must have an important bearing upon the working of the line. The speed, subject to a maximum limit, must be in the hands of the driver. To those with whom may rest the privilege to establish electrically-worked lines, I would, with all respect, venture to say: be careful that you do not retard that great work which sooner or later must invite attention. In the establishment of light, high-speed, point-to-point passenger lines little difficulty may be encountered. It is not, however, with them that the interest of the country needs your aid so much as in the conversion of those lines which are already established. It is where competition of a fruitless character—fruitless, in that it will not prove productive of a return to the shareholder of the new, more than to the shareholder of the old—steps in that capital will be squandered.

The observations with which I have thus far troubled you are the result of careful consideration inspired by a belief in the advantages of that new power which is before us. In the meanwhile the demands of a railway service have to be met by the means at our disposal. In it electricity is playing its part. In no way derogating from that useful service it has always rendered railway enterprise, its field is ever extending. In lighting, in local application of power for pumping, for lifting, traversing, and other purposes its utility and adaptability, wherever it has been applied, is such as to create a desire for its extension. So far it cannot, however, be said that its full advantages are being realised. To reap these advantages it is necessary that the schemes under which it is employed should be more comprehensive, capable of dealing with a more extensive service. Probably the nearest approach to this condition yet attempted is the high-tension generating station laid down by the Midland Company at Highgate-road, Kentish Town, which at present serves to light the Kentish Town, Camden-road, and St. Pancras passenger stations, together with the goods stations at Somerstown, and St. Pancras, the day and night coal depôt at Somerstown, the Midland Grand Hotel, various cranes, traversers, and pumps. The output of this generating station was for the past year 2,081,129 kw. with a load factor of 40 per cent.

There are few railway companies who do not recognise the advantage of electricity for lighting their offices, goods yards, and depôts. In no instance is space or time more valuable than with a railway service. The ability to load and dispatch five trains where, under the old and inefficient mode of lighting, only four could be disposed of in the same time is equal to a saving of 20 per cent. in capital outlay for buildings and land quite independent of questions of labour and rolling-stock. I often doubt, although the advantage of electric lighting is so freely admitted, whether this great and important fact is realised. The North-Western, the Lancashire and Yorkshire, the Brighton and South Coast, the Great Eastern, the Great Western, the

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Great Northern, and other companies are reaping the advantages of their various installations. Still there are fields of usefulness, embracing large economies, of which advantage is not being taken. These are to be found chiefly in relation to goods warehouses and in the large workshops of the companies. The value of electricity for workshop power has been so fully demonstrated in papers read before this and other institutions; it has been in so many cases applied with so much success, and attended with so much economy, that it is difficult to understand why it has not equally readily found a footing in railway workshops and warehouses. An object lesson is that of the Burlington railway shops at Hanibal, Minesota. The entire shops are operated electrically—boiler-house, lifts, turnables, cranes, etc.—the total connected load exceeding 900 h.p.

The London and North-Western, the North-Eastern, and the Lancashire and Yorkshire Railway Companies have made the most use of electrical energy. In many instances each of these companies have, with evident advantage, replaced old and practically obsolete modes of operating cranes and tools by electric motors. The latter company operates its goods depôt at Oldham-road, Manchester, entirely by electrical energy—lighting, cranes, hoists, and capstans—the provender mill and warehouse adjoining being similarly operated. The new station at Bolton is to be similarly equipped for both passenger and goods work, and the signals and points of this station are to be worked electro-pneumatically. Many other portions of their system also employ electrical energy for various purposes. In their workshops considerable advantage has been taken of this source of power, always to good purpose. At Fleetwood a large elevator is similarly worked. The London and North-Western are preparing to work the whole of Crewe Station electrically. The Lancashire and Yorkshire have also at their Lockwood and Castleton Stations electric locomotives, the property of private firms, moving the traffic of those firms. These are worked from an overhead conductor.

That I may not labour you with many details, I have, by the courtesy of the various responsible officers of the companies named, prepared and attached hereto a schedule of the chief work in this respect in operation on the principal British railways; and, similarly, I am also, by the courtesy of the electrical engineers of these companies, enabled to append details of block signalling and telegraph plant. Here it is only necessary to quote the chief features of these schedules—viz.: arc lamps in operation, 7,182; incandescent lamps, 85,683; electric energy applied to power purposes, 10,527 h.p. In telegraphs, total mileage of wire employed on these lines for railway purposes approximates to 113,000; wires maintained for the Post Office, 86,000; number of instruments, 158,286.

In telegraphy there is little to note otherwise than to record a continuous growth of system. As traffic and competition increases so increase the demands on the telegraph service. No form of instrument has, however, proved of greater service in working the trains than the telephone. It has, in fact, become indispensable on all the main lines. In the interlocking of the electric block signalling instruments with the mechanical signals comparatively little progress has been made. The London and South-Western and the South-Eastern—Chatham and Dover section—show the greatest advance in this respect. Electricity as applied to the lighting of railway carriages is steadily making its way. Some 3,000 vehicles chiefly fitted with what is known as Stone's system are now running. Why electrical energy has not made more headway on railways it is hard to determine. We see that with two or three companies it is being employed to some extent, but in no case to that extent which, from its known utility and advantage, one might anticipate would be the case. Possibly the ready provision of power which will be placed at the disposal of most railway companies by the establishment of those electrical power schemes which are now taking shape may prove a means to this end. The cost of laying down generating plant is undoubtedly one reason why the progress has not been greater.

Distribution of Power.—But a few years since it was not unusual to hear electricity spoken of as in its infancy. More recently any such reference has been keenly resented, and, in a measure, properly so, for with the invention of the dynamo, electricity undoubtedly passed beyond the infant stage. The generation of electricity is now limited only by the motive power necessary to produce the motion by which it is evolved; it can be obtained in any quantity. But, let me ask, is not electricity in its application and use still in its infancy? View it in its operations of to-day, and conceive within your mind the extent to which it is capable of being employed. Electricity is but treading on the fringe of that vast domain it is destined to serve. Employed at first to meet isolated demands, it has passed on to fulfil higher and more important duties; and it is only now, in the establishment of those power schemes, destined to serve large areas, foreshadowed in the able address of your past-president, Dr. Thompson, that we are approaching those economical conditions which will confer upon the commonwealth its fullest advantages. In the development of these schemes for the distribution of electrical energy, not merely for power, but for all purposes useful to a community at large, we as a nation are by no means singular. Other countries are equally availing themselves of them for various industrial purposes. Great Britain cannot boast of some of those great natural advantages enjoyed by other countries, but, although water power is not ours to command, we have in our coalfields a product which there is every reason to believe will prove of equal value.

The time has come when we have to put to ourselves the question: To what extent are these schemes destined to aid economical manufacture, and the conveniences and needs of everyday life? To some extent this is an unsolved problem, but that they will prove a great and powerful factor in all industrial operations there can be no doubt. Competition in the production of all marketable articles will in the near future be extremely keen. Equally sure it is that the advantage will lie with those who are able to produce at the least cost. It is only when we fully realise this that we see how important it is, in the welfare of the country, that every means by which production may be cheapened should receive our most careful and considerate attention. We feel that we are entering upon a contest with others, others possessing to all intents and purposes equal if not more favourable means than ourselves for the production of those very articles which we propose to produce. We see that in the establishment of the means for furnishing to those who need it the power which is to aid in this economical commercial propaganda, other lands are in advance of us; that we are only now awakening to the means by which it is given us to compete in this race. The advantage of such a service does not rest merely in the fact that we may take and pay for just such power as we need, but in the fact that space—a valuable asset in most industries—is economised. When we compare the space occupied by one or more electric motors with that absorbed by a steam plant, we cannot fail to realise that this mode of acquiring power is attended by more than one advantage. The extent to which it may be carried must naturally resolve itself into a question of how far it will pay to do so. If it is confined to those localities where population is already congested, it will but tend to aggravate that condition of life, the relief of which it is felt is becoming one of the most serious questions of the day. A cheaper mode of construction would admit of greater latitude, and to this end it might be of advantage to consider whether in practically unfrequented parts, the regulations which now attend the use of overhead wires would admit of such modification as would confer upon these schemes a status which would tend to place them more upon a level with those of other countries.

Gentlemen, you will, I feel, pardon me for thus entering upon a subject so intimately connected with commercial life, but the subject is one of so much material interest at this moment that it is impossible to ignore it, and if the establishment of these power schemes is to be of that service to our industries which may be fairly anticipated, it is of the greatest importance they should receive at our and other hands all the aid in our power. It is in searching out means for effecting economies and securing the higher attainments

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of life that science plays its most useful part, and we must not forget its ultimate object. Science is but a means to an end. When Faraday was engaged in investigating the relationship between the electric current and magnetism, he saw that there was in his discovery that which was new, but he could form no fixed idea of its future utility. Others working upon the foundation he established have given to the world the means by which his discovery is capable of being serviceably applied to the ameliorations of the duties of life. It is so with most great discoveries. The scientist lays bare the principle. Others take up his parable and apply it to the use of mankind. It is in its application that we recognise the merit of the discovery, and pay homage to its author. Its end has been for the benefit of the beings of the world. Faraday had no conception of the value of that which was to spring from its discovery, nor even now do we know the depth of its value, yet there is no name more venerated by every disciple of the electrical profession, or one to whom a greater debt is due by the world at large.

Conclusion.—I feel that I cannot close these remarks without tendering to the members my hearty congratulations on the progress of the Institution. Although the funds at our disposal are not, in the interest of the objects of the Institution, so great as we could well desire, and although we have made but little tangible progress in the establishment of a permanent home, and still, with gratitude, record our indebtedness to the Institution of Civil Engineers for that great and generous consideration so gracefully accorded us in the use of this noble theatre, the Institution is doing work of which we have reason to be proud The membership is a growing quantity, and with its growth the field of operations is widening. Local sections are adding their quota to the work done, in the promotion and discussion of subjects material to the knowledge and development of electrical science; still, the advantages of electrical agency and the simplicity of its application are largely unknown. Compare the simplicity of an electric motor with the details of a local steam or gas plant, and conceive, when electricity is brought to our doors, and its advantages are more clearly understood, how much of that machinery from which motion is now produced will be displaced by the electric motor. It is for you, gentlemen, in your communications and papers to be read and discussed before this and kindred institutions, to remove this deficiency, to show, by what is being daily accomplished, the economies which lie in the use of electricity, and the advantages it possesses over other forms of distributed energy. Nor can I abstain from tendering to you my congratulations on the work of utility which awaits your efforts. No profession has before it so large a field as that which constitutes the basis of this Institution. I would that I could congratulate you on the extent of work done. Electrical development in England has not been so satisfactory as it should have been. In 1877 I read before this Institution, then the Society of Telegraph Engineers, a short paper descriptive of the first application of the electric light in England. The system there referred to was in 1879 employed to light the Victoria-embankment. It was not a success, and was abandoned For 19 years this, the finest roadway in England, remained indifferently lighted by gas. The inauguration of the London United Tramways took place no less than 10 years after the establishment of the first electric railway in London! Over-legislation—that great desire to protect the subject, often at the cost of that to which he has to look for his means of support—has, no doubt, retarded electrical progress, and consequently the production of electrical machinery. Oft do we hear the cry for education. Educate! Educate! Certainly, let us educate, but of what avail is education without experience? Are our engineers deficient in education? Do those electrical plants and installations which have been established indicate a want of knowledge? Do they fail to favourably compare with those of a similar character in other countries? Why is it that America has forged ahead in electrical applications in the manner she has? Is it due more to education than experience? It is experience that has gained for her engineers and manufacturers the position they have attained in the provision of electrical equipment. It is this experience that has enabled them to determine that which is adapted to meet the demands arising out of this new power; to standardise it, and lay down plant for its manufacture.

Experience can only be obtained by actual work, and that actual work has been, by those to whom power to put it into operation has been assigned, delayed till the last moment, when, perforce, much of it has had to be entrusted to those who were prepared to provide promptly the necessary parts. Work has been delayed, experience sacrificed, and much that should have enriched British industry has passed into other channels. I am sure that I do not stand alone in echoing the expression of the president of the Glasgow International Engineering Congress, Mr. Mansergh, the late president of the Institution of Civil Engineers, that what is needed is greater liberty, greater freedom, less restraint! Is electrical science in those applications to which I have referred destined to be of service to the public weal? Is it now serving the community with advantage? If so, is it desirable that statute limitations should interfere to preclude or to prejudice its progress? If found to be undesirable, or in any way injurious, nothing could be easier than to restrain its use. To do so in anticipation is to stay its progress and deprive the country of its value. Do not let us lose sight of the fact that when railways were being established throughout the country there were towns—certain towns—that declined to be associated with them, but in a very short time they became sensible of their folly and had to seek the suffrage of the railway—only in some instances when too late, for they have been left out of the main route, and have never recovered their prestige. In these distribution of power schemes the country has before it something of value to its commerce equally great. Assume that a district desires to be exempt in order that it may provide for itself. Unless it can produce as economically as the larger scheme it must increase the local cost of production and injure its users, or drive them into another area whence they may be more advantageously served.

It is in the full belief that electricity is destined to prove of the greatest service to the commonwealth, and that its advantages have been too long retarded, that I have ventured to submit to your consideration these remarks. In doing so my effort has been to view the subject from that broad standpoint—the national interest; the benefit of the greatest number. This Institution is a composite body, embracing within its folds every branch of electrical science, having various interests to protect; but of this I feel sure, that however varied those interests may be, one and all its members are animated by but one desire—the progress and the welfare of the country. We believe that electricity is to play a very important part in engineering work, and we are ambitious that England shall not sacrifice that high position in engineering science which has for so long distinguished her. In what way, by what means, whether by private enterprise or by municipal effort, electrical progress is effected is not so material as that it is effected. So long as its fullest advantages are placed at the disposal of those who desire to avail themselves of them, you, gentlemen, as well as I, will welcome the means, whatever that may be.

CONDENSATION OF SCHEDULE A, GIVING DETAILS OF ELECTRIC LIGHT AND POWER INSTALLATIONS ON ENGLISH RAILWAYS.

Lancashire and Yorkshire.—500 arc lamps, 6,800 16-c.p. incandescent, 1,460 h.p. of motors, 6 coaches and 3 saloons lighted on the Stone system. Electric power details: the Oldham-road Goods Station (Manchester) is wholly worked by electricity, with 22 18-h.p. capstans, two 40-h.p. motors operating wagon hoists, motors driving traversing cranes, gantries, and a number of 15cwt. jiggers. Provender mills adjoining also operated electrically. At the Bradford warehouse three high-speed travelling cranes for unloading and storing wool, each operated by three motors, are in use. At Bolton, a power station has been built for operating whole of station—capstans and cranes (including 40-ton Goliath crane with longitudinal travel of 200 yards) in goods yard; hoists in warehouses and on station platforms; air valves in connection with pneumatic signalling, and complete lighting of passenger station, offices, goods yard, and signals. An overhead telpher track for parcels at Manchester Victoria Station. At the Newton Heath locomotive and carriage and wagon works, portion of lathes, shafting, cranes, and fans are worked electrically. This railway company has also a number of motors at small stations.

Midland.—1,885 arc lamps, 13,731 16-c.p. incandescent lamps, 750 h.p. of motors installed, and 250 h.p. more arranged for, 11 coaches lighted electrically on the Stone system. The motors

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SCHEDULE B.—MILEAGE AND OTHER DETAILS OF TELEGRAPHS AND BLOCK SIGNALLING ON UNDERMENTIONED RAILWAYS.

Railway.	Mileage of line on which the electric block is interlocked with mechanical signals.	Number of block posts where mechanical signals are operated by electricity.	Number of telephones for all purposes.	Number of telegraph instruments of all kinds, including block.	Mileage of wire employed for railway purposes.	Mileage of wire maintained for the Post Office Telegraph Department.
Caledonian	25	Nil	1,629	16,688	6.870	5,120
Cheshire Lines	1½	Nil	280	1,586	1,184	725
Glasgow and South-Western	4	13*	359	1.620	1,814½	1 888
Great Central	16½	Nil	918	7.036	4.259	1.2 9
Great Eastern	59	109	715	11.704	6,777	4.802
Great Northern	3¾	16	684	10 427	7.747	4 379
Great Western	16	Nil	2,155	25,924	15.256	14,003
Lancashire and Yorkshire	Nil	Nil	1,950	8,380	5,229	2,268
London, Brighton, and South Coast	80	Nil	600	2,944	3,500	2,434
London and North-Western	Nil	Several signals and points are worked experimentally at Crewe (by signal department)	2,361	10,450	13,500	8,200
London and South-Western	345	(Experiment) 6 automatic posts	1,213	14.663	7.325	7.947
Midland	25	Nil	2,820	20.344	12.845	15,243
North British	5½	Nil	552	3.466	7.193½	3,622
North-Eastern	1	Nil	1,820	14,726	10,7 7¾	3,4 9
North Staffordshire	Nil	Nil	418	1,181	85½	433½
South-Eastern and Chatham	350 (Double line)	Nil 55 electrical shunting signals in use	853	6,504	4,613	4,804½
Great Northern of Ireland	Nil	Nil	161	242	1,338	3,280
Great Southern and Western of Ireland	—	Not to hand	—	—	—	—
Midland Great Western of Ireland	—	—	32	401	1.167	2,210
Totals	913¾	138	19,510	158,286	112,256	85,017

* G. and S.W.R. { 66 electric signals operated by means of motor connected with each arm, worked from 30-volt accumulators. 57 disc shunt signals operated electrically by means of electromaguet, worked from 8 to 12 volt accumulators. } These numbers will be considerably increased when installation completed.

above mentioned can be classified as follows: 50 h.p. working pumps at 700lb. pressure for hydraulic lifts; 25 h.p. working compressor for pneumatic drilling, etc.; 78 h.p. working pumps; 83 h.p. working overhead traversers; 20 h.p. working wagon traversers; 135 h.p. working capstans; 35 h.p. working cranes, lathes, etc.; 15 h.p. working fans; 250 h.p. working granary machinery (chaff-cutters, elevators, crushers, hoists, etc.; 9 h.p. working miscellaneous.

North-Eastern.—429 arc lamps, 7,306 16-c.p. incandescent, 2,204 h.p. of motors, and 2 coaches electrically lighted. The motors are used for travelling jib cranes, overhead travelling cranes, capstans, luggage hoists, goods warehouse travellers, ticket-printing and ticket destroying machines, punching and shearing machines, saws, grindstones, paint mills, lathes, coke crushers, and ventilating fans. This company has also in contemplation important installations at Leeds, Hull, and West Hartlepool of electric overhead travellers, cranes, hoists, and capstans, also for goods warehouse at Newcastle, where a number of arc and incandescent lamps not included in summary are installed.

South Eastern and Chatham.—308 arc lamps, 2,392 16-c.p. incandescent, 122 h.p. of motors, and 925 coaches electrically lighted on the Stone system. The motors are mostly employed at the Slade's Green locomotive shed, but light and power installation is in contemplation of the Queenborough Pier.

London and South-Western.—76 arc lamps, 220 16-c.p. incandescent, and 326 coaches lighted on the Stone system. This company has no electric motors at work. Salisbury Station is now being equipped with 30 arc and 800 incandescent lamps.

North Staffordshire.—47 arc lamps, 1,403 16-c.p. incandescent, 20 h.p. of motor, and 79 carriages electrically lighted on a modified Stone system.

North British.—369 arc lamps, 2,681 16-c.p. incandescent, one 10-h.p. motor, and 298 carriages electrically lighted—7 on the Stone system and 291 on the Carswell system.

Caledonian.—480 arc lamps, 6,014 16-c.p. incandescent, 90 h.p. of motors, and 30 coaches electrically lighted—27 on Stone system and 3 by Vickers and Maxim. This company has in progress: Glasgow Central Station—power station of 1,050 kw. capacity for lighting and power, for hoists, pumps, fans, traversers, etc.; Edinburgh—500-kw. additional plant for hotel lighting and other purposes, with 2,000 16-c.p. lamps: Stirling Station—500 incandescent lamps (station and offices); Perth Station Hotel—450 incandescent lamps. In contemplation: Glasgow, Buchanan-street passenger and goods station, head offices, etc.—power station of 2,000 kw. capacity.

Great Eastern.—8 arc lamps, 405 16-c.p. incandescent, and 10 coaches electrically lighted.

Great Western.—166 arc lamps and 8,764 16-c.p. incandescent.

Midland Great Western (Ireland).—100 coaches lighted on the Stone system.

Great Northern.—927 arc lamps, 9,842 16-c.p. incandescent, 1,194 h.p. of motors, and 88 coaches lighted on the Radcliffe system. The Doncaster Locomotive and Carriage and Wagon Works use motors for working 160 travelling cranes (35 tons and 20 tons load each), 2 walking cranes, 1 engine traverser, and for driving shafting in sections and some machine tools with separate motors.

Cheshire Lines.—219 arc lamps, 763 incandescent, and 8 coaches electrically lighted.

Glasgow and South-Western.—185 arc lamps, 5 050 incandescent, and 40 motors for cranes, and 6 coaches lighted on Stone's system.

Great Northern (Ireland).—84 arc lamps, 529 incandescent, and 231 coaches lighted on Stone's system, and 750 h.p. of motors used for working a tramway round the Hill of Howth—five miles. Generating house is at Sutton, where there are three engines, each of 250 h.p.

London, Brighton, and South Coast.—301 arc lamps, 800 incandescent, and 271 coaches lighted on the Stroudley and Houghton system.

Great Central.—716 arc lamps, 6.168 16-c.p. incandescent, 333 h.p. of motors, and 12 coaches electrically lighted.

Great Southern and Western (Ireland).—57 arc lamps, 15 incandescent, and 21 carriages lighted on Stone's system.

London and North-Western.—425 arc lamps, 12,800 16-c.p. incandescent lamps, 3.300 h.p. of motors, and 830 coaches lighted on the Stone system. The motors are used for the working of points and signals, warehouse cranes, capstans, hoists, pumps, and shop tools.

The totals arrived at from the above makes 7,182 arc lamps, 85,683 incandescent, 10,527 h.p. of motors, and 3,452 coaches electrically lighted.

Opening Meeting.

Mr. W. E. Langdon presided at the opening meeting of the winter session of this Institution held on Thursday evening, the 21st inst., in the hall of the Institution of Civil Engineers, Great George-street, Westminster.

The SECRETARY (Mr. W. G. McMillan) having read the minutes of the last annual general meeting, and also of the extraordinary meeting held in Glasgow in connection with the International Exhibition there, the PRESIDENT referred to the decease of the Dowager Empress of Germany and of Mr. McKinley, the late President of the United States, during the recess. He announced that in the name of the Institution on each of these lamentable occasions he had sent letters and telegrams of regret and condolence to the German Emperor through the German Ambassador in London, and to the Government of the United States through Mr. Choate. A telegram was also sent to the president of the American Institute of Electrical Engineers, conveying to him the sympathy of this Institution with the loss the American Institute and the whole American people had sustained by the death of Mr. McKinley. The President then announced that on the occasion of the ninth jubilee celebration of the

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University of Glasgow delegates had attended, in common with many other scientific and learned societies, and presented an illuminated address in the name of this Institution. Reference was also made to the death of Mr. Bristows, of the firm of Messrs Wilson, Bristows, and Carpmael, hon. solicitors to the society. In the course of a short tribute to the memory of the deceased gentleman, the President stated that the Council that evening had passed a resolution of regret and sympathy to his nearest relatives. Having reminded the meeting that the annual dinner of the Institution was appointed to be held on Monday, Dec. 9 next, the president said a few words with regard to the honourable title which had been conferred on Colonel Crompton, C.B., who, he said, had taken so much interest in the volunteer movement in connection with the Institution. He was sure they all rejoiced that Colonel Crompton had received such suitable and timely recognition of his services. The President next called upon the ex-president, Prof. Perry, to present the Institution premiums and awards. In doing so he called attention to a slight modification of the order of procedure that evening. It was customary for the outgoing president, he said, to occupy the chair in the first instance at the opening meeting of the new session, and after certain business had been transacted, to conduct the new president into the chair. On this occasion he had taken the chair on entering the room, and he thought this procedure was more in accordance with the fitness of things, because, in point of fact, the new president and the new officers carried on the duties of their various offices from the time of the annual general meeting. It had the disadvantage attached to it, however, that it deprived the large body of members of the opportunity of testifying to the outgoing president their appreciation of the manner in which he had executed his duties during his term of office. He (President Langdon) was sure that no one could have dealt with those duties more fully more thoroughly, and more devotedly than had Prof. Perry. In office and out of office, whatever might be the demand on his time and convenience, Prof. Perry had always been at his post, and he did not think the ex-president had ever missed an ordinary general meeting when in the chair save on one occasion, and then he was representing the Institution at the obsequies of the late Prof. Fitzgerald in Dublin.

Prof. Perry then presented the premiums and awards, a list of which and the names of their recipients have already appeared in this journal. In addition to these, the Institution have made the following awards of scholarships to students: two Salomons scholarships of £50 each to Mr. Joseph W. Griffin, of the Central Technical College, and Mr. Herbert Ashlin Skelton, of King's College; the David Hughes scholarship, value £50, to Mr. Cyril John Hopkins, of the Central Technical College.

Then began the real business of the meeting—*i.e.*, the reading of President Langdon's inaugural address. This will be found concluded above. The address lasted for just over one hour, and on the President resuming his seat he was accorded a great ovation of applause.

Sir WM. PREECE proposed a vote of thanks to President Langdon for his able address, and in doing so referred to the fact that they two had been colleagues for nearly 40 years. For about 27 years Mr. Langdon and he had worked together with a view to the improvement of railways in general. Mr. Langdon was usually so cheerful in all he did that it was disappointing to find him that night a little doleful about the position of the electrical industry in this country. The speaker reminded the meeting that they must not judge of the progress which the industry was making in this country from what was written in the Press. The position must be looked at with a great deal more cheerfulness than it was by some, and with the certainty that electrical engineers in England were doing all they could to advance the industry. The fault—if there were a fault—rested not with the professors, but with the gentlemen of the city of London, who would not put their hands in their pockets to find the money that was wanted. Whenever he got the chance he would never cease to protest against the despondent view taken by some people with regard to this matter. Pointing to the fact that the total membership of the Institution now numbered 4,000, he asked did that look like the decay of the electrical industry in this country? He remembered a time when he had lectured to sometimes no more than two rows of members and associates of this Institution, and (referring to the fact that the hall on this occasion was crowded to the doors) he asked if that were not evidence of the headway which electrical engineers were making in England?

Mr. R. K. GRAY shortly seconded the motion, reminding his readers that the presidential address came from one of the most distinguished electrical engineers in the railway service.

Prof. PERRY, in a humorous little speech, also supported the motion. He thought it was characteristic of the English people to "pitch into" themselves, and the interesting thing about it was that the foreigners believed them! He sometimes "pitched into" himself, and so, he knew, did Mr. Langdon, but they thought none the less of themselves for all that. He also denied that there were any grounds for the pessimism with which the progress of the electrical industry in this country was regarded. He had much pleasure in supporting the hearty vote of thanks which had been proposed to President Langdon for his address.

The PRESIDENT, in reply, said he was extremely obliged for the kind manner in which the meeting had received the remarks of the three gentlemen who had just spoken. He quite agreed with Sir Wm. Preece that if those gentlemen who were now in the room had the control of the electrical affairs of the country they would have no reason to complain. The question, to his mind, was, Had the progress been so good as it might have been? He hoped he had not spoken in too deprecatory a manner in this respect, but, personally, he held the opinion that the progress might have been greater than it had been.

The vote of thanks was warmly accorded, and the proceedings closed.

FORTHCOMING EVENTS.

SATURDAY, NOV. 30.

Institution of Electrical Engineers (Students' Section). — At 10.30 a.m., visit to the generating station of the City and South London Railway.

MONDAY, DEC. 2.

Institution of Electrical Engineers (Newcastle Section).—Ordinary meeting. Paper: "A Combined Integrating and Maximum Demand Meter," by Mr. J. H. Barker.

TUESDAY, DEC. 3.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "Train Resistance," by Mr. John A. F. Aspinall.

WEDNESDAY, DEC. 4.

Institution of Electrical Engineers (Students' Section). — At 7.30 p.m., ordinary meeting. Paper: "Some Electrical Testing Experiences," by Mr. H. D. Symons.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "The Identification of Wood and its Application to Scientific and Commercial Purposes," by Mr. Herbert Stone.

THURSDAY, DEC. 5.

Rontgen Society.—At 8.30 p.m., ordinary meeting. Paper: "Bullets and their Billets: Experiences with X Rays in South Africa," by Mr. J. Hall Edwards.

FRIDAY, DEC. 6.

Institution of Junior Engineers.—At 8 p.m., Westminster Palace Hotel, ordinary meeting. Paper: "Street Railway Construction for Electric Traction," by Mr. F. S. Pilling.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper: "Gas-Engine Construction," by Mr. R. W. A. Brewer.

SATURDAY, DEC. 7.

Institution of Electrical Engineers Students' Section.—At 11 a.m., visit to the Fulham electricity supply works, Thames Embankment.

Manchester Association of Engineers.—Ordinary meeting. Paper: "Workshop Management," by Mr. A. P. Loscher.

Morpeth.—The Town Council have approved the proposal of the Northern Counties Electricity Supply Company to apply for powers to lay down electric tramways in the town.

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THE GOVERNMENT TELEPHONE POLICY.

The publication of the other terms of the agreement between the Postmaster-General and the National Telephone Company shows how correct we were last week in our argument that the Post Office would have to purchase the system of the National Company in 1911. We presume now that this purchase has only been agreed upon as far as the metropolitan area is concerned, and that the amount to be paid will be determined by arbitration based on the valuation of the plant without goodwill. The other clause in the agreement, by which the Post Office are to provide for the National Company any underground wires they may require, is a most reasonable one, as it prevents the erection of more overhead lines, which would be utterly valueless ten years hence. By the publication of this agreement one is able to learn what is the policy of the Postmaster-General, and, however much fault may be found with the new tariff, it cannot but be admitted that this policy is an honourable one. The great fault that in 1911 the Postmaster-General will acquire a number of exchanges full of plant which only duplicates what he already owns, must be laid to the charge of the Government. We headed our leader "The Government Telephone Policy," and are at once confronted with the difficulty of writing about a policy which most nearly resembles the result obtained when one attempts to extract a square root of a negative quantity. In this respect, we regret to say, the present Government resembles most of its predecessors. They in their time attempted to deal with the telephone question, and laid down the supposed lines on which the public were to derive convenience from the use of telephones, while the Postmaster General received an unearned increment of 10 per cent. on the gross receipts from all telephone exchanges. It required only a few minutes' consideration on the part of any business man for a conclusion to be arrived at as to the impracticability of telephone competition. Still, one Government said that any applicant might receive a telephone license. The result spelt financial disaster to a large number of telephone undertakers, who were all ultimately bought up by what is now the National Telephone Company. The result of this has undoubtedly been that telephone subscribers have had to pay higher rates than they should have done, but the other cause of these high rates, especially in the case of London, is that the company were expected to provide connections to all parts, and were absolutely without any statutory powers either for getting wayleaves for overhead wires or for placing their conductors underground. The cost of continual shifting of overhead wires due to the withdrawal of wayleaves in consequence of the nuisance caused by posts on houses, has led to a wasteful expenditure of money of which an outsider has little knowledge. At the same time, in London at least, any company having a monopoly of supply of any public commodity is looked upon by local authorities as a body to be at the same time condemned and plundered. A review of the report of the London County Council Highways Committee will confirm this. Thus when in 1897 the consent of the Council was required to the placing of the National Telephone Company's wires in the ground, conditions were sought which can be briefly summed up as follows: if the National Telephone Company would reduce their charges to those which the London County Council were advised by their engineer would be quite sufficient to pay expenses on a newly-equipped system, and would also pay the London County Council an annual rent, the consent would be given. These conditions, if accepted, would have necessitated, first of all, the

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writing off as a dead loss all previous expenditure on overhead wires, and then the payment of annual sums to the London County Council, and also to the local authorities whose streets were broken up. We are sure that no such allowance for wayleaves was included in the estimate of the London County Council's engineer. Naturally, these negotiations fell to the ground, and only in the case of outlying areas were the National Telephone Company able to get their wires underground, and then they frequently had to pay very heavily for the privilege. We can say, without fear of contradiction, that the policy of the Highways Committee of the London County Council, both in 1897 and in 1901, has been to get control of the telephone system. We then come to the parliamentary proceedings leading up to the Telegraph Act of 1899. Neither in committee nor in the House of Commons was there any practical attempt made to solve the awkward question as to what is to happen when the license of the Telephone Company expires in 1911. Still, the Government felt that they would be unable to insist on the National Telephone Company ceasing to give their usual service at the date the license expired, unless there were some means provided of preventing the consequent disorganisation in commercial life. The Government obviously could not force the National Telephone Company to sell in 1911, but they could have rendered the whole of the assets of the company valueless by refusing to renew the expired license. To any business man this power would have been quite sufficient to enable an arrangement to be come to at once which would have prevented any uncertainty as to the future. The most feasible suggestion, as we then said, seemed to be for the Post Office to take over the whole telephone system of the United Kingdom, as they had previously taken over the trunk wires. Instead of this, competition was authorised, with presumably two objects, the first being an improvement in telephone facilities at a cheapened rate, and the second, and less honourable one, the reduction of the value of the National Telephone Company's assets as a prelude to purchase in 1911. How successful they were in this endeavour may be judged by the same standard which Mr. Benn brought to bear on the agreement recently effected. Mr. Benn's complaint is that the Postmaster-General's action has, by raising the shares of the National Telephone Company from $3\frac{3}{4}$ to $4\frac{1}{4}$, increased the market value of the company by £295,000. This is correct, but the action of the Government in 1899 decreased the market value of these shares from $5\frac{3}{4}$ down to Mr. Benn's lower figure ($3\frac{3}{4}$). This represents the sum of £1,180,000 on the ordinary shares alone, and must be borne in mind when considering the whole question. We should be the last to say that the rates now fixed are as low as they could be if the Post Office were to start a completely new exchange in a city like London without considering the previous occupiers. Also it would have to take up the field of that rival equipped with pioneering experience, which it has cost money and time to acquire. Granted all this, the price could be reduced to perhaps below the London County Council figure, but this would not have reduced the cost of telephonic communication to commercial firms, because, as we showed last week, they would have to belong to both systems. So in view of the fact that the Government had no policy and debarred the Postmaster-General from doing what he otherwise had the opportunity of arranging—*i.e.*, buying out the company on reasonable terms—we cannot blame the Postmaster-General. He has had to face the question of paying expenses after the purchase in 1911, and has done so from an honourable business standpoint, which is naturally incomprehensible to the London County Council Highways Committee.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TRAFFIC RECEIPTS.

SIR,—I have to inform you that owing to the difficulty experienced by us in getting out our traffics early in the week in time for publication in all the technical papers, it has been decided in future to issue them on Friday morning. There will in future be no necessity for you to send a messenger round for them on Wednesday evening, as all the traffics will be sent by post.—Yours, etc.,

THE COMMITTEE FOR ASSOCIATED UNDERTAKINGS.
(W. G. Bond, Secretary.)

British Electric Traction Company, Limited, London, W.C.
Nov. 21, 1901.

[We are particularly indifferent whether we publish these traffic receipts or not; we certainly shall not publish them a "week after the fair." The British Electric Traction Company, if it thinks to support its actions and to prevent criticism by running a so-called financial and stockbroking paper of its own, is greatly in need of enlightenment. A "close ring," whether electrical or otherwise, is far too vulnerable to be safe from outside criticism, and did we not think that on the whole the work of the "British Electric" had been favourable to electrical progress, there are many details of its work that would be adversely criticised.—ED. *E. E.*]

HORSE-POWER METER.

SIR,—In alluding to the horse-power indicators which we are manufacturing, you say that, in your opinion, an ammeter would be quite as useful as a wattmeter for the purpose in view. With this we quite agree, and we may say, in fact, that for continuous-current motors we invariably instal meters of the ammeter type, graduated in horse-power at a definite voltage.

With reference to your remark that "the workman has not got used to reading the indications of wattmeters, and that reading in watts is more handy to the power station staff," we venture to say that with the rapid extension of motor driving there are many users of motors to whom the terms "watts" or "amperes" are absolutely unintelligible, whereas all have a notion of the meaning of "horse-power." This, at any rate, has been our experience.

Further, as a motor is universally rated in "horse-power," it would seem to us more rational to measure its load in horse-power also.—Yours, etc.,

EVERETT, EDGCUMBE, AND CO.

22, Charterhouse-square, E.C., Nov. 26, 1901.

THE EARTH A CHARGED BODY.

SIR,—Lecturing on terrestrial magnetism, Sir W. H. Preece is reported in your issue of Nov. 23 as using the sentence, "There are many reasons for believing that the earth is a highly charged body." To the mind of a student this provides matter for very careful thought. The old statement that the earth is a magnet is found in every text-book, and is of course accepted, but the above quoted theory I have never before seen put in so striking a manner.

May we consider this in connection with wireless telegraphy? Neglecting the magnetic nature of the earth, and presuming our globe to be highly charged to a certain density, comparable to the spherical charges experimentally demonstrated in the study of static electricity, does this not suggest another medium for the transmission of electrical waves than that of the ether?

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In order to successfully communicate a current by wire, it is necessary to keep certain points at different potential, while with the wireless it is only necessary to create a disturbance in the earth's electrical field, which is accomplished by oscillatory discharges of considerable frequency—there is no actual transference of current. The waves set up by this means in a permanent static charge of electricity present on the earth's surface, would surely radiate through that medium?

Reported failures in South African trials were said to be due to inability of electric waves to pass through hills, while, to come nearer home, the failure of wireless communication between Dover and Chatham is attributed to intervening high grounds; yet the ether is said to pervade all matter. The trials are most successful over water, which presents a clear and uninterrupted extent for radiation; also, the higher the aerial conductor, the better are the results obtained. All this would be in conformation to the theory of a residual charge of sufficient density to allow the radiation of wireless telegraphic waves.

As a student, I ask what are the reasons why the medium of static electricity should be rejected in favour of that very theoretical explanation of radiation commonly given—viz., ether—if it be accepted that "the earth is a highly charged body," and bearing in mind that the mysterious element electricity is capable of demonstration, while demonstration of the ether is, so far, impossible?—Yours, etc., H. T.

LIGHTNING CONDUCTORS.

SIR,—The indifference expressed by Mr. Hands in his first letter in regard to the earth is now modified by his admission that the earth should have the lowest resistance obtainable, but in the same paragraph he damages the value of his admission by the indifference he manifests for the use of the earth, saying that it will not constitute efficiency or non-efficiency, and his assertion that the side flash will occur whether there is good earth or not. He has no proof that it will occur. It would have been better to state that it has occurred, and may probably occur again. These random and over-positive remarks have resulted in this troublesome correspondence, that in the main may be regarded as a mere play of words, and possibly meet with your rebuke shortly.

In stating that the current left the conductor at Nottingham, I did not ignore the principle of divided currents. It was sufficient for my illustration to briefly say "the current"—namely, that portion causing the damage. My remark did not convey an idea that was untenable.

As Mr. Hands states that the earth connection plays such an unimportant part, it must be inferred that he believes the majority of lightning current results in a side flash. Possibly so, the cause for this being, in all probability, the number of unsatisfactory earths that are still in existence. The bad earths of the path were numerous, conductors were frequently terminated in a hole dug in the ground and filled with brick ends, the chippings of mortar, ashes, or apparently any waste material that would keep moderately dry by allowing water and damp to percolate through the interstices; presumably to keep the bottom of the conductor from rusting as quickly as it would otherwise do if buried in soil. In some cases the conductor terminated above the surface of the ground, presumably also to avoid rust. If these peculiar terminations were not to avoid rust, is it to be assumed that workmen at that period were influenced by the side-flash principles of inductance years before the great scientist propounded his theories; or must it be concluded that it was their ignorance as to what constituted an earth, and the purpose for which it is provided at the foot of a conductor? I maintain it was their ignorance. Mr. Hands seems satisfied that the bad earths of former times must have answered satisfactorily, simply because they were numerous and not found fault with. The side-flash theory is indisputable, but so also is the theory of a good earth, and the latter would undoubtedly prevent much of the former. The action of the current is said to be erratic (no doubt it meets with good cause for being so at times), and so, though it does not always take the path of a good earth, that is not any reason for the quality of the earth to be lightly regarded, nor should it be said, as stated by Mr, Hands, that it does not by itself constitute efficiency. Such an insinuation is misleading. There are members of our bodies that are not necessary for our existence, but they constitute our efficiency. I believe that careful attention was given to obtaining earth of the least resistance in the recent renewal of conductors at St. Paul's Cathedral, and that it did not appear to be a matter of secondary importance in the estimation of the engineer. That job may unquestionably be regarded as the best piece of conductor work of the present time.

In regard to Mr. Hands claiming the privilege to criticise, I may say that useless criticism has no good object; it benefits no one, and his remarks in that direction on bends and the replies given to you by "E. M." and "J. C. R.," were of this nature. Those replies had met with your approval; therefore it was bad taste on the part of Mr. Hands to say that he considered them very unsatisfactory.

The concluding paragraph of the last letter by Mr. Hands may be regarded as a withdrawal of his previous statement—that inductance need not be taken into account

Although Mr. Hands sneers about the Nottingham case being cited because it occurred as far back as 1868, he fails to mention one equally interesting of more recent date. Thirty odd years ago is not long for a remarkable incident to be referred to or called to mind. I can well remember the routine of my occupation, that contained no remarkable incident, as far back as that, and even eight or ten years earlier.—Yours, etc., W. DALBY.

187, Ombersley-road, Birmingham, Nov. 25, 1901.

E.E. (R.E.) VOLUNTEERS.

SIR,—It may interest those of your readers who have so liberally subscribed to the fund for sending presents to the Electrical Engineers in South Africa to know that, as a first consignment, a parcel has been sent by post to every man, containing plum pudding, chocolate, tea, plums, a pipe and tobacco, which should reach them by Christmas. With the balance of the fund collected further stores will be purchased and forwarded with the fourth detachment, who are shortly leaving for the front.—Yours, etc.,

A. H. POTTS, Capt. E E.(R.E.)V.

Regency-street, Westminster, Nov. 26.

REVIEWS.

The Indicator Diagram: Its Analysis and Calculation. (Indicator Handbook, Part II.). A practical manual for engineers. By CHARLES N. PICKWORTH, Wh.Sch., editor of the *Mechanical World*, author of "The Indicator: Its Construction and Application," "The Slide Rule," etc.

This is the second and concluding part of "The Indicator: Its Construction and Application," published by Emmott and Co. and Whittaker and Co.; and also C. N. Pickworth (Fallowfield), John Nostrand Company (New York), and G. Robertson and Son (Melbourne), and constitutes an entirely new and thoroughly practical treatise on the indicator. The analysis of the indicator diagram is undertaken in a systematic and thorough manner, special consideration being given to the interpretation of the defects in steam distribution as revealed by the indicator card. The gas-engine diagram is examined in far greater detail than heretofore attempted, while due attention is given to diagrams from air-compressors, water and air pumps, ammonia compression machines, etc. The calculation of the diagram and the best methods and instruments used in connection therewith are also fully described and illustrated. The contents are divided under the following headings: (1) preliminary considerations and definitions; (2) the diagram in detail; (3) diagram analysis; (4) diagrams from compound engines; (5) diagrams from gas and oil engines; (6) diagrams from air compressors, pumps, etc.; and (7) diagram calculations.

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THE LONDON TELEPHONES.

In our last week's issue we published the tariff which has been adopted by both the Postmaster-General and the National Telephone Company for the London area. We then suggested in our leader that the signed agreement between these two parties was sure to contain other clauses which would be of interest to the public, and which would seriously affect any opinion expressed as to the so-called competition, when only one part of that agreement had been made known. On Tuesday last the National Telephone Company published the following further particulars of this agreement, which is said to be based on the principle of co-operation in the public interest. The statement reads:

The agreement which has been concluded between the Postmaster-General and the National Telephone Company, besides fixing rates to be charged equally by the Postmaster-General and the company, provides:

(*a*) For the purchase of the company's plant in London on the expiration of the license in 1911;

(*b*) For full and free intercommunication between the two systems, and for the company's subscribers having all facilities which may be afforded to the Post Office subscribers, and on the same terms.

It also contains provisions under which the company will be able to obtain the use of underground wires in the London area upon reasonable terms.

The real and underlying principle of the agreement seems to be that for the future there is to be mutual co-operation between the Post Office and the company in the development of the telephone system in London so as to make it as convenient as possible for the subscribers to both systems, and to confine the competition between the Post Office and the company to the efficiency of the service and the convenience of the public. In other words, it will be "competition" as regards quality of service, and "co-operation" as regards working arrangements.

The National Telephone Company add that the protracted and difficult negotiations which resulted in the above agreement were carried on by the president of the company, assisted by Mr. Gaine, the general manager. We also learn that Mr. J. Staats Forbes, having now brought the National Telephone Company's affairs into a satisfactory state, desires to be relieved from the responsible position of chairman of the company. Sir Henry Fowler, the vice-president, is to take his place, and Mr. George Franklin becomes the new vice-president.

The above agreement, of which even now more details should be known before any just opinion can be passed, has been severely criticised by the daily Press. The London County Council at their meeting on Tuesday had to consider a report on the same by the Highways Committee, which was introduced by Mr. J. W. Benn. The details of this report are not unlike in some respects those given by the same gentleman before the City Liberal Club on Monday last, and which are given in abstract in our front notes. In the Highways Committee's report, however, more particulars are given of the negotiations between the London County Council and the National Telephone Company respecting the laying of underground wires. These particulars show that the London County Council sought to obtain an annual rent for the wires placed underground, and also that the National Telephone should reduce its charges to £12 per annum for unlimited use on a five-year agreement, £10 per annum for a second instrument, and £8 per annum for private house connections. These rates are what the London County Council engineer reported would pay expenses if an independent system of telephone were laid down by the Council. After further negotiations, the Council reluctantly decided that they should leave the wayleave fees in the hands of the local authorities, but as they would not give way on the reduction question the negotiations fell through. The report goes on to give the history of the subsequent action on the part of the Government which led up to the Telegraph Act of 1899. The report ends with the resolution that a copy of the same should be sent to the Postmaster-General, expressing the regret of the Council that the scheme of the Post Office telephone system for London does not establish real and effective competition, as recommended in the report of the Select Committee of 1898, and does not secure to the public the advantages which they had been led to expect. In the discussion at the Council the question stood adjourned, but Mr. Benn expressed his committee's willingness to take over the Post Office system at cost price, and to work the London telephones at the same rate as those charged in the provinces. With the agreement between the Postmaster-General and the National Telephone Company signed and sealed, Mr. Benn might as well have offered to take over the exchanges of the National Telephone Company at cost price, as the offer does not in any case enter into practical politics.

EDINBURGH ELECTRICITY ACCOUNTS.

The accounts of the Edinburgh electric lighting station for 1900-01 have just come to hand, from which it appears that the total amount expended on capital account to date has been £707,036. We give herewith abstracts of the revenue account, abstract of general balance-sheet, and statement of electricity generated, sold, etc.:

Revenue Account.

Dr.		£ s. d.
Generation of Electricity.		
Coal and other fuel	£17,658 18 10	
Oil, waste, water, stores, etc.	1,293 1 2	
Salaries of engineers	1,164 7 0	
Wages at station	3,283 4 9	
Repairs and maintenance—Buildings...	443 0 6	
Machinery and plant	2,697 7 8	
Instruments	12 2 2	
		26,552 2 1
Distribution of Electricity.		
Salaries of engineers	177 10 0	
Wages	962 3 3	
Repairs, etc., of mains and cables	770 3 8	
Repairs and maintenance of meters	345 11 5	
		2,255 8 4
Public Lamps.		
Wages	2,287 4 11	
Carbons	997 19 4	
Repairs	1,182 11 8	
		4,467 15 11
Rents, Rates, and Taxes.		
Rents	11 14 6	
Feu duties of stations	380 19 3	
Rates and taxes and insurance	4,914 3 1	
		5,306 16 10
Expenses of Management.		
Salaries of engineers	316 14 10	
General establishment charges	1,080 6 5	
Stationery and printing	237 10 7	
Proportion of management expenses	2,309 6 3	
		3,943 18 1
Miscellaneous expenses		1,062 7 10
		43,588 9 1
Surplus carried to net revenue account		35,788 3 1
		£79,376 12 2

Cr.	£ s. d.
Sale of current per meter—at 3½d. per unit	62,762 6 3
Motor power—at 1½d. per unit	6,102 4 2
	68,864 10 5
Arc lamps—public and private lighting	10,243 7 7
Meter rents	23 16 8
Rents of properties in Torphichen-street	218 0 0
Miscellaneous receipts	26 17 6
	79,376 12 2

Balance-Sheet.

Dr. Liabilities.	£ s. d.
Bank balance	24,575 7 1
Sundry creditors for outstanding accounts	34 8 6
Deposits by consumers	33 0 0
Reserve fund	18,700 12 7
Surplus	65,824 2 3
	£109,167 10 5

Cr. Assets.	£ s. d.
Balance at debit of capital account	65,824 2 3
Stores on hand	2,389 1 1
Sundry debtors for outstanding revenues	19,563 14 3
Reserve fund investment	18,700 12 7
Balance of net revenue account	2,690 0 3
	£109,167 10 5

Statement of Electricity Generated, Sold, etc.

Quantity generated (B.T.U.)			7,565,674
Quantity sold	Private lighting	4,484,572	6,707,936
	Motive power	996,850	
	Arc lamps	1,226,514	
Quantity used in stations			493,853
Quantity unaccounted for			363,885

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

433. A large current is required at about 30 volts. The corporation supply is at 220 volts. Taking into account prime cost, upkeep, attendance, etc., would it be more economical to drive the dynamo (producing the 30 volts) by a motor taking current from the 220-volt mains than to drive it direct by a gas or oil engine?—T. T.

434. How is the Hopkinson test for determining the efficiency of dynamos usually carried out, and how nearly do the test conditions represent service conditions?—E. G. B.

ANSWERS.

Question No. 427.—I am trying to demagnetise watches with a coil 3½in. in diameter, through which an alternating current is passed. The current is taken from a 100-volt circuit, but is reduced by a resistance coil to 10 volts. The result is not satisfactory. Can anyone explain why; and also how to test a watch to prove that it has been demagnetised?

Answer to No. 427 (*awarded 7s. 6d.*).—The coil you are using is evidently not strong enough—*i.e.*, the ampere-turns are not sufficient to produce a magnetic field of the requisite strength. From the data given—viz., that the coil is 3½in. in diameter, and has 10 volts across its terminals—it is impossible to say whether the coil is suitable for the purpose or not. A coil made approximately to the following dimensions will be found to answer the purpose. Inside diameter 4in., number of turns 40, size of wire about 0·1in. in diameter (d.c.c.). Wind a circular coil with rectangular section, having four layers with 10 turns per layer. Bind the whole with tape to keep the wires together. This coil, with an alternating current of about 10 amperes (at any frequency) flowing in it, will be sufficient to demagnetise watches.

In using the coil, one may proceed in either of two ways. If the operator can control the speed of the alternator supplying current, do as follows: Adjust the current to, say, 10 amperes with the alternator at full speed. Place the watch in the coil and then cut off the driving power from the alternator, allowing the latter to gradually come to rest. During this process the watch should be continually turned about through all positions in the coil. The maximum current used should not be more than that required to make the hairspring "buzz" when the watch is in the coil. Less than 10 amperes may suffice for this. In the case of a constant supply where frequency cannot be varied, the current in the coil should be reduced slowly by a resistance to zero, whilst the watch is turned about in the coil. Or the watch may be slowly withdrawn from the coil to a distance while being turned about, the current being kept at full strength.

There are other methods of demagnetising by spinning the watch over the poles of a magnet or *vice versâ*, but the coil method is the best. To test a watch for demagnetisation, there is nothing like wearing it and noting its time-keeping properties, or testing its rate in different positions. If its rate is regular, it is certain that there is not much magnetisation left. A small compass placed near the watch may be used, but the method is not very reliable or delicate.—R. C.

Answer to No. 427 (*awarded 7s. 6d.*).—I fear few could explain exactly why "E. L. G." has failed in his attempts to demagnetise watches from the description he gives of his apparatus and methods. On seeing the question it struck me that where he has gone wrong is in supposing that volts produce magnetism in a coil, for he does not describe the 3½in. coil in any way, nor does he give its resistance. Possibly the coil is wrongly shaped for the purpose, and possibly its resistance is far too high. However, an explanation of what has been used by the writer with every success will probably be the most helpful way of getting "E. L. G." out of his difficulty. A wood bobbin 4in. long, with 6½in. flanges and a 2½in. bore, is wound full of No. 16 double cotton-covered copper wire carefully dried and varnished in the usual way. The two ends of this coil are both brought out through one end of the bobbin and secured to terminals fixed to the flange. The coil is connected in series with a switch, an adjustable resistance, and a low-reading ammeter, and the whole connected to the source of alternate-current supply. The bobbin is placed terminal end upwards, and the watch to be demagnetised hung in its interior so as to be midway between top and bottom. The switch is now closed, and the resistance adjusted so that only about one-twentieth of an ampere flows through the coil at first.

The resistance is then very gradually removed until about six amperes is being passed, and then as gradually inserted until the starting point is reached once more, when the switch is opened, and the watch restored to its field of usefulness. The proof of a pudding is in the eating, and the proof of the demagnetisation of a watch in its good time-keeping behaviour, but it will usually be found that a magnetised watch will strongly deflect a compass needle, and if "E. L. G." will get a light one and suspend it by a silk thread 6in. long, he will have an excellent magnetism detector. Indeed, he may compare the relative magnetic intensities of his watches by placing one after another on a certain spot near his needle, and noting to what extent each deflects it.—GRAFTON.

Answer to No. 427 (*awarded 5s.*).—The demagnetisation of watches is a matter of great ease if you have at hand the proper appliances. I think that in "E. L. G.'s" case his failure is due to too weak a magnetic field in his coil, which might be caused by not enough volts across coil, short-circuit in coil, or an open circuit in the coil. If "E. L. G." will put a fuse in circuit with his coil of such a size that it will fuse before hurting the coil, and then gradually reduce his resistance, he will be able to tell by means of a key when he has strong enough field, if the coil has no short-circuit in it (which in this case may be the fault), and then there would be no field, or practical field, in the coil, depending, of course, on the nature of the short. If there is a short in the coil it will soon show itself, either by blowing fuse or burning out the coil. Although good results may be obtained by this method, an apparatus made like Fig. 1 will generally be found to give the best results,

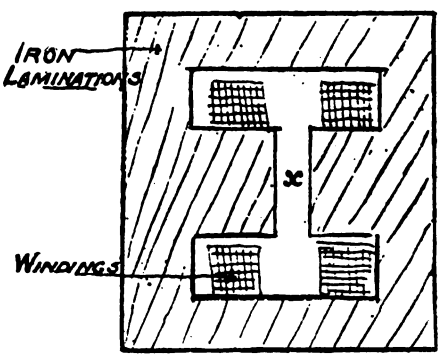

FIG. 1.

its chief advantage being "higher efficiency and more intense field at the point needed." Care must be taken not to leave the watch in the coil too long, or else it would soon get hot, due to eddy currents set up in its case and works. The watch being placed at *x* for two or three seconds and this repeated once or twice, and very rarely have I had a watch brought back again when cured by this method. To test a watch to prove that it is right is to

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compare its time-keeping qualities before and after the curing process.—A. R. C.

Question No. 428.—Describe exactly why a six-phase rotary converter should have an output about 30 per cent. greater than a three-phase one.

Best Answer to No. 428 (*awarded* 10*s.*).—We will first consider what happens in a single-phase rotary converter. If we require 100 volts at the continuous current side, it is necessary to feed the alternating side with current at a pressure of 70·7 virtual volts—that is, assuming the alternating currents follow a sine function; there would be two connections made on the armature differing from each other by 180deg., which two ends are connected to two slip rings. When the rotary is running there is a tendency to increase and decrease the speed once in every revolution due to the motoring and generating currents. The maximum motoring current is always in excess of the maximum generating currents due to hysteresis, friction, and other losses, even when the power factor is practically unity. It is a well-known fact that the wires which lie next to the connections of the slip rings always heat more than those which lie midway between these connections by a matter of 45 per cent. between the maximum and minimum temperatures. The output of the single-phase rotary is about 85 per cent. of the same size machine when used as a continuous-current generator. When connecting rotary windings at four different points differing from one another by 90deg., and connecting these to four slip rings, we get a two-phase rotary converter, which has an increased output over the single-phase converter for the same heating of about 35 per cent. while the difference between the maximum and minimum heating of the windings do not vary more than about 30 per cent. This increased output is partly due to the absence of armature reaction. The direct current flowing out seems to partly neutralise the effects of the armature reaction, due to the alternating current being fed into the rotary; also at certain positions of the armature the current will flow direct from the slip rings to the commutator.

On tapping the rotary at three equal points, differing from one another by 180deg., and connecting these three ends to three slip rings, we get a three-phase rotary, the output being 30 per cent. greater than a single-phase rotary of the same size for the same mean heating; the difference between the maximum and minimum heating of the windings being about 35 per cent. The output can still further be increased by tapping the rotary at six different points, differing from each other by 60deg., connecting these to six slip rings. The increased output by these connections is about 20 per cent. over that of the three-phase for the same mean heating, while the difference between the maximum and minimum temperatures does not exceed 22 per cent. in a well-designed rotary when working with a power factor of practical unity. The rotary would have a still further increased output when being used as an eight-phase or twelve-phase machine, the output being only limited by the internal heating, but the increased cost and complication of connections does not warrant this in actual practice.

Another advantage attained by using a six-phase rotary besides the increased output is that the several connections to the slip rings act as "equalisers," thereby improving the commutation at all loads.—JUNO.

Dearth of Electricians.—We understand from *Indian Engineering* that there is a great scarcity of trained electrical engineers in India at the present time, and it is to be assumed that to this cause is chiefly attributable the little progress made with electricity in that country. The paragraph in our contemporary to which we refer reads as follows: "The Dewan of Mysore (the Honourable Mr. Krishna Murti) in the able exposition of his policy made the other day to the Mysore Assembly, referred to the Cauvery Fall power scheme and enumerated all the appliances that had been collected. So far so good. But what about trained electricians to work them? These are conspicuous by their absence, and, as we have always maintained, the scheme for this reason will prove an expensive white elephant to the Mysore Government."

NEW COMPANIES REGISTERED.

American Electrical Novelty and Manufacturing Company, Limited.—Capital, £3,000. Objects: to acquire the business carried on at 102, Charing Cross-road, W.C., by the American Electrical Novelty and Manufacturing Company, to carry on the business of electricians, toy and fancy goods manufacturers, electrical engineers, etc.

Broadhurst and Co., Limited.—Capital, £10,000. Objects: to acquire the business carried on by James Robinson and William D. Waddell as Broadhurst and Co., and to carry on the business of manufacturers of indiarubber, indiarubber goods, waterproofs, leather goods, and electric cables, etc.

Heatly-Gresham Engineering Company, Limited.—Capital, £20,000. Objects: to acquire the business carried on by H. Heatly at Bassingbourn, Cambs, as the Bassingbourn Ironworks, and to carry on the business of mechanical and electrical engineers.

Hunting and Co. (Felling-on-Tyne), Limited.—Capital, £5,000. Objects: to acquire the business of woodworking machinery engineers as now carried on by Hunting and Co. at the Alexandra Works, Felling-on-Tyne, and generally to carry on business as ironfounders, machine and engineering toolmakers, mechanical, sanitary, and electrical engineers, etc.

Yorkshire (Woollen District) Electric Tramways.—Capital, £300,000. Objects: to carry on in the United Kingdom and elsewhere the business of carriers of passengers and goods, electrical engineers, electricians, engineers, contractors, manufacturers of and dealers in railway, tramway, electric, magnetic, galvanic, and other apparatus, mechanical and chemical engineers, etc.

Benfleet Electric Light and Engineering Company, Limited. Capital, £5,000. Objects: to adopt an agreement with D. Paisley and D. Varty to supply the parishes of South Benfleet, Thundersley, Canvey Island, Hadleigh, Bowers, Gifford, Pitsea, Vange, North Benfleet, and Rayleigh, or any of them with electricity or gas, and to carry on the business of electrical and general engineers, gas-makers, etc.

J. G. McLean, Limited.—Capital, £1,000. Objects: to manufacture and sell motors, cycles, hydraulic and pneumatic appliances, pumps, compressors, etc., to acquire patents, and to carry on the business of mechanical and electrical engineers, etc.

Grant's Drill and Trolley Company, Limited.—Capital, £7,000. Objects: to adopt an agreement made between R. G. Grant, P. C. Pope, and J. F. Simpson of the one part, and this company of the other part, for the acquisition of any patents relating to improvements in boring drills or of holding or driving the same, and in the manufacture of electric tramway equipment, etc.

Werner Motors, Limited.—Capital, £5,000. Objects: to acquire an invention relating to motor cycles, etc.

NEW COMMITTEES.

The following new committees have been selected:

ABERDEEN.—*Tramways*: Councillor Wilkie, convener; Bailies Maitland, Taggart, and Meff; Dean of Guild Walker; Treasurer Bisset; Councillors W. Coutts, G. Brown, Jonston, Kemp, Lyon, and Taylor. *Watching, Lighting, and Fires*: Councillor Lyon, convener; Bailies Maitland and Middleton; Councillors Boddie, Booth, John Brown, J. Coutts, W. Coutts, Milne, Sinclair, and Skinner.

ANNAN.—*Lighting*: Mr. D. A. Bond, convener; Bailie Crail, vice-convener; Treasurer Caldwell; Messrs. Gilbertson, I. Rae, Shankland, and Bonner (or successor).

BARNSTAPLE.—*Electric Lighting*: Aldermen Young, and Hamling; Councillors Hopper, Andrew, T. R. Seldon, Sloman, Youings, Arnold, Reavell, and Cooke, with the Mayor as chairman.

BATTERSEA.—*Lighting*: Mr. J. Oswald, chairman.

BURY.—*Tramways*: Aldermen Parks and Barrett; Councillors Ashworth, Duxbury, Howarth, Fletcher, Hewart, Sykes, Hill, and Spencer.

RAWTENSTALL.—*Electric Light*: Chairman, the Mayor; vice-chairman, Alderman Compston.

APPOINTMENTS VACANT.

Clerk of Works, Hornsey Urban District Council electricity works, £250 per annum, Dec. 2. Full particulars in our advertisement columns.

General Manager and Traffic Superintendent, Southend-on-Sea Corporation electricity tramways, £150 per annum, Dec. 2. Full particulars in our advertisement columns.

Resident Electrical Engineer, Rhyl Urban District Council, £150 per annum, Dec. 5. Full particulars in our advertisement columns.

Junior Assistant, with mechanical and electrical training, £65 per annum. Full particulars in our advertisement columns.

Draughtsman for designing high-class switchboards. Full particulars in our advertisement columns.

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TRADE NOTICES AND NOVELTIES.

Single-Phase Electric Crane.

In the accompanying illustration is shown what may be described as a new departure in electric cranes, so far, at least, as this country is concerned. The crane, which it will be seen is of the jib type, is designed to lift one ton at a radius of 25ft., and has been working with satisfactory results at Messrs. Sankey and Co.'s wharf, Hammersmith, for some months past. The claim which the crane has to novelty consists in that it is worked by a single-phase electric motor, power for which is obtained from the mains of the Hammersmith Borough Council. The periodicity of the supply is 50, and the pressure at the motor terminals 200 volts. It is well known that the difficulty attending the use of single-phase currents for crane purposes is connected with the necessity hitherto experienced of starting up on load. In the case under notice, this difficulty is surmounted by employing Hollick's patent friction gear in conjunction with a single-phase motor of the Langdon-Davies type. The combination, which is also illustrated herewith, owes its introduction to Messrs. Wimshurst, Hollick, and Co., Limited. The exceeding compactness of the combination is apparent. The object of the gear is to reduce the speed of the electric motor without undue loss of power, noise, or wear, and to form a starting and stopping gear, so that when the motor is running at full speed the load may be started gently and without the usual rise in current above that required to lift the load. No resistance or controllers are used in working the crane, and it requires no more power to start than to lift full load. Moreover, the motor base is made to oscillate, so that the friction pulley, which is of paper, adjusts itself to bear equally against the two iron pulleys shown in the illustration. The design of the gear makes it impossible to damage the motor should the crane be overloaded, in which case the gear simply slips. Hollick's gear is too well known in its other useful applications to call

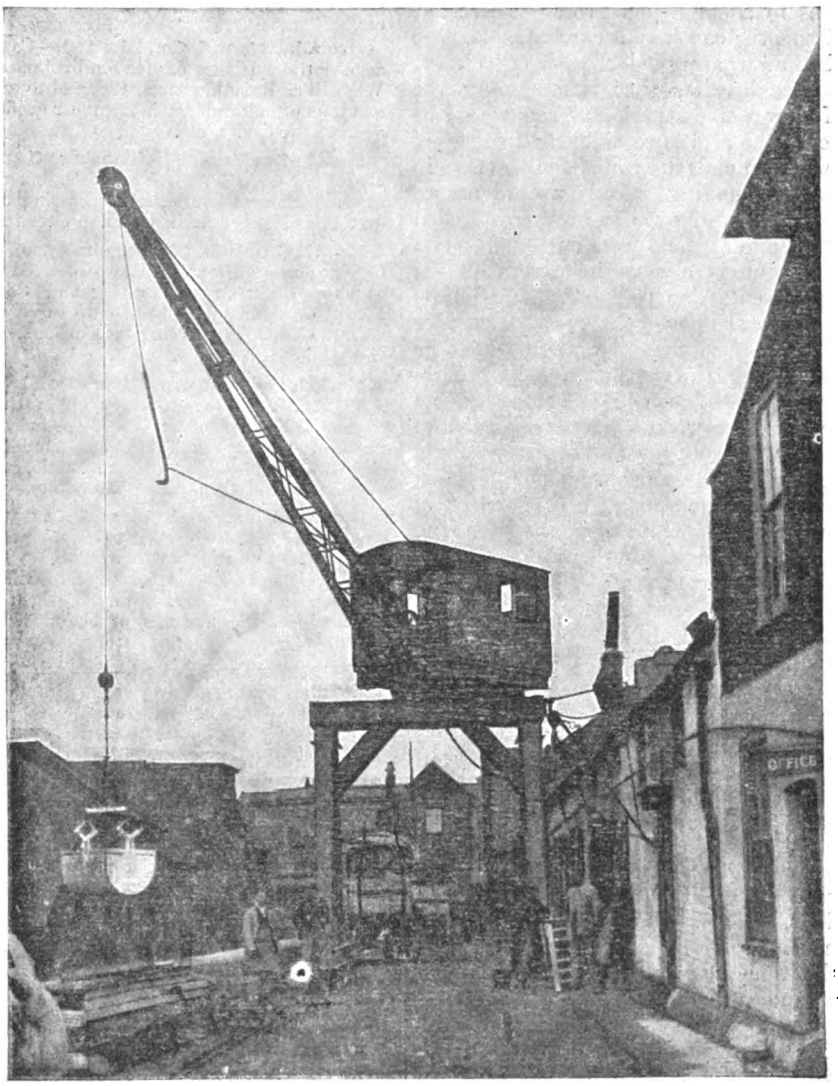

FIG. 1.—Single-Phase Electric Jib Crane.

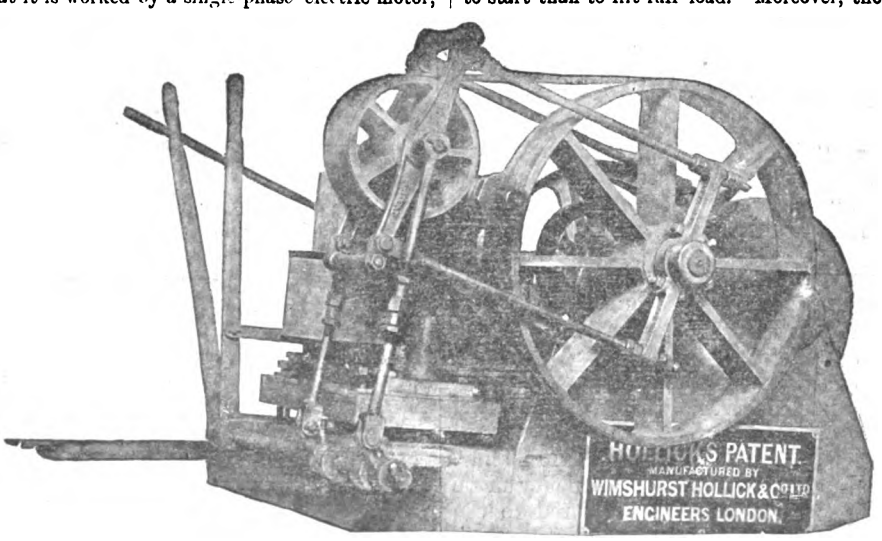

FIG. 2.—Combination of Langdon-Davies Single-Phase Motor with Hollick's Gear.

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for a detailed description here, but its combination with a single-phase electric motor for crane purposes is certainly a departure which merits commendation. The enterprise of the above-named firm in making the departure should have its reward in a large field of usefulness for single-phase electric cranes required for constant-speed working

Testing Keys.

The testing keys herewith illustrated are of the Rymer-Jones type, manufactured by the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, of Silvertown. Fig. 1 shows a discharge

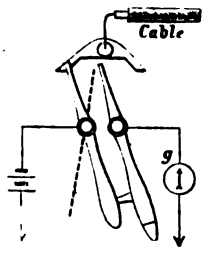


FIG. 1.

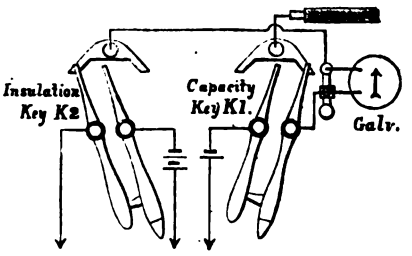


FIG. 2.

key for measuring electrostatic charges, used also as a well-insulated two-way switch. In the figure both handles are shown to the right—viz., in position for charging the cable or condenser. When the left handle is moved to the position of the dotted line, the cable, or condenser, is free for a loss of charge test, and leakage over the apparatus is restricted to its well-insulated support. Switching over the right handle to the left carries with it the left handle also (if not already over), breaks the battery contact, and discharges the cable, or condenser, through the galvanometer, *g*. In the testing-rooms two of these keys are connected, as in Fig. 2, to admit of both capacity and insulation tests being made without changing the key connections.

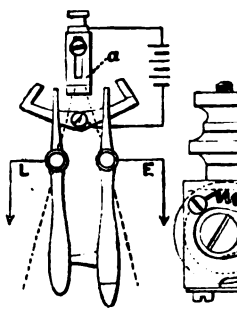


FIG. 3.

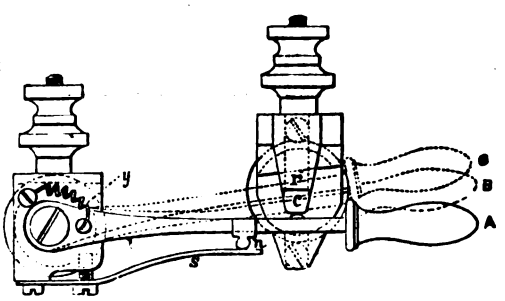


FIG. 4.

The handles are shown in normal positions. For capacity test both handles of K_1 are placed hard over to the right to charge, and to the left to discharge, while for insulation test, both handles of K_2 are placed hard over to the left for insulation readings, and to the right for earth readings. Fig. 3 shows a reversing key for battery or galvanometer. In the figure it is arranged as a battery reverser. As a galvanometer reverser, the galvanometer, of course, takes the place of the battery. The dotted lines indicate the normal positions of the handles. Both handles placed over to the right gives + to line and - to earth, while both handles to right gives – to line and + to earth. Contact "a" is made with a slot, so that when its clamping screw is slackened it can be withdrawn out of the reach of the contact arms, and this key may then be used as a discharge key, or two-way switch, like Fig. 1, if desired. Figs. 4 and 5 illustrate an improved form of key for short-circuiting the galvanometer. It is claimed that, while retaining the important principle of the "tapper," this key has the advantage of a broad and firm rubbing contact for checking the instrument zero. Being always kept clean by friction, it

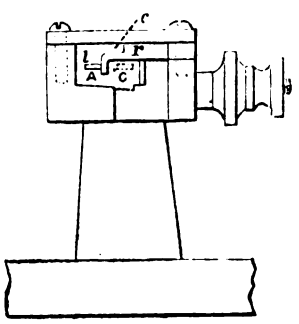


FIG. 5.

effectually short-circuits the galvanometer, and prevents the deviation not infrequently noticeable with the ordinary short-circuit key, having only small platinum contact studs pressed together by a not very strong spring, and therefore requiring frequent cleaning to reduce the contact resistance. In the position for observing insulation and earth readings, no trigger, cam, or other detent is employed to keep the short-circuit key open; thus an important point for leakage over the key in damp weather or at sea, is done away with. When used as a tapper, A is the position of the key lever, *l*. For insulation or earth readings, *l* is moved to position C. To check the zero, *l* is raised by the handle above *r*, and rubs firmly on *c* (see Fig. 4). Perfect metallic connection between lever, *l*, and its terminal is secured by a spiral wire, *y*, and also by the rubbing contact between springs and vertical pin, *n*. This permits the lever bearing, well lubricated, to move quite freely.

It may be mentioned that all the keys described have spiral wires to ensure perfect metallic connection between the contact arms and their terminals, so that the bearings may be well lubricated to secure free movement. Friction between the rubbing contact surfaces keeps them clean, and as one is of gold and the other of platinum, there is no tearing action.

Connectors for Electrical Testing.

Figs. 6 and 7 illustrate patent connectors for electrical testing, also introduced by the India Rubber, Gutta Percha, and Telegraph Works

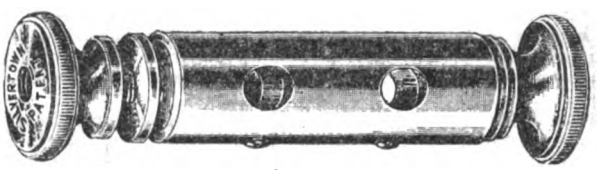


FIG. 6.

Company, Limited. These connectors are adjustable within wide limits, and can therefore connect two large conductors or a large one with a small one; or two or more small wires may be secured in the same slide hole without the risk of one being loose. The slide contacts encircle the wires and give a broad and tight grip, ensuring perfect

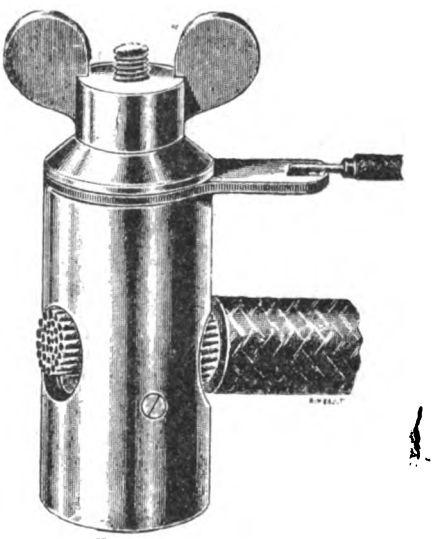
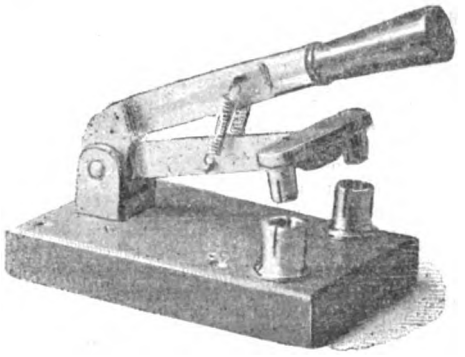


FIG. 7.

contact. With a large conductor in each slide contact, other small wires, to the testing apparatus, may be hooked on to one or other of the slide spindles, between the nut and its washer. These nuts are practically two single terminals, and may be employed for connecting very small wires which might be damaged if clamped by the slides.

A New Plug Switch.

The accompanying illustration shows a new type of switch patented in the name of Broadbent and Brooke, and manufactured by Mr. T. W. Broadbent, of the Victoria Electrical Works, Huddersfield. An



A New Switch.

improved method of making contact is claimed for the switch. The plugs on the cross-bar are slit across, so that when contact is made by closing the switch the plugs are forced into sockets in place of the usual sliding contacts. The sockets are slit across in four places, so that the plugs (which are slightly taper) expand the sockets at the top half. The lever and double spring method for ensuring a very quick break is employed, while the question of renewing working parts has also been kept well in mind in designing this switch. The switch, as shown, is for 100 amperes. They are made for 50 to 500 amperes, single or double pole, change-over, etc.

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PHYSICAL SOCIETY.

At the ordinary meeting held Nov. 22, Prof. S. P. Thompson, president, in the chair,

Prof. W. Cassie read a paper on **"Multiple Transmission Fixed-Arm Spectroscopes."** The simplest form of spectroscope shown consisted of two half prisms silvered on the back, between which a beam of light goes backwards and forwards with a slight upward inclination. The result in dispersing and resolving power is equivalent to direct transmission through a long train of prisms. The collimator and observing telescope are fixed, and adjustment is made by a double tangent screw, which moves both the prisms. Two other types constructed on a similar principle were described, of which one had one prism and two speculum mirrors and the other had two refracting prisms and a reflecting right-angled prism. The adjustments of these instruments are simple and their power great. By a small movement of an adjusting screw the observer can produce great changes of dispersion by passing from one to another of the series of spectra which are produced.

Prof. J. Perry asked if the third form of spectroscope, in which there is total internal reflection, had been tried experimentally. The amount of light lost at total internal reflection was much less than at reflection from mirrors, and he had found that the chief difficulty in using multiple reflections from mirrors was the great absorption of light.

Mr. T. H. Blakesley asked if there was any confusion due to overlapping of the spectra.

Mr. R. T. Glazebrook said he would like to know whether the author had any measure of the relative brightness of the first and last spectra.

Mr. W. F. Stanley said that by using three prisms instead of two it would be possible to substitute, in the first form of spectroscope, total internal reflection for normal reflection at a silvered surface.

The **Chairman** suggested a possible way of improving the third arrangement by using two prisms with their apices outwards, refracting at both faces but not in the position of minimum deviation. Twenty-five years ago the present Astronomer Royal suggested the use of half-prism spectroscopes, and although they were often described in books they were seldom actually used. The advantage of using total internal reflection was well known, and was exemplified in binoculars, in some of which there were eight reflections from the object glass to the eye-piece. He congratulated the author upon the mechanical arrangements used in his spectroscopes.

Prof. Cassie said there was no confusion of spectra due to overlapping. With an ordinary Bunsen burner sodium flame a series of about five spectra were easily observed with dispersion equivalent to direct transmission through 10 full-sized prisms. The loss of light at the reflections limited the number of transmissions that could be used, but he believed that no other spectroscope with only two prisms would give dispersing power and resolving power in any way approaching the instrument described.

Prof. W. Cassie then read a paper on **"The Measurement of Young's Modulus."** The apparatus described consisted of a horizontal needle (a bar of large moment of inertia) supported by a bifilar suspension made of the wire of which the stretch modulus is to be measured. The periods of the pitching, rolling, and bifilar oscillations of this system are observed, and an expression for the stretch modulus is obtained which involves no measurements except the weight of the needle and the periods of the oscillations. The necessary adjustments, and the means of eliminating residual errors of adjustment, were described for two forms of the apparatus. One form also affords a simple means of statical measurement by hanging a small weight on the needle at measured distances from the centre, calculating the difference of tension produced in the wires, and observing with a mirror and scale the consequent dip of the needle.

Dr. Chree said that it would be possible to get a check on the theory by placing the movable weights at various positions on the needle and observing the times of swing for pitching and bifilar vibrations. The ratio of the squares of these times should remain constant. It was difficult to say exactly what the apparatus measured, and he would like to see numerical results before expressing an opinion upon it.

Prof. J. Perry said it would have been interesting to have had results from the apparatus, so that they could be compared with those obtained by other methods. In the bifilar vibration there was a small twist in the wires, on account of which the torsional rigidity of the material affected the time of swing. He drew attention to the necessity of having the tensions in the two wires equal.

Mr. R. T. Glazebrook, referring to the arrangement for clamping the bifilar at the top, pointed out that a small slip would modify the whole of the theory. An advantage of the apparatus lay in the fact that the wires used were shorter than those necessary in other methods. It was an interesting and ingenious application of theory to the methods of measuring Young's modulus.

Mr. Whipple asked how the rolling and bifilar vibrations were experimentally separated?

Mr. A. Campbell suggested that the difficulty of equality of tensions in the wires could be reduced by using longer wires a greater distance apart.

Prof. H. L. Callendar said he had found that the torsional effect in a bifilar vibration was negligible, and that the flexure effect was not important. The absolute rigidity of the fastening at the top was the greatest difficulty.

Prof. Cassie said his object had been rather to describe and exhibit the apparatus than give numerical results, although he had obtained numbers agreeing with those got by other methods. The mirrors for observing the vibrations were so placed upon the apparatus that each one was affected only by the particular vibration which it was designed to measure.—The society adjourned until Dec. 13.

LEGAL INTELLIGENCE.

THE CROYDON TRAMWAYS.

The Court of Appeal, consisting of the Master of the Rolls and Lords Justices Stirling and Matthew, on Tuesday gave judgment in the case of the British Electric Traction Company *v.* the Commissioners of Inland Revenue, which came before the Court on appeal from the decision of Mr. Justice Kennedy in favour of the traction company. The short facts of the case were that the Corporation of Croydon, by an indenture dated Jan. 24, 1900, demised to the British Electric Traction Company the right to use certain tramways at a yearly rental of £3,250. The indenture also provided that the company should pay to the Corporation as from the date of the Board of Trade certificate authorising electric traction £100 per mile per annum, making in all the sum of £900, in lieu of maintaining the roads, and should purchase all electric energy from the Corporation as and from that date at the rate of 2d. per unit, the minimum sum payable in any year being £4,000. The question was with what stamp duty the indenture should be charged. The case came before a Divisional Court, the members of which were divided in opinion, Mr. Justice Kennedy holding that the sums of £900 and £4,000 did not represent rent, and, therefore, the contention of the company was well founded that those sums were exempt from the payment of duty in addition to that charged on the lease. Mr. Justice Phillimore thought otherwise, being of opinion that both sums represented rent, and ought, therefore, to be taken in consideration in assessing the *ad valorem* duty with which the instrument was chargeable as a "lease or tack." Judgment was entered in accordance with the decision of the senior judge, hence this appeal of the Commissioners.

In giving judgment the **Master of the Rolls** said the conclusion he had come to was that the contention of the Crown that the rent should include the £900 for the purpose of assessing the stamp duty was right, and, therefore, on that question the Crown succeeded in the appeal. He thought, however, that Mr. Justice Kennedy's judgment ought to be supported in excluding from duty the £4,000, and on that point the present appeal failed.

The **Lords Justices** concurred, and judgment was entered accordingly. No order made as to costs.

AN ELMORE PATENT CASE.

The case of the English Electro-Metallurgical Company, Limited, *v.* Glasdeur Copper Mines, Limited, was heard before Mr. Justice Joyce in the Chancery Division on the 22nd inst.

Mr. Dibden, K.C. (who appeared with Mr. Stokes for the plaintiffs), explained that his clients moved that a Mr. Nicholson, who had been appointed receiver in a debenture-holders' action, should be restrained from using, exercising, or putting in practice Elmore's patent for the treatment of mine refuse. On Jan. 23, 1899, a license from the patentee to the company was executed, containing a covenant that the company would not, without the consent in writing of the plaintiffs, assign, mortgage, or grant sub-licenses, but that such consent should not be arbitrarily withheld. The license was worked under Elmore's own superintendence, and he was the principal shareholder in the company. On Nov. 8 it came to his knowledge that Mr. Nicholson was proposing to work under the license, and Mr. Elmore's solicitors wrote him advising him not to do so. On the 9th a reply came saying Mr. Nicholson was considering the matter, and asking plaintiff not to take proceedings. On the 11th the defendants began to work under the license. The point was whether the receiver and manager appointed on behalf of the debenture holders could work a license granted to the company, such license being granted before the issue of the debentures. The license had not been assigned.

Mr. Hughes, K.C. (with him Mr. Frank Wright) for the defendants, argued that the company had not parted with possession or control of the license or attempted so to do, and they denied the alleged breach of the covenant, the receiver having done no more than use that license and the invention for the benefit of the company as the company's representative. Whether it was for the benefit of the shareholders and debenture holders remained to be seen.

Mr. Dibdin said the patent was being tried with insufficient machinery, and, as that might produce a bad report, it would be very injurious to the prospects of the patent.

Eventally **Mr. Justice Joyce** held that the patent was no part of the property comprised in the debentures, and consequently the receiver had no right to work it. He granted the injunction accordingly, but stayed its operation if the defendants entered an appeal within a week.

GREAT NORTHERN AND CITY "TUBE."

Before Mr. Justice Joyce in the Chancery Division of the High Court on Tuesday, the Great Northern Railway Company applied for an interim injunction to restrain the Great Northern and City Railway Company from entering on or in any manner interfering with for the purpose of laying an electrical conductor, or for running over and using any part of the plaintiffs' railway known as the High Barnet branch, or any other works of the plaintiff company lying to the north of their Finsbury Park Station.

Mr. Cripps, K.C., Mr. Haldane, K.C., and Mr. P. B. Abrahams appeared for the Great Northern Railway; and Mr. Danckwerts, K.C., Mr. Younger, K.C., and Mr. Hutchinson for the Great Northern and City Railway Company.

It appeared that the undertaking of the defendant company was authorised by Act of Parliament, and by Section 91 the defendant company was empowered to run engines, etc., on so much of the up

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and down lines of the Finsbury Park and Canonbury branch of the Great Northern Railway as was situate between Finsbury Park and Railways Nos. 1 and 2, which, the plaintiffs contended, were south of Finsbury Park Station. Defendants claimed a right to carry their running powers on the down line over the High Barnet branch to a spot 33½ chains to the north of Finsbury Park Station, and on the up line to a place 20 chains from Finsbury Park. The plaintiffs' case, on the other hand, was that the defendants had no right either to lay down electrical apparatus, or to exercise running powers to the north of Finsbury Park. The defendants contended that under the Act the question to be determined should be submitted to an arbitrator appointed by the Railway Commissioners, but the plaintiffs argued that the Act did not provide for arbitration on a point which would extend the powers of the Great Northern and City Railway, though if the defendant company was acting within its statutory rights it was agreed that the matter could go to arbitration.

After hearing the arguments of counsel on both sides, **Mr. Justice Joyce** decided that the cross-over which the defendants were contending for was not part of the works or conveniences of Finsbury Park Station, and granted the injunction asked for until the trial of the action.

CLAIM FOR AN ELECTRIC SHOCK.

A curious claim was held in the Leeds County Court before Judge Greenhow on the 20th inst. under the Employers' Liability Act. The plaintiff, Carol Schnidler, a journeyman painter, sued his employer, Mr. David Emsley Hutton, a master painter, to recover £50 damages in respect of injuries received from an electric shock. It appeared that a short time ago he was painting the walls of the English Electric Metallurgical Company's works at Hunslet, when he came into contact with a wire charged with 600 volts of electricity, which, he alleged, was not properly guarded. He received a terrible shock, and was still partially paralysed. On behalf of the employer it was urged that he was in no sense negligent, that through his foreman he warned the plaintiff of the danger, and that there was in any case contributory negligence on the part of the plaintiff. It was contended for the plaintiff that if the defendant's foreman gave any warning—which was denied—it was not sufficiently understood (the plaintiff being a foreigner) or sufficiently enforced, and on this ground his Honour awarded him damages in the sum claimed and costs.

MOTOR MANUFACTURING COMPANY.

In the Chancery Division on the 24th inst. the plaintiffs in the action La Soci tó Anonyme des Anciens Etablissements Panhard et Levassor *versus* the Motor Manufacturing Company, Limited, applied to Mr. Justice Farwell for judgment by consent.

Without stating the nature of the case, **Mr. Walter**, who appeared for the plaintiffs, said that his Lordship had heard something about the matter in another action, not against the Motor Company, but against Panhard and Levassor. The defendants had consented to an order being made for perpetual injunction, an enquiry as to damages, and to pay the taxed costs of the action.

His Lordship concurred in the settlement.

COMPANIES' MEETINGS AND REPORTS.

BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING.

The second general meeting of the shareholders in this Company was held on Monday at the Cannon-street Hotel, E.C., under the presidency of Mr. George Westinghouse, the chairman.

The **Chairman** moved the adoption of the report, which appeared in our last issue. In the course of a long speech, he first summarised the history of this company. After referring to the Westinghouse Company of Pittsburg, which, he said, had grown up from small beginnings till it now had works employing 9,000 men and a capital of over £4,000,000, he said that three years ago they in America found that they had so large and valuable a business in the British Empire that they decided to transfer the seat of it to this country. It would obviously be more economical to manufacture at Manchester the electrical plant required, *e.g.*, for the Mersey Railway than to incur the cost of shipping it all the way from Pittsburg. The result was that in July, 1899, the American company sold its British business (including patents and plans which had cost a very large sum) for ordinary shares in the British company, whose second annual report was under consideration that day. Those gentlemen who were 6 per cent. preference shareholders had the satisfaction of feeling that the American Westinghouse Company—which had borne all the burden, the risk and the expense of pioneers, and had established this great business on the profitable basis over there—had put in the whole of its interest behind this Company. It could get no return upon its outlay till the preference shareholders in this Company had had 6 per cent. on their money. Further, after 6 per cent. was paid upon the ordinary shares, the preference shareholders became entitled to one-fourth of the profits remaining available for dividend. The profits in excess of the preference dividend already amounted to something considerable, but were carried forward for the present. Referring to their gas-engine business, as distinguished from the business of manufacturing electric machinery, the chairman stated that the Pittsburg Westinghouse Company had made gas-engines of 650 h.p., and was making one of no less than 1,500 h.p. A demand, he prophesied, was coming in this country too. These considerations led to the decision to combine the manufacture of gas-engines with that of electrical machinery under the same roof. The two businesses worked in together. Coming now to the accounts, he explained that until the Manchester works were open orders had to be executed, as heretofore, at Pittsburg. In other words, the British company only got a portion of the manufacturing profit. As soon as the Manchester works were running this Company would get the whole profit whatever it might amount to. In the circumstances he was sure they would be well satisfied with the net result for the past year (£46,533), which had been arrived at after liberal deductions from the gross profits for writing down the three accounts enumerated in the balance-sheet—viz., (1) the stock on hand; (2) the laboratory fittings, tools, etc.; and (3) the expenditure on development, exhibitions, etc. The 6 per cent. dividend on the preference shares as paid up required £30,625, and after paying it there was still £18,908 surplus to carry forward. The orders on hand showed a steady growth from £279,000 in July, 1899, to £738,000 in July, 1901. Among the orders, one of the more important was the contract for electrifying the Mersey Railway. This, when completed, would be another object lesson in the North, like the "tube" in London, as to the speed and cleanliness of underground lines in big cities worked by electricity. It happened that the Mersey Railway Company required to pay for its electrification in debenture stock, as authorised under its Act of Parliament, instead of in cash, and according to their experience in America, the same was often the case. In order to meet this and other such cases, they had formed the Traction and Power Securities Company, Limited, with a nominal capital of £1,000,000, to handle such securities and give this company cash for its machinery. The chairman then gave the following description of the works, upon which he said they had spent, up to July 31, £433,126, exclusive of the land. He said: "I think I shall be meeting the wishes of the shareholders by giving them a fuller account than could be embodied in our report concerning the important works which your Company is erecting at Trafford Park, Manchester, which are rapidly approaching completion, and when in full operation will be even more extensive and complete than the Pittsburg works. They are most favourably situated, and adjacent to both the Manchester Ship Canal and the Bridgwater Canal, besides being in direct connection with the main railways, thus providing unusual shipping facilities to all parts of the world. The manufacturing methods of your Company will follow very closely those adopted at Pittsburg, where the advantage gained in quality of work and in quick output by the use of modern labour-saving devices wherever possible cannot be overestimated. Your Company will, however, have a great advantage in the selection and location of machine tools, in its manufacturing methods, and in many other particulars, due to the fact that its management have in all preliminary and final work utilised the services of the staff of the Pittsburg plants, and the experience gained during the past 10 years is exactly the same class of business as that to be undertaken at Manchester. It is expected that manufacturing operations of your Company at Manchester will begin early in 1902. The buildings run almost due north and south, the northern ends are permanent and brought up into line, the other ends might be termed temporary, as it is from here that the buildings will be increased in length as required, there being a considerable space for this purpose. The works proper are located in six buildings, each one being of proportionate size and adapted for one particular branch of manufacture. They are all of rectangular form, and arranged side by side in the order most convenient for securing straightforward work in the manufacture of the machinery from the raw materials to the finished product. On the extreme east is the ironfoundry, 170ft. wide and 500ft. long, where a plant will be installed capable of turning out and handling the huge castings required in the largest sizes of electric power machinery. Next to the ironfoundry are the smaller brassfoundry, malleable ironfoundry, pattern shop, steelfoundry, and forge. The last two are built end to end, forming a building 170ft. wide by 580ft. long. The next building is the machine shop, probably much larger than any other engineering shop in the United Kingdom. It is 430ft. wide by 900ft. long, divided longitudinally into bays, and will be equipped with the most modern electrically operated machine tools, large and small. Electric cranes of all types are to be placed wherever required." He then went on to explain that in addition to the six buildings mentioned, there were two others, one the office building, and the other box factory and stores. He proceeded: "In these new works the comfort and health of the employés will receive every attention. Efficient heating and ventilation arrangements will be provided, and all conveniences, such as clothes lockers, lavatories, etc., will be numerous, and of the most modern type. Not only in the works proper will the workman be well dealt with, but, if he wishes, he may rent a house built purposely for him adjacent to the works. These houses, of the most modern construction, will be supplied with electricity, and gas for heating purposes. The houses are being built by the Trafford Park Dwellings Company, Limited, an independent Manchester company, which has acquired some 120 acres of land, whereon will be erected 2,500 or 3,000 dwellings. About 300 of these are completed, and 300 more are being rapidly pushed forward. Arrangements are also being made for the erection of some better cottages for the use of foremen, and for the erection of a large hotel to accommodate commercial travellers, etc.; also schools, clubs, and recreation grounds. The careful attention given to the securing of the health and happiness of the employ·s is held to be an essential condition for business success. The Manchester works will be devoted to the manufacture of the well-known types of Westinghouse electrical apparatus for lighting, power, and traction, by alternating and direct current, including generators, rotary converters, stationary and tramway motors, transformers, switchboards, and auxiliary apparatus. A considerable portion of the works will be devoted entirely to the manufacture of gas and steam engines. The Company's works manager, Mr. H. S. Loud, has, with a competent staff of assistants, and with the aid of the officers and engineers at Pittsburg, prepared plans and selected the machine tools required for the conduct of the business on a large scale, and is at the present time at Pittsburg, with a force of mechanics, engaged in the preparation of special machines, patterns, jigs, and templates in a portion of the works

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of the American company which has been set aside for the purpose. Lastly, as to the field of operation, and how to utilise it for your benefit. You are aware that your field is the British Empire, with the exception of Canada, which can be supplied more economically from Pittsburg. Westinghouse companies are established also in France, Germany, and Russia, each company dealing with its own field, but with agreements providing for mutual co operation. This makes a very strong combination for exchange of engineering information, for securing valuable patents that may turn up anywhere, and for mutual assistance throughout the world. The future of electrical engineering is one which I should like to enlarge upon, but I should take up too much time. The next 10 years will witness great developments. If railways want to protect the properties they have built up they have got to take the initiative, and handle their suburban traffic by electricity instead of sitting still and seeing competing companies started to cut into them. Why, in Paris you may even see the outgoing expresses for Bordeaux and Madrid taken out of the Quai d'Orsay Station by electrical motors. You can see already in England an electrical line to Richmond and Kew, and the effect upon congested population in London, and the value of suburban land. The New England and some other States are already gridironed with light electrical railways. The question for old-fashioned steam railways is, what to do? Something they have got to do. It is a burning question in America already, and it is just as much so here. . . . Well, gentlemen, your works are the only ones at present on a large enough scale to cope with the orders that must come in this country, and they will be ready none too soon." He concluded by putting the motion for the adoption of the report.

Mr. Joseph Lawrence, M.P., in seconding the motion, thought it was a subject for congratulation that the revenue of this Company had increased in two years from £279,000 to £738,000. He did not think Mr. Westinghouse was one whit too sanguine when he predicted for this industry of the British Westinghouse Company a great future. He did not think that their Manchester works in the next 12 months, or even in the next two years, would be in the least too large for the trade that was coming to them. They had already got a foretaste of it in the fact that, without having any works here in England, this Company had already been able to turn over something like £750,000 in legitimate trading.

The resolution was adopted unanimously.

After a few congratulatory remarks, the meeting closed with a vote of thanks to the chairman.

MARCONI INTERNATIONAL MARINE COMMUNICATION.

Presiding over the annual meeting of this Company at 18, Finch-lane on the 21st inst., **Major Flood-Page** said the business was being firmly established. The object for which the Company came into being was to work throughout the world, except in the United States, Hawaii, Chile, and the colonies or dependencies of those States, an exclusive license, for all maritime purposes, granted by the Marconi Wireless Telegraph Company, Limited. In the prospectus there was also a paragraph excluding from the license the British navy and the Italian navy. The directors had been engaged in England, and in many parts of the Continent, in using their influence to further the adoption of Marconi wireless telegraphy for maritime purposes by all countries on an international basis, and they were well satisfied with the success so far obtained. A number of land stations had already been established by this Company in different parts of the United Kingdom, as well as in Belgium and Germany. In addition, other stations had been equipped by the parent company in the United States, and one was now being equipped at the entrance to the Gulf of St. Lawrence. The greater part of the period under review was taken up in negotiations, and in laying the foundations of the business. The Company had entered into an important arrangement with Lloyd's, and under the agreement Lloyd's had definitely adopted the Marconi system for their signal stations. Referring to the conditions on which the Marconi system was used on large steamships, he said that the owners of the vessels supplied the masts and made all necessary additions on board, and the Company supplied and worked the apparatus. The steamship was entitled to transmit a certain number of words, but this Company received all money derived from sea telegraphy. The Board proposed to fit up all first-class passenger steamships on like terms, but different terms would be offered for cargo vessels, where there would be practically no sea telegraphy, but only what might be called signalling. The development of the system could not reach its full growth until there were stations established, which the vessels could freely use on both sides of the Atlantic. When ample provision of that kind was made there would be a great increase in the use of the system by steamships. The Cunard Company, the Norddeutscher Lloyd, La Compagnie Transatlantique, the Beaver Line and others, besides the Belgian Mail Packets were already successfully employing the Marconi apparatus on their vessels. Fog and storm made no difference to the efficient working of the system, and he thought it would be agreed that its installation on all large steamships must minimise considerably the risk which underwriters ran, and so lead to a reduction in premium for insurance. He then formally moved the adoption of the report.

Mr. H. S. Saunders seconded the motion, which was carried.

PROPOSED NEW BILLS AND ORDERS.

Notices have appeared in the *London Gazette* of intention to apply for Bills or provisional orders as follows:

Electric Lighting.—Birkenhead (Corporation), Stanley (U.D.C.), Tottenham, Edmonton, Enfield, Wood Green (North Metropolitan Electric Power Supply Co.), Wood Green (U.D.C.), Slough (U.D.C.), Newcastle-on-Tyne (Co.), Leyland (U.D.C.), Tadcaster and District (Tadcaster Electricity Co.), Bournemouth (Corporation), Finchley (U.D.C.), Abertillery (U.D.C.), Ardsley East and West (U.D.C.), London County Council (Electric Supply), Beeston (U.D.C.), Blaydon (U.D.C.), Chester-le-Street (County of Durham Electrical Distribution Co., Limited), Eston (U.D.C.), Enfield (North Metropolitan Electric Power Distribution Co., Limited), Pokesdown (Bournemouth and Poole Electric Supply Co., Limited), Penarth (Co.), Lower Bebington (U.D.C.), Abram (U.D.C.), Cowes (Isle of Wight Electric Light and Power Co.), Carnarvon (Corporation), Saddleworth (U.D.C.), Morpeth, Ashington, Newbiggin-by-the-Sea, Bedlingtonshire (Northern Counties Electric Supply Co.), Barton Regis (R.D.C.), Leadgate (Durham) (Northern Counties Electric Supply Co.), Stevenage (U.D.C.), Hitchen (U.D.C.), Louth (Corporation), Southwark (B.C.), Stanley and Tanfield District (Northern Counties Electric Supply Co.), Stockton (R.D.C.), Seghill, Earsdon, and Tynemouth (Rural) (Northern Counties Electric Supply Co.), Amble (Northern Counties Electric Supply Co.), Camberwell (B.C.), Trefriw (Llanrwst Electric Supply Co.), West Riding (Co.), Church Stretton (Church Stretton Lamp Co., Limited), Lees (U.D.C.).

Electric Tramways and Railways.—County of Middlesex (North Metropolitan Tramways Co.), Erdington (U.D.C.), Underground Railway between North Shields (North Shields and South Shields Electric Railway Co.), Rhondda (U.D.C.), Electric Railway (Great Northern and City Railway Co.), North Ormesby, South Bank, and Grangetown Tramways (Co.), Charing Cross, Euston, and Hampstead (Co.), Brighton and Rottingdean (Brighton and Rottingdean Seashore Electric Tramroad Co.), New Electric Lines (Central London Railway Co.), Subways and Tramways (L.C.C.), Brompton and Piccadilly-circus (Co.), Aberdare (U.D.C.), Newcastle-on-Tyne Extensions (Corporation), Northumberland (Northern Counties Electric Supply Co.), London County Council (Tramways and Improvements), Romford (U.D.C.), Manchester and Liverpool (Manchester and Liverpool Electric Express Co.), Whitechapel and Bow (Co.), South Shields (Corporation), City and North-East Suburban (Co.), Metropolitan District Railway (Co.), Southport and Lytham (Co.), London United Electric Railway (Co.), Metropolitan Railway (Co.), Heywood (Corporation), London and Brighton Electric Railway (Co.), Edgware and Hampstead Railway (Co.), Mountain Ash (U.D.C.), Birmingham and Midlands (Co.), London, Tilbury, and Southend (Co.), Bradford (Corporation), Manchester (Corporation), Wigan Tramways, North Staffordshire (Co.), King's-road Railway (Putney Extension) (Co.), York (Corporation), Nottingham (Corporation), Middlesex (C.C.), Croydon and District (British Electric Traction Co.), Manchester City Circle Railways (Co.), Cheadle and Gatley (U.D.C.), Lees (U.D.C.), London United Tramways (Co.), South Shields, Sunderland, and District (Corporation), City and Crystal Palace Tramway (Co.), City, Wandsworth, and Wimbledon Electrical Railway (Co.), Charing Cross, Hammersmith, and District (Co.), Swansea (Corporation), Salford (Corporation), Todmorden (Corporation), Scarborough (Corporation), Victoria, Kennington, and Greenwich (Co.), Exeter and District Tramways (Co.), Piccadilly and City Railway No. 2 (Co.), North-East London Railway No. 2 (Co.), Southport (Corporation), Hove, Worthing, and District (Brighton and Shoreham Tramways Co.), Walker (U.D.C.), Saddleworth, Springhead, and Lees (Co.), West Riding Tramways (Co.), Hastings (Co.), West Riding (Co.), Torquay and Paignton (Co.), East London and Peckham (Co.), Bournemouth (Corporation).

Omnibus Bills have also been prepared containing applications for power to supply electric fittings, etc., by the Huddersfield Corporation, London County Council, Manchester, Bristol, Liverpool, Dartford (U.D.C.), Wigan, Leicester, Felixstowe and Walton (U.D.C.), Cleethorpes (U.D.C.), Swansea (Corporation), Salford (Corporation).

Tram and Electricity.—Devonport (Corporation), Gillingham, Kent (U.D.C.).

Electric Power Supply, etc.—Kent (Kent Electric Power Co.), Gloucester (Co.), Leicestershire and Warwickshire (Co.), Derbyshire and Nottinghamshire (Co.), Northumberland (Co.), South Wales (South Wales Electric Power Distribution Co., Limited), Cornwall Electric Power (Co.), Norwich (Corporation), Leatherhead and District (Co.).

Various.—Manchester District Telephone Board (Corporation), National Telephone Co., Kingston-upon-Hull (Co.). Application will also be made to the Light Railway Commissioners as follows: North Shields, Tynemouth, and District Extension (Tynemouth and District Electric Traction Co.), Poole and District (Poole and District Electric Traction Co.), Middlesex (Enfield extensions) (C.C.), Preston and Lytham (Syndicate), Hounslow, Slough, and District (Metropolitan Electric Traction), Accrington and Burnley (Syndicate), London United Tramways (Co.), Tottenham and Walthamstow (Metropolitan Tramway and Omnibus Co.), Erewash Valley (Co.), Llandudno and Colwyn Bay (Co.), Derby, Notts, and District (Co.), Preston-Horwich (Syndicate), Dover, St. Margaret's, and Martin's Mill (Syndicate), Dover Valley and Alkham (Syndicate), Asley, Swadlincote, and Bull, Windsor and Maidenhead (Metropolitan District Traction Co.), Clacton-on-Sea and St. Oswyth (Syndicate).

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Walsall.—The Borough Council will receive tenders for tramway equipment until Dec. 7.

Barnstaple.—The Urban District Council will shortly advertise tenders for the electric lighting contracts.

East Ham.—The Urban District Council will receive tenders for wiring their new municipal buildings until Dec. 9.

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Oban.—The Burgh Commissioners will receive tenders for three 60-kw. steam dynamos, with two boilers, economiser, etc., by Dec. 18.

Paris.—The Under-Secretary of Postal Telegraphs, Rue de Grenelle, 103, will receive tenders for 650,000 kilos copper wire by Dec. 4.

Paris.—The Under-Secretary of Postal Telegraph, Rue de Grenelle, 103, will receive tenders for 11 magnetic apparatus by Dec. 10.

Dewsbury.—The Corporation invite tenders for the supply, delivery, and erection in the electricity works of two 100-kw. dynamos. Tenders by Dec. 2. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the mason and brick work and the smith and founder work of the electric generating station to be erected off Dunnikier-road. Tenders by Dec. 14.

Brussels.—The administration of the Belgian Government Telegraphs will receive tenders for 7,300 telegraph posts by Jan. 8, 1902. Specification No. 12 may be obtained at the office of the department, Brussels.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection of 12 water-tube boilers and superheaters, economisers, and feed pumps. Tenders by Dec. 4. Details in our advertisement columns.

Warrington.—The Corporation invite tenders for permanent way at the entrance to car-sheds. Specifications, etc., may be obtained at the offices of Messrs. Preece and Cardew, 8, Queen Anne's-gate, London, S.W. Tenders by Dec. 3.

Hampstead.—The Metropolitan Asylums Board invite tenders for the installation of an electric fire-alarm system at the North-Western Fever Hospital, Lawn-road, Hampstead, N.W. Tenders by Dec. 19. Details in our advertisement columns.

Dublin.—Tenders are invited for the hire of plant, etc., required for the electric lighting of the State apartments, Dublin Castle, during the next Castle season. Specification can be seen at the Office of Public Works, Dublin. Tenders by Dec. 2.

Bermondsey.—The Council invite tenders for the supply of the undermentioned articles up to March 31 next: ironmongery, arc lamp carbons, engine oils, indiarubber cables, and jointing material. Tenders by Dec. 3. Details in our advertisement columns.

Turin.—The Royal Artillery Arms Factory require 15,000 kilos of aluminium, to be delivered within two months of signing the contract, and estimated at 67,500 francs, 10 per cent. deposit is required. Tenders will be received by the above until 2 p.m. on Dec. 6.

Southampton.—The Director-General of Ordnance Survey invites tenders for the supply of motors, motor-generators, cables, switchgear, etc., and fixing and adapting the same to existing machines in the Ordnance Survey Office. Tenders by Dec. 14. Details in our advertisement columns.

Middleton (Lancs.).—The Corporation invite tenders for the lighting of the electricity works. Specification, etc., may be seen at the offices of the consulting engineers, Messrs. Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Tenders by Dec. 2.

Pontypridd.—The Urban District Council invite tenders for water-tube boilers, stokers, and economiser, three steam-engines, two 300-kw. and one 150-kw. dynamos, balancing set, switchboard and test-room, workshop, travelling crane, and arc lamps. Tenders by Dec. 14. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of the following material: 2,000, 3,000 or 4,000 tons steel straight track rails; 200, 300, or 400 tons steel curved rails; 100, 150 or 200 tons steel fishplates. Specification, etc., can be obtained on application to Mr. John Young, general manager, 85, Renfield-street, Glasgow. Tenders by Dec. 20.

Nantwich.—The Urban District Council invite tenders for the supply and erection of boiler-house plant: one water-tube tube and one Lancashire boiler, fittings, steam and exhaust pipes, etc.; engine-house plant: continuous-current steam dynamos, pumps, etc.; switchboard, etc., underground mains, lamp posts, etc., accumulators, meters, crane, etc., dust destructor. Tenders by Jan. 6, 1902.

Bideford.—The Urban District Council invite tenders for lighting the district comprised in the borough, for three years certain, commencing from March 31, 1902. Each tender to include the cost of lighting and extinguishing. It is requested that each tender may be based on the terms and conditions, which may be seen at the office of Mr. Wm. B. Seldon, town clerk, Bideford. Tenders by Dec. 11.

Maidenhead.—The Corporation invite tenders for the supply and erection of steam, exhaust, and other pipes, pumps, condensing plant, etc., balancing transformers and motor-generators, storage batteries, switchboard, arc lamps and fittings, cable work, and travelling crane. Specifications and all information may be obtained at the office of Messrs. Burstall and Monkhouse, consulting engineers to the Corporation, 14, Old Queen-street, Westminster, S.W. Tenders by Dec. 13.

Burnley (Lancs.).—The Guardians invite tenders for the electric lighting of the workhouse, electric lighting plant, storage cells, and switchboard, complete system of wiring and underground mains for the electric lighting of the various workhouse premises, and steam, exhaust, and water-pipe work, pumps, injector, feed water heater, valves, etc. Specifications, etc., may be obtained from Messrs. Shepherd and Watney, consulting engineers, Greek-street-chambers, Leeds. Tenders by Dec. 7.

Huddersfield.—The Corporation invite tenders for the supply and erection of one vertical cross compound condensing engine, 750-kw. traction generator, boosters, one Lancashire boiler and fittings, steam and boiler feed pipes, mechanical stoker and conveyor, economiser, switchboard, overhead line equipment and car-sheds, wiring, cables, etc., cable conduits, car bodies, trucks, and electrical car equipment. Specifications, etc., may be obtained on application to Mr. K. F. Campbell, M.I.C.E., borough engineer. Tenders by Dec. 9.

Reading.—The Corporation invite tenders for the supply and erection of water-tube boilers, superheaters, and mechanical stokers, fuel economiser, piping, feed pumps, etc., compound condensing direct-coupled engines, surface condensers, air pumps, circulating pumps, piping, etc., electric generators, switchboard and connections, electric lighting, overhead travelling crane, motor trucks, motors and electrical equipment for cars, car bodies, trolleys, and miscellaneous minor works and fittings. Tenders by Dec. 28. Details in our advertisement columns.

Rockhampton (Queensland).—The Municipality invite applications from companies desirous of undertaking the construction and working a system of electric tramways under the Queensland Tramways Act of 1882 and the Amendment Act of 1890, within the municipality of Rockhampton aforesaid. Rockhampton, with a population of 15,461, is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882 and the Amendment Act of 1890, copies of which may be seen at the office of this paper. Applications to be forwarded to Mr. H. W. Johnson, mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31.

RESULTS OF TENDERS.

Limerick.—The acceptance of the tender of Mr. P. Dillon, at £16,289, for the electric light works is proposed. A long discussion took place at the last meeting of the Town Council, but nothing was settled.

Mansfield.—The tender of Messrs. J. H. Williamson and Co., Castle Works, Nottingham, has been accepted for the erection of the buildings in connection with the electric light station and refuse destructor.

Battersea.—Cables, cast-iron troughing, street joint-boxes, disconnecting boxes, house service boxes, etc., are to be procured from Callender's Cable and Construction Company, Limited, at the schedule rates, so as to bring the total amount up to £3,000, in lieu of £1,470. 5s. 10d., as previously arranged.

Exeter.—The Electric Lighting Committee have recommended the acceptance of the tender of Mr. W. Brealey to carry out the work of erecting the buildings for the new electricity works for £13,905, subject to satisfactory arrangements being made for the completion of the work within less than the specified time - viz., 12 months.

BUSINESS NOTES.

TRACTION.

Bury.—A poll of the ratepayers is to be taken in regard to the tramways question.

Ayr.—The returns for the nine weeks the electric trams have now been running aggregate £1,257.

Norwich.—The whole of the street widenings in connection with the electric tramways have now been completed.

Margate.—The Town Council have under consideration the terms on which the light railways company are prepared to light the sea-front with electricity.

Eston.—The Urban District Council have agreed to support the proposed new tramways scheme between Middlesbrough, South Bank, and Grangetown.

The Monorail in Belgium.—Mr. Behr is reported to be in Brussels in connection with the proposed electric railway between Antwerp and Brussels

Rangoon.—The concession for the present steam tramways expires on June 22, 1903, when the municipality hope to introduce electric traction and also electric lighting.

Walker.—The Urban District Council have now given formal notice of an intended application to Parliament next session to construct electric tramways in their district.

Newcastle.—The running of an electric car on a trial trip last Saturday gives hope that the service will soon be in operation on several of the completed sections of the new tramways.

Dudley.—The Town Council have agreed to a proposal to join with Rowley Regis in obtaining an order for the construction of a light railway from Dudley to Blackheath, through that place.

Another London "Tube" Scheme.—Notice has just been given of an intended application to Parliament next session for powers to construct a "tube" railway from Edgware to Hampstead.

Manchester.—At a meeting of the Tramways Committee on Wednesday it was resolved to take over the Stockport-road and Hyde-road tram routes on May 31 next for the purposes of electric traction.

Wakefield, Castleford, and Dewsbury Light Railways.—The Town Council of Dewsbury have appointed a special committee to watch the interests of the town in connection with the above scheme.

South Shields, Sunderland, and District.—The British Electric Traction Company intend to apply in the next parliamentary session for powers to construct tramways in South Shields, Sunderland, and district.

Birmingham and Midland Tramways.—Notice has just been given of an intended application to Parliament next session for powers

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to construct tramways in Handsworth, Smethwick, Oldbury, Rowley Regis, etc.

Naples.—The plant for the generating station for the new electric tramways, which, as noted last week, was opened on the 16th of this month, has a capacity of 8,100 h.p., and was made by Messrs. Tosi, of Legnano.

City, Wandsworth, and Wimbledon Electric Railway.—Under this title a syndicate intend to apply in the next parliamentary session for powers to build a "tube" railway from the City to Wimbledon *via* Wandsworth.

Croydon.—The British Electric Traction Company have decided to apply in the next session of Parliament to construct tramways in connection with the Croydon Corporation's system in Sutton, Mitcham, Morden, Carshalton, etc.

North Holderness Light Railway.—The North-Eastern Railway Company are reported to have definitely decided to abandon this scheme, the reasons adduced for such a step being the present high prices of iron and labour.

Llandudno.—Up to the present the Colwyn Bay Light Railway Company have been unable to come to an agreement with the Urban District Council as to the supply of electrical energy for the line. Negotiations are still proceeding.

Halesowen.—The District Council have announced their intention to make immediate application to the Light Railway Commissioners for an order authorising the construction of light railways in and adjacent to the district of Halesowen.

Crompton.—A committee of the District Council has been appointed to consider with representatives of the Royton District Council as to the advantage or otherwise of having a joint electricity station for both lighting and tramway purposes.

Manchester-Salford Dispute.—Further negotiations between the Manchester and Salford Tramways Committees will probably shortly take place with a view to the removal of the unpleasant deadlock in regard to through tramway traffic between the two places.

Burton-on-Trent.—It has been decided to memorialise the Town Council in favour of a town's meeting at which the ratepayers may have an opportunity of deciding for or against the tramways scheme, which is calculated to involve an expenditure of £80,000.

Tilbury and Southend Railway.—Among the powers proposed to be sought in a Bill to be promoted by this Company in the next session of Parliament is authority to work "the railway or any part of the same, or railways in connection, by electrical power."

Dundee.—Lieut.-Colonel F. Bailey, R.E., has held an enquiry on behalf of the Secretary for Scotland into an application by the Corporation for powers, among other things, to make a new street from Rosebank-street to Hilltown, for the Constitution tramway route.

Accident in the "Tube."—A well-known City stockbroker, Mr. Oscar Dettelbach, fell in front of a train on the Central London Railway on Monday morning, and was crushed to death. At the inquest on Wednesday a verdict of "accidental death" was returned.

Leicester.—It is proposed to ask for powers to borrow £650,000 on tramways account in the Bill to be promoted in the next session of Parliament. On Wednesday a representative meeting of ratepayers and burgesses passed a resolution favouring the Corporation tramway scheme.

Mountain Ash.—The Urban District Council have given notice of an early application to the Board of Trade for a provisional order empowering it to construct a network of electric tramways for the convenience of the thickly-populated industrial districts within its jurisdiction.

Devonport.—A suspension of the tramcar traffic for about an hour was enforced at this place on Saturday owing to the breaking of one of the overhead wires. The ends of the wire fell on to the roadway, but fortunately missed touching any of the foot-passengers who were passing at the time.

Birmingham.—The scheme to construct a tramway to Edgbaston and Harborne, to cost about £180,000, is meeting with vigorous opposition. A representative meeting of ratepayers has passed a resolution against the scheme, which, as reported last week, has yet to be sanctioned by Parliament.

Brighton and Rottingdean Tramway.—The Town Council have received intimation that the Brighton and Rottingdean Seashore Electric Tramroad Company intend to apply for power to construct a narrow-gauge tramroad on a viaduct from the eastern boundary of Brighton to Rottingdean jetty.

Slough.—Notice has been given at this place of the intention of the Metropolitan District Electric Traction Company to apply to the Light Railway Commissioners for an order authorising the construction of a light railway from Hounslow along the Great Bath-road to Slough, with a branch line to Datchet-on-Thames.

Hampstead.—The Hampstead, Euston, and Charing Cross Railway promoters have agreed to a deviation of the line of route in order to avoid passing underneath the Hampstead waterworks, and also to meet the wishes of the residents, who are of opinion that damage might be caused to Heath House by the line passing under it.

Proposed Crystal Palace "Tube."—The City and Crystal Palace Railway scheme, of which notice was made in our last issue, is for a line from Cannon-street to the Penge entrance to the Crystal Palace, and it is to be underground, of 4ft. 8½in. gauge, and worked by electricity or any mechanical power other than steam.

Windsor.—The Metropolitan District Electric Traction Company have given notice of an intended application to the Light Railways Commissioners for an order to authorise the construction of a light railway in the neighbourhood of Windsor and Maidenhead, including a generating station for the supply of electrical energy.

Whitworth.—A public meeting convened to consider the question of electric tramways in Whitworth Valley has resolved to recommend the District Council to invite a syndicate to view the district with the intention of establishing an electric tram system.

Light Railways in Kent.—Two syndicates have given notice of applications to the Light Railway Commissioners—the one for powers to connect the Dover Corporation tramways at Buckland with Kearsney by a light railway, the other to take a light railway from the Corporation tramways at East Cliff to St. Margaret's.

Folkestone.—The Cheriton District Council are getting impatient at the slow progress being made by the Folkestone Corporation in the matter of the tramways. The former Council have sent a letter asking if Folkestone intends to carry out its order, and if so, whether it is prepared to at once formulate a working agreement with Cheriton.

Cardiff.—The latest step in the dispute between the Corporation and the tramways company as to the purchase price of the latter's undertaking is that the Corporation Tramways Committee, "recognising the importance of getting possession of the lines at the earliest possible moment," have resolved to recommend the Council to make an offer of £50,000.

Camberwell.—The Works Committee recommend the Borough Council to contribute one-third of the cost of widening the streets for the projected London County Council tramway to Lordship-lane, *viâ* Denmark-hill, Champion-park, Grove-lane, Dog Kennel-hill, and Grove-vale. The proposed improvements, exclusive of laying down the tramway, will cost £100,000.

London United Electric Railway.—Notice has been given that application will be made in the next session of Parliament by a syndicate for powers to construct "underground railways from Shepherd's Bush, and Hammersmith and Barnes, Charing Cross, Clapham Junction, and Marble Arch," including electric generating stations. It is also sought to make agreements with the London United Tramways Company as to interchange of traffic, etc.

Notts and Derbyshire Light Railways.—A letter was read at the last meeting of the Hucknall Huthwaite Urban District Council stating that the promoters of the Mansfield and district light railways orders are about to apply to the Light Railway Commissioners for powers to extend the line authorised for powers by that order. The proposed extension will pass through Hucknall, Blackwell, and Alfreton to Ripley, and thence to Belper and Alfreton.

Bolton Appointment.—Of 50 applications for the general managership of the Corporation electric tramways the following have been selected to appear before the committee: Messrs. C. C. Howard, Liverpool; G. W. Maxfield, Bolton; J. Strank, Glasgow; J. Mason, Manchester; C. W. Shepherd, Harpurhey; W. H. White, Leeds; and W. Evans, Halifax. The position is vacant through the late manager's appointment to similar duties at Sunderland. The salary offered is £250, rising by £50 to £400.

South Shields.—A special meeting of the Town Council was held on Tuesday in connection with the promotion of a Tramways Bill in the ensuing session of Parliament. A discussion took place as to the probable cost of the tramway scheme to the Corporation, in the course of which the estimates were criticised. It was stated, for instance, that no provision was made for additional generating plant and buildings, which would cost another £100,000. Altogether, the town had other schemes in hand involving an expenditure of over £1,000,000. A resolution in favour of the promotion of the Bill was carried.

Glasgow.—The Magistrates Committee (Police) have asked the Corporation Tramways Committee to take out stage-carriage licenses for the tramcars, motormen, and conductors till the new by-laws have been made and approved. At present we believe it is the fact that there are numbers of unlicensed car drivers employed by the Corporation, but this, of course, does not mean that they are not perfectly competent to act as such. Some delay was caused to the tramcar traffic on Friday due to the snapping of one of the overhead trolley wires. The extension from Hyndland-road to Anniesland is now completed.

Brighton.—The Lewes-road section of the new electric tramways was formally opened by the Mayor for public traffic on Monday. The remaining sections, for the working of which the Board of Trade certificates are being awaited, serve practically the whole of the borough, and have cost something over £175,000. At the opening of the Lewes-road section on Monday the seven cars accommodating the mayoral party were gaily decorated with flags and bunting, and in the presence of a great throng of townspeople the Mayor started the first car. Subsequently a five minutes' service was put on the road.

Chester.—At a meeting of the Tramways Committee on Monday the question of the working of the trams which have been acquired by the Corporation from the tramway company from Jan. 1 next was considered, and it was decided to recommend the Council to proceed with the electric overhead trolley system from a point near the fountain in Bridge-street to Saltney. The system of traction to be adopted in Bridge-street, Foregate-street, etc., is regarded as a matter of great importance, and nothing will be definitely adopted pending the trial of the contact system which is being experimented with at present at Wolverhampton.

Wolverhampton.—According to the *Wolverhampton Express and Star*, the withdrawal by the British Electric Traction Company of their contentious appeal to establish a right of running powers over the Corporation tramways in the borough, has paved the way to an amicable arrangement for restoring the tramway communication between Wolverhampton and the outlying districts. The negotiations between the Wolverhampton Tramways Committee and the representatives of the company are now proceeding smoothly, with every indication of an arrangement being shortly arrived at which will prove satisfactory to all parties.

Lea Bridge Tramways Co.—Speaking at the ordinary general meeting of this Company on Tuesday, the Chairman remarked that

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some gentlemen had spoken very strongly in favour of using electric traction on their tramways. Though the directors would be very pleased to see this done, believing that it would bring the property up to date, it was impossible under the existing conditions to consider the matter, as certain portions of their line came under the operation of Section 43 of the Tramways Act in August, and the local authorities would be competent to purchase those portions if they should be so advised, and it was certain the electrification of this line could only be carried out by the Board if they were granted a long lease of the tramways.

Shipley.—At the last monthly meeting of the District Council considerable time was taken up with an explanation of the negotiations which have taken place between the Council and the Tramways Committee of the Bradford Corporation with regard to the running of electric tramcars through from Bradford to Saltaire. It appeared that the Bradford Committee will only pay 1d. per unit for current, and also object to pay anything towards the maintenance of the Shipley tramways for repairs, or any interest on overhead works. We understand that no agreement has yet been come to on the point. The Council, however, have approved the plans and specifications of the proposed tramways, and the commencement of the work will probably be made next spring.

Hanley.—A serious collision between two of the electric trams occurred at this place on Monday, resulting in five persons receiving more or less severe injury. It seems that while a car was proceeding down an incline from Hanley in the direction of Fenton the driver lost the control, owing, it is said, to the brakes refusing to act on the greasy rails. Eventually it dashed into the front of another car coming in the opposite direction, and so great was the impact that the two travelled together some 200 years before they came to a standstill. The two drivers and the conductor of one of the cars were badly injured, as well as two passengers. After the collision the cars are spoken of as presenting "an indescribable entanglement of broken wood, pipes, and wires."

District Railway.—A report has appeared in one of the daily papers to the effect that the British Westinghouse Electric and Manufacturing Company have received the contract from the District Railway for the electrical equipment of their generating station. This means the supply of engines, generators, and auxiliary plant of an aggregate horse-power of 36,000. The company have given notice of intention to promote a Bill in the next parliamentary session for powers, among other things, "to work certain railways by electricity," and for "variation of agreement with the Metropolitan District Electric Traction Company, Limited; agreements between the Metropolitan District Electric Traction Company, Limited, and the Metropolitan District, the Brompton and Piccadilly Circus, the Charing Cross, Euston, and Hampstead, and the Great Northern and Strand Railway Companies."

"Twopenny Tube" Extension.—As we briefly announced last week, the Central London Railway Company propose to apply in the next session of Parliament for an extension of the "Twopenny Tube." It will be remembered that last session they applied for powers to make a loop at each end of their line, so that the necessity for reversing engines at the termini might be avoided. They have now apparently abandoned that scheme in favour of a very much more ambitious one. Commencing at the Bank Station, the proposed new line is to be taken round Liverpool-street, and then by Bishopsgate-street and Cornhill to Cannon-street. Here it will bear to the south a little in order to avoid coming too near St. Paul's Cathedral, and will proceed under Upper Thames-street to New Bridge-street and Ludgate-circus. Then the line will go down the length of Fleet-street and the Strand to Charing Cross, where it will turn north-westward to Piccadilly-circus. Here there will be communication with the Baker-street and Waterloo line. Leaving Piccadilly-circus the route goes past Hyde Park-corner, and under Knightsbridge and Kensington-road to Walham Green. Thence the line will bend northward through Hammersmith and Brook-green to the existing Shepherd's Bush terminus.

St. Pancras.—At Wednesday's meeting of the Borough Council a letter was received from the London County Council with reference to their proposal to construct a tramway across Euston-road and along Tottenham Court-road. The Borough Council had objected to the extension unless the County Council had a complete scheme of tramways for connecting the North and South and East and West of London. With regard to this the clerk to the County Council has replied that the proposed extension "is a part of a large scheme which the committee have in contemplation for gradually linking up the various parts of the tramways systems in London; and that the committee consider the proposed extension so essential to the object in view that the Council will be advised to adhere to its decision, already communicated to you, to insert in the Bill to authorise the widening of Hampstead-road a provision that the carrying out of the widening shall be proceeded with immediately upon the St. Pancras Borough Council giving its statutory consent to the construction of tramways along Tottenham Court-road. It is hoped that the road authorities concerned may eventually be induced to consent to this particular line, if constructed, being extended, by means of either surface or underground tramways, along Charing Cross-road and Northumberland-avenue, to the Victoria-embankment, and ultimately over Westminster Bridge to join with the Council's tramways in Westminster Bridge-road. By that means direct tramway communication would be provided between the northern and southern tramways systems of London."

Exeter.—At Tuesday's meeting of the City Council the Tramways Committee presented an interesting report on the question of the proposed electric tramways. In regard to the application of the Electric Tramways Construction and Maintenance Company to Parliament for powers to construct the tramways within the city and to certain places beyond the city boundary, the committee recommended the Council to decline to give their consent to the application; if necessary, oppose it. The committee also submitted the report of Messrs. Robert Hammond and Alfred Dickinson, the experts called in to advise the Council on the subject of electric traction. In the experts' opinion it is advisable for the Council to purchase the existing lines. They recommended a change of route, but that the gauge should remain as at present—viz., 3ft. 6in.—and that the overhead trolley system should be adopted. The current could be supplied from the new works the Corporation are about to erect. They estimated that to acquire the present undertaking, reconstruct the permanent way thereof, construct new lines, including generating plant, feeders, and cars, would cost £9,500 a mile. This would provide 11 miles of tramway laid in approximately 8½ miles of street. However, if they decided not to construct the whole of these tramways, they might for the purposes of a rough estimate deduct £8,000 for each mile of tramway deducted from the suggested lines. They were of opinion that the overhead system of electric traction, if properly installed, would be unobjectionable, and meet all requirements. The minimum car miles which ought to be run on the system should be 400,000 per annum. At the low traffic receipt of 9d. per car mile, this car mileage would yield a traffic receipt of £15,000 per annum. The working expenses should not exceed 5½d. per car mile run. On this basis the sum left to pay interest and sinking fund would be £5,833 per annum. A special Act of Parliament would best meet the case of the Council in obtaining powers. They were distinctly of opinion that no service of cars in the city could be successful which did not pass through the High-street. This could be accomplished without any injury to the business of the street, and also without unduly interfering with the traffic therein. It would be necessary to lay a double line of tramway through the narrow parts on what was known as the double-single method, that was two lines of tramway one on each side of the roadway, to be used only as single line. This would have the effect of having one side of the street quite clear during the passage of a car in either direction. Another report was received from the committee dealing with a communication from the British Electric Traction Company, who pointed out that the Board of Trade had now given their sanction to the purchase of the existing tramways by the company, and they would, in the course of the next week or so, become owners of the undertaking, with the view of carrying out a scheme of electric trams. The committee decided that they were not in a position to discuss the question of electric traction with the company at present. The committee further recommends that the two following questions be submitted to every burgess, and a reply requested thereto on a postcard which will accompany the same: (1) Should a system of electric tramways connecting the various parts of the city be established? (2) If such a system be adopted, should the tramways be laid through High-street, Queen-street, and Fore-street?

London County Council.—An interesting report was presented by the Highways Committee at Tuesday's meeting of the London County Council showing the receipts and expenditure in connection with the Council's southern and northern tramways during the year ended March 31 this year. Dealing with the system on the southern side of the Thames first it was shown that the capital expenditure upon the undertaking on March 31 has been £901,528. The total receipts from the undertaking during the year under review amounted to £462,896. 5s. 8d., while the working expenses were £405,185. 19s. 6d., showing a profit on working of £62,710. 6s. 2d., to which have to be added certain repayments, making the disposal balance £65,680. 12s. 1d. Out of this balance charges on account of interest, sinking fund, etc., have had to be met amounting to £51,354. 17s. 3d., which leaves a balance of £14,325. 14s. 10d. to be carried to appropriation account. As regards the northern tramways, the first cost to the Council of the undertaking was £806,007, and the Council have since expended on capital account, for extensions of lines and depots, sums amounting in all to £39,377 (of which £28,145 was expended in 1900-1), making the total capital expenditure £845,384. The total receipts from all sources in respect of the undertaking have amounted to £78,968 17s. 5d. The total expenditure was £38,817. 0s. 5d., leaving a balance of £40,151. 17s. It will be seen, therefore, that the profits derived during the year 1900-1 from the Council's southern and northern tramways together amounted to £54 477. 11s. 10d., which added to £21,673. 17s. 3d. brought forward from last year made a total of £76,151. 9s. 1d. After various payments a balance remained of £69,215. 7s. 5d. The Council on Jan. 29 last ordered £40,000 of this balance to be transferred in relief of the special county rate, and of the remainder the committee recommended that £29,000 be similarly transferred, leaving a balance of £215. 7s. 5d. to be carried forward. Thus the total amount transferred in relief of the rates in respect of tramway profits during the year 1900-1 will be £69,000. The Highways Committee also presented the following report on the reconstruction for electric traction of the Tooting, etc., tramways: "The Council on Nov. 5 last accepted the tender of Messrs. J. G. White and Co. for the execution of the roadwork and platelaying required in connection with the reconstruction for electrical traction of the tramways between Westminster and Tooting, etc., and that firm has since asked to be allowed to sublet to the Anderston Foundry Company, of Glasgow, the manufacture of the cast-iron yokes and road boxes, and of other cast-iron work in connection with the contract. Dr. Kennedy, the electrical engineer, under whose supervision the work is to be carried out, states that he is satisfied with the capacity of the company to carry out the work, and he is of opinion that the necessary written consent of the Council under the hand of its clerk should be given, under Clause 41 of the contract, to the sub-contracting by the company for the work specified. Having regard to the opinion expressed by Dr. Kennedy, we recommend that Messrs. J. G. White and Co. be allowed to sublet to the Anderston Foundry Company the manufacture of the cast-iron yokes and road boxes and of the other cast-iron work specified in the contract for the roadwork and platelaying in connection with the reconstruction, for electrical traction, of the London County Council tramways between (*a*) Westminster Bridge and Tooting, (*b*) Blackfriars-road and Kennington, and (*c*) Waterloo-road and St. George's-

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circus." It was also recommended to amend the proposals in regard to the construction of tramway No. 9, by omitting that portion which would be between the point of junction of High-road, Lee, with High-street, Lewisham, and Eltham.

LIGHTING AND GENERAL.

Dumbarton.—The Council have decided to apply for an order for electric power.

Londonderry.—The Corporation have adopted Mr. Macrory's report on the electric lighting.

Llanelly.—The Harbour Commissioners have decided to light the new dock by electricity.

Hull.—We understand that it is proposed to borrow £42,000 for electric light extensions.

Cheshunt.—The electric lighting order has been referred to a special committee for consideration.

Brownhills.—The question of electric lighting is to be considered by the whole Council at a future meeting.

Stepney.—At the next meeting of the Borough Council proposals will be made to light Spitalfields by electricity.

Islington.—The London County Council have agreed to lend the Borough Council £5,811 for electric light installation.

New Electrical Wiremen's Association.—We are informed that a meeting of the above will be held on Dec. 1 at 7.30 p.m. at The Alma, Parson's Green-lane, Fulham.

Power Bills.—Reference to another column will show that amongst the Bills to be submitted in Parliament during the next session Power Bills will play an important rôle.

Keighley.—An electric cable is to be laid in Goulbourne-street from South-street to the works of the Keighley Ironworks Society (170 yards), at an estimated cost of £85.

Brechin.—The Town Council have decided to obtain a voltmeter for the purpose of testing the electricity supplied by the Angus Electric Light and Power Company, Limited.

Change of Address.—We note that Mr. A. C. Eborall, M.I.E.E., has removed to Kirkstall Lodge, 115, Tulse-hill, London, S.W., his City address remaining 49, Cannon-street, E.C.

North Berwick.—We understand that the Town Council have decided not to sign the proposed agreement with Messrs. Crompton and Co. for the introduction of the electric light into the town.

Sale of Plant.—The City of London Electric Lighting Company, Limited, have for disposal a number of second-hand engines, dynamos, and disused and old material. Details appear in our advertisement columns.

Southborough.—The District Council have referred back to committee a suggested refusal to grant the National Telephone Company power to lay underground wires with a view to give the company the facilities asked for.

Post Office Telephones.—Mr J. H. Stanhope, late of Leeds, and recently sectional engineer of the Post Office telegraphs, Bradford, has been promoted to be engineer-in-charge of the central telephone exchange, London.

Elland.—The scheme for the proposed electric installation and refuse destructor is progressing. The plans for the destructor are before a committee. The proposed site at the sewage works has been found to be suitable for the new works.

New German Cable.—The German Atlantic Telegraph Company have under consideration a project for laying a second cable from Emden, *via* the Azores, to New York, and is about to commence the preliminary surveys and investigations.

Telephone Switchboards.—We are informed that owing to the satisfactory working of the multiple telephone switchboard recently made for the Glasgow Corporation, the Telegraph Manufacturing Company, Limited, have obtained a large extension order.

Fire.—Mr. A. H. Hunt informs us that his warehouse and office at 59, Gresham-street, E.C., were entirely burnt out on the night of Monday last. Mr. Hunt has taken temporary premises pending rebuilding, and his postal address remains as hitherto.

Arbroath.—On Wednesday telegraphic communication between Arbroath and Auchmithie was opened to the public. The new line is an extension of the coastguard communication, and embraces the coastguard stations at Carnoustie, Arbroath, and Auchmithie.

Finchley.—We note that Mr. E. Calvert is taking up his appointment as chief electrical engineer to the Finchley District Council, to prepare a scheme for supplying their district. His address will now be Electricity Department, Finchley District Council, Finchley, N.

Hammersmith.—The following estimates of expenditure have been approved: sub-station at Messrs. Schweppe's premises, £90. 8s. 6d.; King-street sub-station, £454; Hammersmith-road sub-station, £573; Uxbridge-road sub-station, £717. The works are to be carried out.

London County Council.—Fresh tenders are about to be invited for the lighting by electricity of the Manchester square, Bishopsgate, and Brompton stations, previously accepted tenders of £236. 10s., £208. 10s., and £122. 10s. for wiring and fittings having been cancelled.

Manorhamilton.—The County Council have agreed to accede to the application of Messrs. William Parke and Co. for sanction to the erection of the necessary poles, etc., in connection with their contract for providing electric light in the town of Manorhamilton and district.

Hackney.—It is proposed that prior to the presentation of certificates for wages, etc., the several appointments made by the Electric Lighting Committee, or by the borough electrical engineer, with the authority of that committee, shall be submitted to the Council for its approval.

Manchester Association of Engineers.—At a meeting of the Manchester Association of Engineers, held in the Grand Hotel on Saturday last, Mr. T. T. Heaton (London) read a paper on "Electric Welding."

Chepstow.—The Chepstow Electric Lighting Company having at length given way on the matter of the maximum charge of 8d. per unit, the Urban District Council have consented to the application for a provisional order, the maximum price to be 7d. per unit for lighting and 5d. for power.

Water Concession.—A syndicate having obtained a water concession abroad is willing to negotiate with a company, individuals, or firm of engineers to provide machinery and working capital for utilising the power. About £18,000 is required. Particulars appear in our advertisement columns.

Machine Tools.—We have received from Messrs. Ludw. Loewe and Co., Limited, makers of machine tools, small tools, and gauges, 30-32, Farringdon-road, E.C., a number of illustrated pamphlets on limit gauges, chucking, and foundry practice, which have been prepared by them in explanation of foundry and workshop practice.

Share Market.—There has been considerable gambling in National Telephone shares during the past week. Several electric light companies' shares also advanced, and there were some enquiries concerning the new issues of the London United Tramways Company. The preference were 1 premium and the debentures 3 premium.

Edinburgh.—The Electric Lighting Committee have agreed to recommend that an application be made to the Secretary for Scotland for authority to borrow a further sum of £90,000 for the erection of additional works, making a total of £790,000 of capital expenditure in connection with the Corporation's electric light undertaking.

Kent.—A Bill is to be promoted in the next session of Parliament to incorporate a company for the purpose of establishing works for the production of electricity in the county of Kent. This Bill empowers the company to enter upon and use, compulsorily or otherwise, lands in the parish of Tonbridge rural, in the rural district of Tonbridge.

Electric and Ordnance Accessories Co.—We are informed that the Electric and Ordnance Accessories Company, Limited, have now taken over the business formerly carried on by the British Electric Works Company, Limited, and in the course of a few weeks they expect to be on the market for the purpose of supplying electrical material as hitherto. At present they are engaged in reorganising and putting into working order their telephone, switch, dynamo, motor, and electrical accessories departments.

Postal Telegraph Clerks' Association.—At a meeting of this association on Wednesday at the Memorial Hall, the Postmaster-General's reply to a deputation, asking for an increase of salary and the removal of grievances, was considered. A resolution was adopted expressing regret that the Postmaster-General had found no remedy for the admitted stagnation of promotion in the telegraph service, and had again refused to restore the legitimate maximum of £190 a year to London operators. The meeting reiterated its opinion that an impartial parliamentary committee was necessary to enquire into the whole question of pay reform in the postal telegraph service.

London Gazette.—The date fixed for hearing the application for the discharge of B. Symmons (trading as B. Symmons and Co.), electrical engineer, 2, North-street, Quadrant, Brighton, is Dec. 20, at 12 noon, at Court House, Church-street, Brighton.—A first and final dividend of 6½d. per £ has been declared in the estate of J. A. M. Collier, Claremont-grove, Claremont-place, Gateshead; payable from Nov. 27 at office of official receiver, 30, Mosley-street, Newcastle-on-Tyne.—The hearing of the application for the discharge of F. W. Henton (lately carrying on business at 24, King William-street, Strand) will take place Dec. 12, at 11 a.m., at Bankruptcy-buildings, Carey-street, London, W.C.

Stock Exchange.—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: British Westinghouse Electric and Manufacturing Company's further issue of 50,000 6 per cent. preference shares of £5 each fully paid, Nos. 100,001 to 150,000; Calcutta Electric Supply Corporation's further issue of 10,000 shares of £5 each fully paid, Nos. 20,001 to 30,000; Primitiva Gas and Electric Lighting Company of Buenos Ayres, Limited, 78,375 ordinary shares of £5 each fully paid, Nos. 160,001 to 238,375, and 156,750 5 per cent. cumulative preference share of £5 each fully paid, Nos. 1 to 156,750. The committee have also been asked to allow the Folkestone Electricity Supply Company's £50,000 4½ per cent. first debenture stock to be quoted in the official list.

Northern Section of the National Association of Electrical Contractors' Association.—At a meeting held at Leeds last Saturday it was resolved "that a sectional association, comprising the North of England, embraced by Berwick and Carlisle on the north and Hull, Sheffield, and Manchester on the south, be formed with the object of easier organisation and combination for mutual interests of the respective local associations in their districts." The following officers were elected: President—H. Bland, West Hartlepool. Vice-presidents—E. J. Dugdill, Manchester; E. C. Wallis, Leeds; and S. H. Gowdy, Newcastle. Hon. secretary and treasurer—W. Cross, 4, St. Nicholas-buildings, Newcastle. The association consists of the various local sections in the district bounded on the north by Berwick and Carlisle and on the south by Hull, Sheffield, and Manchester. Two general meetings and four executive meetings will be held annually in towns selected by the executive. The objects of the association are: (*a*) the better education of the non-technical public and the raising of the status of the skilled electrician; (*b*) mutual protection in trade disputes; (*c*) the protection of general trade interests. The next meeting will be held in Manchester on the third Saturday in January.

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Horsham.—At the last meeting of the Urban District Council a letter was read from Messrs. Gordon and Gunton, architects, stating that the electric lighting station was being satisfactorily finished, and they hoped to report at the next meeting that the works were completed. The cost would not be more than that estimated in the contract.

Louth.—The Corporation have decided to apply for a provisional order to enable them to supply electricity for lighting and other purposes throughout the borough. It is stated that the sum required will be about £10,000, which would cost, to be paid off in 25 years, £606 per year. The Corporation are at present paying about £700 a year for gas.

Helsby.—The Parochial Committee are about to purchase the Helsby and District Water Company's undertaking for £1,050 for the goodwill and the pipe line and the reservoir at a valuation, the committee to have power to make their own arrangements in regard to the agreement between the water company and the Telegraph Manufacturing Company, Limited.

Colwyn Bay.—The Lighting Committee's last report shows an increase in the generation of electricity of 1,670 units on the previous month. During the quarter ended Sept. 29 50 consumers were connected, and an increase of 9,164 units on the previous quarter is reported. No action has been taken with regard to the proposed extension of arc lighting.

Camberwell.—The agreement between the Council and the London Electric Supply Corporation has been sealed. The County of London and Brush Provincial Electric Lighting Company, Limited, intend to lay electrical conduits on both sides of Stradella-road, in each case one 2in. low-tension pipe; also crossing Stradella-road, by Burbage-road, one 2in. low-tension pipe.

Guildford.—Colonel Hughes, Messrs. Bullen, Briggs, Brown, Folker, Drewitt, and W. Emery have been appointed a special committee to enquire into and report upon the value of the electricity supply company's undertaking to the town of Guildford, if taken over by the Corporation. In doing so, the committee is authorised to employ the best expert opinion obtainable.

Electrically-Driven Steelworks.—At Messrs. Bolckow, Vaughan, and Co.'s huge Cleveland steelworks at South Bank, Middlesbrough, electric motive power is as far as possible being substituted for steam. The estimated cost of the installation is between £60,000 and £70,000. Several contracts have been completed, but the whole of the work will take some months yet before it is finished.

Heckmondwike.—The electrical works have now been completed, and the light was switched on on Monday. The District Council room was lit up, and so were several shops, and the trial was considered very satisfactory. The Council have decided to charge £12 per year for each arc lamp, and to prepare a statement of the total consumption of all the street lamps within the township.

St. Pancras.—A special committee is to be appointed consisting of the Mayor and two members selected from each of the following committee—namely, Finance, Parliamentary, Works, and Electricity—who shall consider the requirements of the electricity department in relation to a site or sites in or outside the borough for the future development of the installation, and report to the Council.

Football.—The annual match for the Lampmakers' Challenge Cup was played between the Robertson lampmakers and the Ediswan lampmakers last Saturday at Ponders End. For the third year in succession the Robertson lampmakers succeeded in winning by three goals to two, the cup thus becoming the property of the Robertson lampmakers until retaken by any other lampmakers' football club.

Fulham.—The Council have instructed the borough electrical engineer to proceed with the erection of new lamps in Peterborough-road, Clancarty-road, Parson's Green-lane, and Seddlescombe-road. The underground conveniences at Gibb's Green, New King's-road, and St. John's Church are to be wired for electric lighting at an estimated cost of £141. 2s. The work will be carried out direct by the Council's workmen.

Kensington.—Notices by the undermentioned electric lighting companies relative to proposed extensions of their mains in the borough have been agreed to under the usual conditions: Kensington and Knightsbridge Electric Lighting Company—Beauchamp-place; Notting Hill Electric Lighting Company—High-street, Notting Hill, and Silver-street; Brompton and Kensington Electricity Supply Company—Kensington-road.

St. Andrews.—The Electric Supply Corporation have given public intimation that application is to be made by them for a provisional order under the Electric Lighting Acts, 1882 to 1899. The proposal to introduce the electric light into the city has engaged the attention of the Electric Lighting Committee of the Town Council for some time, and last week experts were consulted on the subject. No decision has yet been arrived at by the Council.

Withington.—Electric mains will shortly be laid along Burford-road, on the south side of Whalley Range; Clarendon-road, from the electric sub-station to Egerton-road; Egerton-road, Chorlton-cum-Hardy; Wilbraham-road, south side from Egerton-road to Manchester-road; Manchester-road, from Wilbraham-road to Edge-lane; Edge-lane, south side from Manchester-road to Highfield-road; and Highfield-road, from Edge-lane to the sub-station.

Grays (Essex).—At the last meeting of the Urban District Council Mr. Long reported that there had been 44 applications for current, which was equivalent to 3,533 8-c.p. lamps. He also reported that 20 street lamps had been connected. There had been generated 3,276 units, making an average per day of 200 units. The refuse consumed from Oct. 21 to date was 151 tons, and the coal amounted to 12½ tons. If they had had sufficient refuse they would not have used any coal up to the present.

Presentation.—On Saturday, at the New Brompton electricity works, Mr. Arthur C. J. Reynolds, junior assistant engineer, was presented with a Gladstone bag on his leaving to take up an appointment under the Charing Cross and Strand Electric Supply Company. The presentation was made on behalf of the subscribers by Mr. A. J. Ryan, A.I.E.E., who spoke of the good feeling that existed between Mr. Reynolds and the other members of the staff, and wished him every success in the future. Mr. Reynolds suitably responded.

Dundee.—The third annual supper of the employés of the Dundee electricity station was held last week in the City Hotel. Mr. W. H. Tittensor presided. In proposing the "Outside Employés," Mr. J. H. Mackail pointed out that they had been busier during the past year than at any previous time in Dundee, and had the prospect before them of still harder work, when they would have to deal with an increase in the electrical pressure from 200 to 400 volts. Several songs and readings also contributed to the evening's enjoyment.

Cable Rates.—The Eastern Extension, Australasia, and China Telegraph Company announce that as the "standard revenue" from the Australasian traffic, as fixed by the Cape-Australian agreements, will be maintained for the current year, the tariff for messages exchanged between Europe and the contracting States—viz., New South Wales, South amd Western Australia, and Tasmania—will, in accordance with the provisions of the said agreements, be reduced, on and after Jan. 1 next, to 3s. per word for ordinary telegrams and 1s. per word for Press telegrams. The tariffs for telegrams to and from the non-contracting States will remain unchanged.

Falkirk.—The Town Council have received the report by Messrs. Burstall and Monkhouse, consulting electrical engineers, London, on the electric lighting of the burgh. The Electric Light Committee are about to consider the question of conjoining a destructor with the electric light. The capital cost for an installation providing for 6,000 8-c.p. and 20 arc lamps is given at £22,945, the income at £2,700 per year, and the income, including £1,380 for interest and sinking fund, at £2,613, leaving a balance for rent, taxes, and insurance of £87. Various offers by the Allgemeine Electric Company, Edmundsons' Electricity Corporation, and Crompton and Co. are also reviewed in the report, which is to be printed and circulated.

Italy.—The Department of the Interior has been enquiring into the facts relating to the municipalisation of public undertakings, and it is expected that the laws governing these enterprises will be considerably modified in the near future. The International Association for the Protection of Industrial Property, of which the Hon. Tommaso Villa is president, has recently held various meetings at Lyons. It was decided to hold a congress at Turin in 1902 during the forthcoming Exhibition of Decorative Art. It is proposed to establish wireless communication between Mount Mario, near Rome, and a point on the coast of Sardinia. Experiments recently made in Switzerland between Crauss and Vevey are said to have given excellent results.

New Issues.—The Electric and General Investment Company, Limited, are issuing at £11 per share 15,000 6 per cent. cumulative preference shares of £10 each in the Electrical Power Distribution Company, Limited. This company was incorporated in 1898 with a capital of £300,000, divided into 14,980 ordinary and 15,000 preference shares of £10 each and 200 deferred shares of £1 each. All the ordinary and deferred shares have been subscribed and paid up. The company was formed to promote the supply of electrical energy for lighting, power, traction, and other purposes in the United Kingdom and elsewhere, and is associated with the British Electric Traction Company, Limited, the Brush Electrical Engineering Company, Limited, and others.

Battersea.—Steps are to be taken to obtain a loan of the sum of £1,529. 14s. 2d. for the provision of cables, cast-iron troughing, street joint-boxes, disconnecting boxes, house service boxes, etc., for stock purposes. Application is also to be made to the London County Council for the loan of a further sum of £10,000 in connection with the electric lighting of the borough. The electrical engineer's last report states that up to the present time the number of applications for the supply of electricity to premises, including the Council buildings, amount to 104, with an aggregate equivalent to 10,371 8-c.p. lamps; the number of actual consumers being 74, with an aggregate equivalent to 6,061 8-c.p. lamps. Applications for motive power equivalent to 20¾ h.p. have been received, and motive power equivalent to 6¼ h.p. is being actually used.

Barnsley.—The Park and Lighting Committee have offered to supply the Board of Guardians with electric energy to the workhouse on the following terms: (1) The Guardians to guarantee that their electricity account should not fall below £200 for any one year. (2) The Guardians to agree to take the supply for not less than three years. (3) The Corporation to charge for lighting at 7d. per unit for energy equal to 90 hours per quarter of the maximum rate of consumption during each quarter, and 1½d. per unit for all energy in excess of that amount, or in the alternative the uniform rate of 4d. per unit; for power purposes the uniform rate to be 1½d. per unit. (4) The Corporation to give the Guardians the benefit of any reductions in the price charged to consumers.

Glasgow.—Owing to the sudden descent of a very dark cloud over the centre of the city between 12 and 1 o'clock on the 21st inst., the electricity department experienced an increase in the demand from the equivalent of about 59,200 to 220,000 lamps of 8 c.p. in the space of about six minutes. This required the immediate service of four additional boilers at Port Dundas, and until steam was available the light was not very good. Special arrangements are already in progress to meet such sudden demands as far as possible by means of induced draught, which will enable the boilers under steam to double their output for the short time that such demands usually exist. It is said that last week's occurrence was the most severe strain which has been experienced for some years.

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Cardiff.—In his report to the Lighting Committee on Monday, the electrical engineer (Mr. A. Ellis) reported that there were now about 480 private consumers connected with the mains. This was equivalent to 46,682 8-c.p. lamps, an increase of 39 per cent. compared with the corresponding period of last year. The total amount of power generated during the month of October was 123,951 Board of Trade units, which also showed an increase of 39 per cent. He had received a requisition from Splotlands, asking that the electric supply mains should be extended to that district, many of the householders being desirous of getting it connected with their premises. The cost of the extension would be about £362. The revenue for the six months ended Sept. 30 last amounted to £5,242, as against £3,683 for the corresponding period, an increase of 46 per cent. Mr. Ellis stated he had every reason to believe that the increase would be maintained during the current six months. The committee considered the report very satisfactory, and decided to make the extension to Splotlands as soon as possible.

Sale.—Mr. W. O. E. Meade-King has held an enquiry into the application of the Council for power to borrow £8,000 for electric lighting purposes. Mr. D. Hallewell, clerk to the Council, said about 20 applications for electric lighting of shops and houses had been received. There were scattered all over the township, and were not confined to one street. It was not proposed to light the streets at present. The consulting engineer, Mr. C. Hopkinson, pointed out that the current would be supplied in bulk to Sale by the Trafford Power and Light Company, whose works were between two and three miles from Sale. The loan was required for the laying of mains and carrying out incidentals to the scheme. The Trafford Power and Light Company were desirous of obtaining an increased output for domestic purposes, so as to employ their machinery in the evenings, and they had obtained from the company very favourable terms. Those terms were based upon the Lancashire Power Company's parliamentary maximum charges, less 20 per cent. For the first 100 hours per quarter the price would be 4d., less 20 per cent. For the second 100 hours they would be charged 1·6d., and for any further demand beyond 200 hours—which was a purely theoretical charge—they would be charged ·8d. per unit. They might take it that in the summer they would not get beyond the maximum, but in the winter they would reach into the 200 hours, and get their price substantially below the maximum charge of 3·2d. per unit. The system would be the three-wire system. Part of the present cart-shed in the Council's yard would be made into a house to receive machines provided by the company for converting their high-pressure supply to the pressure which they were undertaking to let Sale have.

Bristol.—The Electrical Committee reported at the last meeting of the Council as follows: "Your committee remind the Council that at their meeting on the 9th inst. they resolved to promote a Bill in Parliament to authorise the construction of certain works recommended in the Docks Committee's report of the 4th inst. Your committee consider that advantage should be taken of this opportunity to obtain the following amendments and extensions of the provisions of the Bristol Electrical Lighting Order, 1883, which in the opinion of your committee are desirable in the interests of the Corporation—viz.: (1) power to provide and supply electricity in the parishes of Shirehampton, Henbury, Westbury-on-Trym, Filton, Stoke Gifford, Horfield, Mangotsfield, Kingswood, and Hanham, in the county of Gloucester, and Brislington, Long Ashton, Abbott's Leigh, Easton-in-Gordano, Portbury, and Portishead, in the county of Somerset; (2) power to charge special rates and make special conditions with respect to the supply of electricity to parties having a supply of energy, electrical or otherwise, separate from and independent of that supplied by the Corporation; (3) a reduction of the rate of interest payable by the Corporation on deposits made with the Corporation as security for the payment of accounts due for supplying electricity, the rate of interest fixed by the order of 1883 being 5 per cent.; (4) power to provide, let on hire, and sell apparatus, appliances, and fittings for generating, transforming, distributing, and utilising electric energy, and to provide and fix in any premises, with or without charge, electric lines, wires, and appliances; (5) power to make by-laws, regulations, or conditions for securing the efficiency of electric lines, fittings, works, and apparatus in premises, the owners or occupiers whereof are supplied with electricity by the Corporation, and for securing the safety of the inhabitants of such premises, and for the prevention of fire therein. For the purpose of enabling the Council to include these provisions in the proposed Bill, if they so desire, your committee have caused notice thereof to be included in the advertisement of the Bill, and they recommend that their action in the matter be approved, and that the suggested provisions be included in the Bill." The report was approved after considerable debate.

Electrical Transmission of Power in Collieries.—Messrs. Ernest Scott and Mountain, Limited, Close Works, Newcastle-on-Tyne, who have for many years now made a speciality of mining work, inform us that they have just arranged an important contract with the Broughton and Plas Power Coal Company, Limited, near Wrexham, for an important extension to the installation which they supplied some time since for the Plas Power Colliery, the original consisting of two sets of horizontal compound engines of 350 h.p. each, driving by ropes two Scott and Mountain generating dynamos of 200 kw. capacity each, supplying power to the electric motors underground, and for driving haulage gears and pumps. The haulage gears are dealing with 1,300 tons of coal per day, and the pumps delivering 200 gallons per minute against a head of about 900ft. The extension plant which Messrs. Scott and Mountain have now in hand consists of one of their vertical two-crank, enclosed, compound, self-lubricating engines of 350 h.p., coupled direct to one of their 200-kw. six-pole dynamos of the continuous-current type, and the new plant will supply current to the Gatewen Colliery, situated about 2,000 yards from the generating station, for driving the underground haulage gear there, the motor for driving this gear being of 200 h.p. The company's object in adopting electrical machinery has been to concentrate the whole of the power in one central station at Plas Power, and distribute current to the various collieries for driving pumps, haulage gear, etc. The extremely satisfactory results of the first plant has induced them to make extensions as described above. Messrs. Scott and Mountain also inform us that they have also just settled a very important pumping contract with the Ashington Coal Company for their Woodhorn Colliery, this plant consisting of one of the firm's multipolar continuous-current dynamos of 270 e.h.p., driven by a horizontal long-stroke compound engine. This generator will supply current to four electric motors, each driving three-throw ram pumps, also of Scott and Mountain's manufacture—the first set of pumps being for main shaft pumping and delivering 400 gallons per minute against a head of 600ft., the second set of shaft pumps delivering 150 gallons per minute against 350ft. head, and the two smaller pumps for dip workings each delivering 100 gallons per minute against 100ft. heads. The same firm are also supplying the complete electrical generating plant for Messrs. Pease and Partners' Bankfoot Colliery, Crook, for driving coal-cutting machines, etc., this plant consisting of a long-stroke compound engine of 350 h.p., and a generating dynamo capable of giving an output of 270 e.h.p. at the terminals. The large pumping plant which the same firm have had in hand for the South Durham Coal Company, Bishop Auckland, is now nearing completion. This plant consists of a horizontal long-stroke compound engine of 450 h.p. driving a 250-kw. generator which supplies current to two sets of main shaft pumps, each pump delivering 500 gallons per minute against a head of 400ft., or collectively 1,000 gallons of water per minute, and each pump is driven by one of the same firm's electric motors of 120 i.h.p. We are informed that, in addition to the above, Messrs. Scott and Mountain have a very large amount of work in hand all over the United Kingdom, the advantages of electricity for transmission of power being greatly appreciated by the various colliery owners and managers.

PROVISIONAL PATENTS, 1901.

Nov. 18.

23261. Automatic switch for switching off an electric motor used for pumping purposes. Mervyn George Drake and Drake and Gorham, Limited, 66, Victoria-street, Westminster, London.

23294. Improvements in earth conductors for lightning conductors. Paul Immich, 18, Buckingham-street, Strand, London. (Complete specification.)

23300. Improvements in electromagnetic couplings. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Johann Ludwig Onken, Germany.)

23308. Improvements in and relating to incandescent electric lamps. Ferdinand Fanta, 1, Queen Victoria-street, London.

23309. Improvements in or relating to trolley heads for tramways and the like. David Blythe Foster, 6, Lord-street, Liverpool.

23312. Improvements in insulating gloves for use in electrical or chemical operations. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

23315. Improvements in electric glow lamps. Albert Jones Harding Gurney and Alfred Sidney Blundell, 77, Chancery-lane, London.

Nov. 19.

23358. Combination shade tilter, cord grip, and cord shortener for electric lamps. John Joseph Williams, 12 Osborne-road, New Evington, Leicester.

23376. Improvements in electric fuse boxes. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Tycho Van Aller, United States.) (Complete specification.)

23377. Improvements in electric fuse boxes. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Robert H. Read, United States.) (Complete specification.)

23378. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Richard Fleming, United States.) (Complete specification.)

23379. Improvements in electric current transformers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Walter S. Moody, United States.) (Complete specification.)

23380. Improvements in electric fans. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (James J. Wood, United States.) (Complete specification.)

23381. Improvements in end play devices for rotary machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry Geisenhoner, United States.) (Complete specification.)

23382. Improvements in end play devices for rotary machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett and William B. Potter, United States.) (Complete specification.)

23398. Improvements in the equipment of electrically-propelled cars. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Francis Lydall, Germany.)

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23399. Improvements in the equipment of electrically-propelled cars. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Francis Lydall, Germany.)

23400. Improvements in the equipment of electrically-propelled cars. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southamptcn-buildings, Chancery-lane, London. (Francis Lydall, Germany.)

23401. An improvement in controllers for electrically-propelled cars. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Francis Lydall, Germany.)

23413. Improvements in or relating to dynamo-electric machines. Alfred Julius Boult, 111, Hatton-garden, London. (Claude Marie Joseph (styled Claudius) Limb, France.)

23423. Improvements in and relating to means for supporting and insulating the trolley wires of electric tramways on the overhead trolley wire system. William Charles Ullmann and Amos Edward Barber, 322, High Holborn, London.

23429. Improved system of electrical propulsion for railway and other cars. William Phillips Thompson, 6, Lord-street, Liverpool. (Gordon John Scott, William Smith Janney, and Frank Le Bar, United States.) (Complete specification.)

23433. Improvement connected with incandescent lamp-holders. Eduard Schulz, 166, Fleet-street, London.

2344. Improvements in electric lighting and in apparatus connected therewith. Charles Hemlet Woodward, 23, Southampton-buildings, Chancery-lane, London.

23446. Improvements in automatic electric circuit breakers. Herbert John Haddan, 18, Buckingham-street, Strand, London. (The General Incandescent Arc Light Company, United States.)

23456. Improvements in and relating to electrical resistances. Henry Alexander Mavor and Mavor and Coulson, Limited, 46, Lincoln's-inn-fields, London.

Nov. 20.

23485. Improvements in and relating to the working of electric or other tramway or railway points. William James Stewart, 96, Buchanan-street, Glasgow.

23536. Improvements in apparatus for treating patients with electrical lighting and heating rays. Herbert John Dowsing, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

23542. Improvements in or connected with electric arc lamps. John Llewellyn Davies, 40, Chancery-lane, London. (Complete specification.)

23550. An improved road contact stud for use in connection with closed conduit systems of electric traction. William Griffiths and Benjamin Harry Bedell, 4, South-street, Finsbury, London.

Nov. 21.

23570. Improvements in or connected with shades or screens for electric glow lamps. George Davis, 38, Margravine-gardens, West Kensington, London.

23581. An improved clip for coupling severed wires in overhead wire systems of electric traction; applicable also as a coupling for use in connection with fittings appertaining to such systems, and as a section insulator. Henry Brecknell, Edward May Munro, and Hugh Innes Rogers, Lloyds' Bank-buildings, Bristol.

23600. Improvements in shunts for electrical measuring instruments. August Eckstein and Frank Panter, Peel Works, Adelphi, Salford, Manchester.

23611. Self-acting electrical indicator requiring no replacement. John Henry Crisp, 76, Park-street, Church-street, Stoke Newington, London.

23613. A guide fork for facilitating the changing of the trolley pulleys of electric cars from one electric wire to another. Arthur Walker and Henry Ingham Rhodes, 7, Chiswick-terrace, Burley Lodge-road, Leeds.

23622. An automatic device for cutting off the electric current from suspended or overhead conductors, in case of breakage or falling. Harry Ernest Hunt, 19, Paget-road, Great Yarmouth.

23637. Improvements in electromagnetic couplings. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Johann Heinrich Ludwig Onken, Germany.)

23659. Improvements in hoisters for suspended electric lamps. Otto Graetzer, 18, Buckingham-street, Strand, London.

23668. Improvements in street feeder boxes or disconnecting pillar boxes for electric traction, electric lighting, or electric power purposes. James Ashton Fletcher and Samuel Fletcher, 18, Southampton-buildings, Chancery-lane, London.

Nov. 22.

23690. Improvements in electrical switches. Albert Edward King, Brougham-chambers, Nottingham.

23703. Improvements in and relating to prepayment meters for the supply of electricity. James Finlayson Bank-buildings, Busby, Lanarkshire.

23708. Improvements in inter-communication telephones. Max Binswanger-Byng and Francis George Bell, 71, Queen Victoria-street, London.

23721. Improvements in regulating friction. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles H. Ingalls, United States.) (Complete specification.)

23722. Improvements in indicating instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Thomas F. Mullaney, United States.) (Complete specification.)

23723. Improvements in galvanometers. The British Thomson-Houston Company, Limited, and Frank Holden, 83, Cannon-street, London.

23729. Improvements in brakes for electrically-operated cranes and similar hoisting apparatus. Franz Jordan, 39, Hill-crest-road, Acton, London.

23728. Improvements in magnetisable bodies for use n telegraphones. Peder Oluf Pedersen, Palace-chambers, Westminster, London.

23756. An improvement in mechanical converters of electric current. Leonard Joseph, 40, Chancery-lane, London. (Complete specification.)

Nov. 23.

23768. A detachable overhead covering for electric cars. Arthur Woods and William Henry Brown, 21, Rufford-street, Leeds-road, Bradford, Yorks.

23773. Improvements in drums for holding electric cables. Henry Sutcliffe, 18, St. Ann-street, Manchester.

23804. Improvements in electric motor systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (George O. Baker, United States.) (Complete specification.)

23805. Improvements in electric circuit breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles C. Badeau, United States.) (Complete specification.)

23806. Improvements in systems of electric motor control. The British Thomson-Houston Company, Limited, 83, Cannon-London. (William B. Potter, United States.) (Complete specification.)

23823. Improvements in magnetic ore separators. Anders Eric Salwén, 322, High Holborn, London.

23824. Improved automatic means of electrical signalling for railways, tramways, lifts, and other vehicles. Thomas Cloke, 144, Pomeroy-street, Peckham, London.

23838. Improvements in or connected with telephone systems. Isaac Hardy Parsons, of the firm of Gent and Co., and Thomas Sloper, 4, South-street, Finsbury, London.

23845. Improvements in and relating to dynamo-electric machinery. Henry Alexander Mavor and Mavor and Coulson, Limited, 46, Lincoln's-inn-fields, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 14.

1900.

21027. Ground detectors for electric circuits. British Thomson-Houston Company, Limited. (Pratt.)

21031. Systems of electric motor control. British Thomson-Houston Company, Limited. (Armstrong.)

21629. Means for the conversion of electrical energy derived from a source of direct current into varying or alternating currents. Duddell.

22126. Apparatus for wireless telegraphy. Fleming and Marconi's Wireless Telegraph Company, Limited.

22679. Means applicable for use in operating and controlling electrically-propelled trains or tramcars. Short.

23148. Connection of current conductors separated by dilatation gaps and apparatus therefor. Holzmann.

23385. Machine for winding electric cables on drums or reels. Claremont.

23448. Telephone switchboard cords. Whalley.

23543. Plates for secondary or storage cells. Ayrton and Fithian.

1901.

500. Joint fittings for electric cables. Henwood and Reason Manufacturing Company, Limited.

585. Electric switches and the like. Headley.

946. Adjustable supports for electric lamps. Stevenson and Farnsworth.

1309. Brakes to be used in connection with railway cars and wagons, tramcars, electric cars, or other vehicles running on rails. Smithson.

1347. Telephone exchange systems. Kingsbury. (Western Electric Company.)

1568. Electric cables. O'Gorman.

4810. Electrolytic interruptors. de Mare.

6851. Electric lamp-shade holders. Kemp.

9147. Life-guard for electric cars, railway locomotives, motor-cars, and other self-propelled vehicles. Kirby.

14562. Alternating-current electricity meters. Catenhusen.

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12721. Machine for use in the manufacture of electric fuses for cartridges. Tirmann and Tirmann.

15530. Regulating electric currents and switches therefor. Thieme.

19510. Electric cables. Bennet and Johansson. (Date applied for under International Convention, March 29, 1901.)

19538. Electric railways and tramways with motor-driven collectors in a closed conduit. Janecek.

19990. Electric arc lamps. Shafer and Voye.

21293. Electrically-illuminated signs. Goehst.

21294. Electric accumulator batteries. Tribelhorn.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Nov. 23	599	597	+ 2	19,986	18,115
Birmingham Tramways	—	—	—	—	—	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 22	469	412	+ 57	23,722	21,057*b*
Blackpool Corporation	,, 21	224	200	+ 24	36,194	27,187
Blackpool-Fleetwood Tramways	,, 23	187	162	+ 25	20,186	19,576*b*
Bolton Corporation	,, 24	1,295	1,212	+ 83	68,207	56,071*b*
Bradford Corporation	,, 24	1,030	714	+ 316	42,699	21,838
Bristol Tramways Company	,, 22	3,626	2,704	+ 922	—	—
Carlisle Tramways Company	,, 23	121	121	—	3,895*b*	3,856
Central London Railway	,, 23	6,649	5,755	+ 894	127,433	—
City and South London Railway	,, 24	3,029	1,849	+ 1,181	42,695	33,957
Cork E. T. and L. Company	,, 21	343	324	+ 19	21,748	19,319*b*
Darwen Corporation	,, 22	178	166	+ 12	8,871	7,295
Dover Corporation	,, 23	173	162	+ 11	10,296	9,762*b*
Dublin & Lucan Electric Railway	,, 24	72	65	+ 7	2,518	2,169
Dublin U. T., electric cars	,, 22	3,258	3,127	+ 131	—	—
Dublin S. District, Electric	,, 22	680	684	- 4	—	—
Dundee Tramways Company	,, 20	631	457	+ 174	—	—
Glasgow Corporation	,, 23	10,322	8,840	+ 1,482	—	—
Halifax Corporation*	,, 24	1,671	1,306	+ 305	38,648	26,245
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 23	1,536	1,306	+ 290	36,609	29,978
Liverpool Corporation	,, 16	8,543	8,118	+ 425	413,920	365,595*b*
Liverpool Overhead Railway	,, 24	1,434	1,525	- 91	33,550	35,074
Portsmouth Corporation	,, 23	744	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 24	3,406	—	—	—	—
Southampton Corporation	,, 21	635	603	+ 81	—	—

* Fortnightly. *b* From Jan. 1.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £1,304 decrease.
Barcelona Ensanche y Gracia, £5 decrease. Barcelona, £246 increase.
Brisbane, £149 increase (month of Oct., £943 increase).
Buenos Ayres and Belgrano Electric, £907 decrease.
Calcutta, £20 decrease.
Cape Town (month of Oct.), receipts, £14,063; expenditure, £6,817.
La Capital Traction and Electric, Buenos Ayres (month of Oct.), £1,350 increase.
Mexico Electric (month of Oct.), receipts, £17,400; expenditure, £10,100.
Perth Electric, £141 increase.
Port Elizabeth (month of Oct.), receipts, £3,240; expenditure, £1,960.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅜-½
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅜-½
—— Ordinary, 1-125,000	1 ..	9/16-11/16
British Electric Works, Ordinary, 50,001-95,000	1 ..	1 16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-5½
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5-5½
Brush Electrical Engineering, Ordinary	2 ..	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1⅜
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	112-116
—— Ordinary	5 ..	16-17
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3½
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	⅛-¼
—— 5 per cent. Debentures	5 ..	1½-2½
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1⅞-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	23-24
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6½
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	106-107

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-102
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9½-10⅛
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	8-8½
—— 7 per cent. Preference	5 ..	8½-8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7½-8½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10½ xd
Charing Cross and Strand" ,,	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5½-5⅝
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5½-5⅝
—— 40,501-50,936	5 ..	5-5½
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	11½-12½
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	103-105
County of London and Brush Provincial, Ordinary	10 ..	8½-9⅛
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5½-6
—— 6 per cent. Cum. Pref.	5 ..	5½-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4½-4⅝
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5½-5⅝
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10⅛
London Electric, Ordinary	3 ..	1½-1⅝
—— 6 per cent. Pref.	5 ..	3½-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	113-116
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	96 99
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6½-6⅝
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1½-1⅝
—— £5 Shares	5 ..	7⅜-8½
—— £4½ Shares, New	4½ ..	7-7½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15½-16⅛
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11½-12½
Electric Railways.—		
Central London, Ordinary	100 ..	108-111
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	107-110
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-119
City and South London, Consolidated Ordinary	100 ..	59 62
—— Ordinary	10 ..	5¼-6
—— 4 per cent. Debenture Stock	100 ..	111-115
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	3⅛-4⅛
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-128
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2⅜-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	5⅜-6½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	8½-9½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.e.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14-14½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11⅜-12½
—— 5 per cent. Perpetual Debenture Stock	100 ..	121-124
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¼-2¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
—— Prov. Cert., all paid	100 ..	100-103
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅛-2⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11½-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3½-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	104-106
New General Traction, Ordinary	5 ..	2½-3½
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	98-102
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10⅝
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9½-10½
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8s. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Telephones.—		
National Telephone, Ordinary	5 ..	4⅛-4⅜
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅛-5⅛
—— 4 per cent. Deb. Stock, Red.	100 ..	95-98
—— 3½ per cent. Deb. Stock, Red.	100 ..	99-102
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

Technical Instruction in Scotland.—Mr. Andrew Carnegie has just been formally elected Lord Rector of St. Andrew's University, Edinburgh. It is common knowledge that Mr. Carnegie proposes, subject to certain conditions, to give £100,000 for the building, endowing, and equipment of a technical college for the South of Scotland, to be erected in one of the border towns, preferably Galashiels, and the choice of the students of St. Andrews in electing him Lord Rector of the University is hailed with general approval throughout the country.

Cape-to-Cairo Telegraph.—Progress with the construction of the African trans-Continental telegraph has been so marked of late that the line is now practically completed from the Cape to Lake Tanganyika. Latest advices state that the line has now reached Ujiji, a place about two-thirds of the way up the east coast of the lake. It is at Ujiji that an important junction with the German East African system from Dar-es-Salaam is contemplated. After reaching the northern extremity of Lake Tanganyika, the telegraph will turn to the north-east to join up with the line which already exists between the western shores of the Victoria Nyanza and the coast.

Electrical Steering.—Some important experiments, we read, have recently been made on board Earl Crawford's steam-yacht "Valhalla," at Cowes, with an invention of the Hon. R. Brougham for steering vessels by electricity. The tests were carried out in the presence of the inventor, Earl Crawford, and Earl Dunraven, and representatives of both the British and Japanese Admiralties are said to have watched the results with a view to the probable introduction of the invention on warships. Considerable success appears to have attended the experiments, and it is claimed for the apparatus that the rudder of the yacht was under perfect control the whole time.

Nobel Prize Awards.—A Berlin correspondent gives the following names as the probable recipients of the Nobel prizes of £7,500 each, to be awarded by the Christiania Committee on the 10th inst.: The science awards to three German professors—Dr. Behring, the bacteriologist; Dr. Röntgen, of Röntgen-ray fame: and the Berlin expert in chemistry, Dr. Von Hoff. The literary award is expected to go to the Spanish poet, Señor José Echegary, and the prize for the promotion of peace to the eminent Swiss, M. Dunant, the originator of the Red Cross movement. It is believed in Berlin that Count Tolstoi will not receive a prize, his candidature not having been put forward in accordance with the regulations.

Electrical Stamp Cancellation.—The authorities at the General Post Office are just now trying the merits of an ingenious machine for cancelling the postage stamps on letters. The motive power for the machine is electricity, and the operator's work consists solely in facing the letters in bulk toward the machine, which disposes of them at the rate of 420 a minute. This is claimed to be a great advance on the performance of the electrical device which was introduced at the central office some four years ago, the working of which was much handicapped by the capacity of the operator, who passed the letters through one by one. The new invention comes from across the Atlantic, but pending the results of the tests which are now being made with it, nothing has been settled as its permanent adoption at St. Martin's-le-Grand.

Theory of the Drop Electrode.—An experimental contribution to the theory of the drop electrode, by Mr. J. Bernstein, is digested in the current number of the *Journal* of the Chemical Society. In the experiment in question a cell containing two mercury electrodes (one being a drop electrode) were connected with a capillary electrometer. The movements of the meniscus in the electrometer and the formation and fall of the mercury drop in the cell were photographically recorded on the same plate. The current corresponding with the fall of each drop is thereby shown to be produced at the very moment of separation of the drop. The meniscus of the electrometer reached its point of maximum displacement 0·034 second after it began to move. The observation is interpreted according to Ostwald's and Paschen's views.

Demagnetising Watches.—A correspondent to the *Daily Mail* of the 3rd inst. ought to have forwarded a reply to the recent question in our "Questions and Answers" columns on the subject of the demagnetisation of watches. He prefers, however, the greater publicity and lesser criticism which he has to encounter in the columns of the *Daily Mail*. His favourite cure is to place the watch face down on the top of an alternating-current electricity meter, but in order to prevent the magnetisation, he says that if the watch is worn in a rubber or silk-lined pocket it will generally be found to be effective. This reminds us of the man who put his hand over his watch when going into a central station in order to keep off the effect of the dynamos. We should think that the correspondent of the *Daily Mail* is one of those noted experts who put originality before accuracy or usefulness.

The Potteries Electric Tramway Accident.—The report which we have received up to the present of the violent collision which occurred recently on the lines of the Potteries Electric Traction Company does not impress us with the discipline enforced by the company on its staff. It seems that one car was going down a steep hill, and that the driver found he could not check the increasing speed with his brakes. He promptly deserted his post, jumping off the car and leaving it to run down the hill, and eventually the car was emptied by the passengers also jumping on to the road. When the collision occurred the driver of the car which was run into also left his charge, but he was not perhaps so much to blame, unless he had time to reverse his motors and so lessen the shock. We trust for the company's sake that they will succeed in obtaining a better discipline amongst their drivers, and also a higher knowledge on their part of the way to brake the cars, as we cannot conceive that the brakes were insufficient if properly applied.

Teneriffe Electric Railway.—On Oct. 11 last we published a description of the above-mentioned railway, which gave some idea of the convenience it would be to the inhabitants round about Teneriffe. We hear now that the company who have equipped the line are having considerable difficulty in completing the extensions we then described. It seems that in the first instance the islanders were exceedingly sceptical as to the success of the undertaking, and in consequence they refused in any way to assist in the financing of the same. Now that the opening of the line has proved how successful and useful it is, the local financiers with their small amounts wish to get the concern into their own hands. As a means to this end we find that they are obstructing the contractors in the completion of their work. In this respect history repeats itself. People are only too glad for pioneers to take the risks, but there is a rigid objection to a pioneering undertaking receiving profits which by reasonable foresight should have accrued to local people or authorities. While we are referring to the matter we wish to correct a mistake

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which occurred in our article, where we spoke of the contractors as MM. Tichefet frères, of Brussels, instead of MM. Fichefet frères.

Lighting of an Operation Theatre.—The following arrangement for the efficient lighting of an operation theatre by electricity is given by Mr. Peyton T. B. Beale in the current number of the *Lancet*, as providing at once a simple, cheap, and satisfactory method: "A steel frame maintained in a position about 10ft. above the floor by cross-wire stays from the skylight carries three trolleys, which support three counterweighted tilting and swivelling shades. The trolleys have a lateral motion of about 3ft. The shades are of solid aluminium, tilting through 180deg., swivelling through a complete circle, and rising and falling about 3ft. Three 16-c.p. lamps are arranged in each, either one, two, or three being brought into use by means of two switches, one of which controls one lamp and the other two lamps. There are therefore six switches in all, two to each pendant. There are wall plugs for hand lamps, cautery, etc. This arrangement was installed at the operation theatre of the Great Northern Central Hospital over a year ago, and has been found to work excellently. The special points in its favour are: (1) the pendants and wires when not in use hang well above, and entirely on one side, of the operation table, so that any dust which may settle upon them does not fall upon the wound during an operation; (2) any amount of light can be obtained at will, at any level, at any angle, and on either side of the patient; (3) the light is absolutely steady; and (4) the arrangement is inexpensive."

Armstrong Memorial.—Announcement was made by the President at the last meeting of the Institution of Electrical Engineers that a letter had been received from Earl Grey with reference to a memorial which it is proposed to erect to commemorate the scientific and practical work of the late Lord Armstrong. It is intended, said Mr. Langdon, that the memorial shall take the shape, first, of the erection of a statue to Lord Armstrong by one of the most eminent sculptors of the day, and in some conspicuous position in his native city of Newcastle-on-Tyne; and, second, a substantial contribution towards higher education in the North of England by the completion and equipment of the buildings of the Durham College of Science in Newcastle. It is thought that there are many members of the scientific professions who will gladly assist in the movement, and members of the Institution and others wishing to participate in the memorial are asked to communicate with the secretary, Mr. Herbert J. Richardson, of 67, Westgate-road, Newcastle-on-Tyne. Among those figuring on the General Committee are the following influential gentlemen: Earl Grey, Earl of Durham, Duke of Northumberland, K.G., Viscount Ridley, Lord Barnard, Sir Lowthian Bell, Sir B. C Browne, the Bishop of Newcastle, Mr. Thomas Burt, M.P., the Dean of Durham, Principal Gurney, Sir Andrew Noble, Mr. J. Wilson Swan, Mr. W. A. Watson-Armstrong, Sir Thomas Wrightson, M.P., and Sir Lindsay Wood. Although the memorial was not definitely decided upon until last September at a meeting held in Newcastle, we understand that the first list of subscriptions already amounts to £21,963.

Electric Welding.—Mr. T. T. Heaton, of London, read a paper before the Manchester Association of Engineers last month on "Electric Welding" He described in detail two systems, the first being the Benardos system, in which an arc is used in conjunction with the article to be welded, and the other the Thomson system, in which the welding is effected by means of a heavy alternating current induced in the material to be joined. The author pointed out that the chief item in the cost of electric welding was not so much the labour involved, as the large power required in order to get the necessary heat. He advocated that the plant used for supplying the welding machinery should not be direct coupled, but that the engine should drive the dynamo by means of a belt. In conclusion, he pointed out that, as in other welding, the best results were to be obtained if they could keep one man on one type of job, so as to get him specialised. It appeared to the author that in future electric welding would be more largely used than at present, and that steam-boiler makers would find it of service for welding their seams, rings, flanges, etc. In the discussion which followed a number of speakers, while praising the author's paper as being a well-thought-out and moderate one, did not agree with him as to the use of welding for boiler work. Their chief argument seemed to be that the strong local heating which occurred with the electric welding was apt to so change the character of the steel plates as to make them unreliable in working. Another speaker, while testifying to the advantage of electric welding for steelwork, did not consider it had been proved so serviceable when wrought iron had to be welded together. In reply, Mr. Heaton, admitting that there had been failures in the welding of various fittings on to boilers, said he thought they were largely due to the want of skill in the work, and that if the various classes of welding were only specialised and carried out by special men, uniform good work could be obtained. He also advocated that, where possible, hammering should be used on the welded joint.

The Telautograph.—Sir William Preece visited the old Welsh town of Carnarvon on Monday night for the purpose of lecturing on the interesting features of the telautograph, which is an instrument for transmitting writing by electricity. The invention, which was first described and illustrated by us some two years ago, is said to have now been brought to as near perfection as possible. Its main principle is that the writing is transmitted from the sender to the receiver by the variation of the strength of the electric currents. When these arrive at the receiver their varying strengths are recorded by means of two measuring needles placed on either side. Diagrams and illustrations are transmitted in the same way. Tracing the history of the invention, Sir William Preece related how the first attempt to transmit written records by electricity carried back to the year 1848, but the operation then was so slow that the apparatus was not practical. Twenty-two years later Cowper produced his instrument, and in 1893 Prof. Gray devised an instrument which, like that of Cowper's, required four wires to work with. Subsequently an Englishman named Ritchie took the matter up, and the result of his labours was the instrument in question. The lecturer emphasised the fact that in the telautograph as it was now introduced there were five distinct connections—viz., the telephone circuit, call circuit, writing circuit, paper-shifting circuit, and the pen-lifting circuit, the last of which was the most ingenious device of them all. A point which was decidedly in favour of the apparatus was that the workmanship and strength of the mechanism were entirely void of delicacy. For the purposes of illustrating the lecture one of the instruments had been brought from London, and in the course of his remarks Sir Wm. Preece pointed out that it had been set in perfect order in less than five minutes after its arrival. He prophesied that the telautograph, which could not but be most valuable for merchants and other men with large business transactions, was certainly destined to occupy a very prominent position in connection with commerce in this country. We under-

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stand that the company owning the invention intend very shortly to place a number of the machines on private lines with a view to their early adoption by the public services.

Continuous-Current Transformer.—An interesting report has just been published by a committee of the Franklin Institute which has been investigating the merits of a constant-current transformer used by the General Electric Company for alternating series arc lighting The type of transformer in question, which is the invention of Prof. Elihu Thomson, is intended to have its primary connected to an alternating-current circuit of constant potential, and to deliver from its secondary a current of uniform amperage but of varying potential. These transformers are regularly made to take their supply from commercial circuits of 1,100 or 2,200 volts, and to deliver a constant current of 6·6 amperes under a varying potential up to 6,000 volts, depending on the size of the transformer. They are made in sizes for running 25, 50, 75, and 100 light circuits, with a liberal allowance for circuit drop. With regard to the question of efficiency the following figures were obtained from tests made on a transformer which had been in commercial use some months. With 58 lamps on the circuit the efficiency obtained was 94·24 per cent.; with 55 lamps, 94·17 per cent.; with 50 lamps, 93·87 per cent.; with 40 lamps, 92·11 per cent.; and with 20 lamps on the circuit the efficiency was 85·67 per cent. In several towns where a member of the committee has seen lamps operated from constant-current transformers, there has been a noticeable improvement in the uniformity of illumination over the intense contrasts made by the open arc. Correspondence with owners of plants using this system has also brought universally favourable replies, both as to the operation and to the character of the lighting. "In view," concludes the committee's report, "of the importance of the invention, providing as it does such an excellent method of operating series arc lamps from the same generators which supply incandescent light and power, the Franklin Institute have decided to award the John Scott legacy premium and medal to Prof. Elihu Thomson for his constant-current alternating arc light transformer." We believe that the transformer in question is practically the same kind of instrument that has been used for years by Messrs. Ferranti in conjunction with their rectifiers, which, however, have the additional advantage that a direct current is obtained for the arc lamps instead of an alternating.

Electricity Supply in Germany.—*Elektrotechnische Zeitschrift* has just published its annual table of statistics relating to the electricity supply works in Germany. These statistics represent the state of things up to April 1 last, and show that on that date there were 768 electricity supply works in operation in that country, as compared with 652 works in the preceding year. On an average the expenditure has been at the rate of just over £80 per kilowatt of generating plant installed, while the total capital expenditure on electricity supply works, exclusive of tramways, in Germany has been about £27,000,000. The number of works generating nothing but continuous current on April 1 was 81·3 per cent., as compared with 80·4 per cent. the previous year. However, this only represents 43·8 per cent. of the total kilowatt capacity of all the works, a decrease of 3·6 per cent. since last year. This is explained by the fact that there is a large number of small works with outputs below 100 kw. supplying continuous current, while the larger works usually lie at a distance from the supply areas, and generate three-phase or single-phase current, which is led to the sub-stations. The number of three-phase continuous-current systems has increased from 38 to 43 (41,757 kw. to 86,985 kw.), and the number of combined single-phase current systems from 6 to 10 (1,599 kw. to 6,874 kw). Purely three-phase works have increased from 39 to 45 (35,150 kw. to 40,759 kw.), and of works employing nothing but single or two phase currents the number has increased from 42 to 44 (21,570 kw. to 27,547 kw.). In two works, with an aggregate capacity of 950 kw., monocyclic generators are employed. Nearly all the continuous-current stations are equipped with batteries, only 24, or 33·8 per cent. of the whole, being without them. It is calculated that the average capacity of the accumulators in use is 36·2 per cent. of the capacity of the generators in the works in which they have been erected. Of the total 768 works, 56·4 per cent. have a smaller capacity than 100 kw., and there are in all 38 works with capacities of over 2,000 kw. The connections to the mains of all the stations represent an aggregate of about 352,500 kw., an increase of 28·8 per cent. over last year. The largest of the works now in operation in Germany is the huge water-power station at Rheinfelden, the capacity of whose generators is 12,000 kw., and next in order comes the Oberspree station, near Berlin, with a capacity of 10,770 kw., both these figures being exclusive of sub-station equipment. At the present time there are 90 additional works either contemplated or being erected.

Central Generating Stations.—The inaugural address of Mr. John F. C. Snell at the opening of the winter session of the Newcastle Local Section of the Institution of Electrical Engineers dealt principally with the question of the distribution of energy from central generating stations. Mr. Snell is the borough electrical engineer of Sunderland, and his views on municipal electrical undertakings therefore carry with them considerable weight. He showed, for instance, that no less than 81 municipalities had installed their own electrical undertakings in the last 18 years, representing an aggregate horse-power of 163,000 and a capital expenditure of over 10 millions sterling. In addition to these, during the same period 44 companies had established electrical undertakings in different parts of the country, representing an aggregate horse-power of 110,000 and a capital of over nine millions sterling. These figures together represented something like £63 per horse-power installed for municipalities and £82 per horse-power installed for private companies, and in passing he commented on the fact that apparently municipal undertakings cost much less to lay down than private installations. He also gave some interesting figures relating to electric traction in this country. At the present time there were electric tramways and light railways completed or under construction with a total mileage of 1,628 single track, and with a capital outlay of 16 millions. There were also 720 miles of other light railways contemplating the adoption of electricity as the motive power. Referring to the energy which had been displayed of late in obtaining powers to lay down immense generating stations from which electrical energy could be transmitted over wide areas of country, Mr. Snell expressed his opinion that unless this development were fully considered it might be a serious matter for the whole industrial position of England. He admitted that when there were a number of little towns of no more than 10,000 inhabitants it would be a waste of public money to put down separate sets of plant for each, and the most rational method in such case was to establish a station common to them all. In the case of a town of about 20,000 inhabitants, however, it was a matter for consideration whether it was not cheaper and better to instal a local station rather than to take energy in bulk from a large power station some distance away, and then after transformation to dis-

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tribute it in the locality. In the course of his address, which, we understand, was well received, Mr. Snell referred to the benefits which would result from the formation of these local sections of the parent institution.

Elasticity of Copper Wire.—When different specimens of the same substance are used for determining elastic moduli, the results vary considerably, so that the values obtained for any one specimen describe the behaviour of that specimen only, and do not hold universally for the substance in question. Determinations of the elastic moduli of metals are most often made on wires. It is, therefore, especially important to know how the elasticity of wires is affected by the processes used in their manufacture; of these drawing is the most important. In an article from the pen of Mr. J. R. Benton, which appears in the current number of the *Physical Review*, he gives the results of some experiments on the changes in elasticity which the process of drawing produces in copper wires. These are the principal facts that have come to light in the experiments. First of all, if a copper wire is first annealed by heating electrically to redness and is then drawn, its modulus of rigidity decreases, and Young's modulus increases. Also, each successive drawing causes a further diminution of the modulus of rigidity, and a further increase of Young's modulus; for both moduli the amount of change becomes less with each drawing. Finally, if the wire is annealed after having been drawn several times, the modulus of rigidity returns to a value considerably greater than its original value, and Young's modulus to one considerably less than its original value. The author puts forward the theory that the difference in elastic properties between the wires annealed before drawing and those annealed after drawing, is due to the fact that the latter cool from red heat more rapidly on account of their smaller diameter, and are therefore more completely annealed. Referring to the change in Young's modulus, the author thinks this is not sufficiently great to account for the very considerable increase in resistance to bending, notwithstanding that drawn copper wires offer much greater resistance to bending than annealed ones. The author, therefore, determined Young's modulus for the same wires by the method of bending. Contrary to expectation, the values obtained by flexure were considerably less than those observed by extension. This would seem to indicate, though by no means prove, that Young's modulus increases more in the interior of the wires than near the surface. It is to be noticed that the values obtained by the two methods very nearly agree for the annealed wire. The greater stiffness of drawn wires as compared with annealed wires must then be due simply to the increase in the limit of elasticity. The flexural elasticity itself increases only slightly in drawing. The experiments from which the author obtained the above results were carried out in the physical laboratory, Princeton University.

Falkirk Electric Lighting.—The proposed lighting of the Scotch burgh of Falkirk by electricity assumed a promising form last week, when the Municipal Council were presented by the Electricity Committee with the report of their consulting engineers, Messrs. Burstall and Monkhouse. This report gave every hope of a municipal scheme in the hands of the Council proving a profitable undertaking, and it obtained a favourable reception at the Council meeting. The engineers estimate that for an installation of 6,000 lamps the capital cost would be close upon £23,000, and that with about 5,400 lamps connected there would be a handsome profit. Offers have, however, been received from three electric companies who are willing to instal the electric light and work the undertaking themselves in Falkirk—viz., the Allgemeine Elektricitäts-Gesellschaft, Edmundson's Electricity Corporation, and Crompton and Co., Limited. It is interesting at this time to see what terms are proposed by these firms. The Allgemeine Elektricitäts-Gesellschaft, for instance, suggest that the Corporation should find cash for the equipment, and the company would then undertake to work it for a term of 10 years. If the town wished, it could take the plant over at an earlier date by paying to the company the difference in cash between the cost of operation and the receipts. The company would in any case pay 5 per cent. as interest and sinking fund charges to the Council. The Edmundson's Electricity Corporation offer much about the same terms with a period of 14 years. The Council, however, would have the option of terminating the agreement at the end of seven years by paying a premium of 10 per cent. on the capital outlay. This company would undertake to charge on the maximum-demand system at 7d. per unit for the first hour and 3d. for any further quantity. For motive power the charges would be 4d. per unit for the first hour and 1½d. afterwards. The company would charge the Corporation 3d per unit for electricity used in street-lighting. Messrs. Crompton and Co., Limited, have also submitted an agreement, in which the maximum price charged would be 7d. and 4d. per unit on the maximum-demand system or a flat rate of 6d. Street-lighting would be charged for at 3d. per unit, and 4½d. per unit would be required for all electricity used in lighting municipal offices. The full terms of this offer are not given in the report, but the consulting engineers advise that either of the first two are preferable in the event of its being decided to let a company come in. It remains to be seen whether the Falkirk Council will not take the advice of these engineers and keep the working of the plant in its own hands. By so doing, while they may make a slight loss the first few years in consequence of the repayment of loans, they will ultimately receive the profits to be derived from the working of the undertaking when more fully loaded.

German Electrical Industry.—From time to time we have referred in these columns to the general depression which is pervading the electrical industry in Germany, due in some measure no doubt to the craze for speculation which for some years now has been going on in that country. This state of things has led to the keenest competition for contracts for electrical plants and materials in this country from the German firms, who have sometimes gone so far as to accept orders on which only a financial loss was to be anticipated so as to keep their works from being shut down altogether. That the industry in Germany is at the present time in a critical condition is borne out by a review of affairs which appears in the issue of *Kuhlow's German Trade Review* for the 27th ult. Only as recently as three months ago, one large electrical company in that country had to go into liquidation, notwithstanding the attempts made by the two principal electrical companies in Berlin to reorganise the business. There was no prospect of a purchaser, and the very limited output at the works had to be discontinued. Following on this, proposals to wind up have also been made by one or two other electrical concerns of less importance, and these are still under consideration. The result, according to our contemporary, is that no one will look at an electrical security in Germany at the present time, and there is little hope of any improvement until the confidence of the public has been restored. Whilst the idea of apparent insecurity dominates the minds of investors, the industrial banks are marking time, and all their resources it is thought may be required to weather the storm which is passing over the country. On their part the manu-

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facturing companies have, generally speaking, found business slacker this year, and there have been large dismissals of workmen, but the full effects of the depression will scarcely be known until next year. The results of the past year's working of some of the large companies have not yet been published, but our contemporary furnishes a summary indicating the position in regard to some of the other undertakings. Practically, the only electrical concern mentioned in this list which does not appear to be under the influence of the general depression predominating in German industrial circles, is the Felten und Guilleaume Gesellschaft. This company has recently been reconstituted, and the first general meeting was only held a short time ago, when accounts extending over a period of 18 months were passed. With a capital of £1,800,000, the profits earned by the company during that time amounted to £400,308, of which £42,554 was written off for depreciation, and out of the balance of £357,754 the shareholders received £225,000 by way of dividend at the rate of 10 per cent. per annum. But this is only the exception which proves the rule, and nearly all the remaining concerns mentioned show a falling off in profits and in the distribution of dividends.

The Post Office Telephones.—The vitally important question as to the purchase of the National Telephone Company's plant by the Post Office at the expiry of their license at the end of 1911 has up to the present by no means been made clear. From different quarters come different reports, the conflicting nature of which render it impossible to decide whether the agreement between the company and the Post Office binds the latter to buy up the whole or only a part of the company's plant in London when the times comes for the Post Office to take over the sole control of the metropolitan systems. From what appeared in one of the financial papers this week, the conclusion to be drawn is that the Post Office have only agreed to purchase such part of the company's plant as they may actually require. According to the *Financial News*, which presumably has seen a copy of the complete agreement between the parties, it is provided that at the termination of the company's license "the Postmaster-General shall buy and the company shall sell and convey all such plant as is at the date at last aforesaid in use by the company for the purpose of the company's London system, and as is suitable for the actual requirements at the date last aforesaid of the telephonic service of the Post Office within the London area." A further clause qualifies this provision, to the effect that no plant shall be considered suitable which has been introduced without the sanction of the Postmaster-General. The conclusion to be drawn from the words "actual requirements," naturally is that only that portion of the company's plant as the Post Office may like to have will be taken over in 1911; but instead of leaving the public to speculate as to what the effect of the terms come to by the company and the Postmaster-General really is, would it not be only right to publish the agreement in full? Turning to another side of the question, we are pleased to see that the London County Council have decided to send a deputation to wait upon Lord Londonderry next Friday to represent the general dissatisfaction which is felt with the new telephonic arrangements for London, Lord Londonderry's consent to this having previously been obtained. The discussion of the question which took place at the meeting of the Council last Tuesday brought out one or two interesting facts as regards the tariff to be enforced. The present arrangement, so far as it is known, implies that no reduction can be made without the consent of the company, but Mr. Stuart Sankey, in his defence of the Government on Tuesday night, stated that, according to the all-important agreement, which he had had the privilege of seeing, the road was left open for a revision of the tariff in January, 1905. If this be so, the case is not so black as it looks at first glance. It may be that the agreement is far more favourable than we have been led to believe, and in justice to the public—who, after all, by their patronage will be responsible in no small measure for the success or non-success of the Post Office telephones in London—we sincerely trust that the full terms of the agreement will be published at as early a date as possible.

Train Resistance.—Mr. J. A. F. Aspinall read a valuable paper on this subject before the Institution of Civil Engineers on the 26th ult., in which he gave the results of experiments carried out with a dynamometer car on the Lancashire and Yorkshire Railway, in an endeavour to arrive at the tractive effort required to haul modern railway carriages. Especial attention was paid in making these tests to the important question of wind pressure as affecting the speed of the trains, and the apparatus used for determining the velocity and direction of the wind allowed of two separate diagrams to be taken to make sure that accurate results were obtained. The trials were made on the line between Wigan and Southport, and the following was the method employed: The position of the regulator and reversing gear on the engine was marked for each test, these positions being governed by the speed at which it was desired to run. After the regulator and wheel had been set they were left in position during the whole of the run, the engine being allowed to acquire whatever speed it could, and steam pressure being kept as constant as possible. Both the outward and return journeys were made with the engine set in exactly the same position. This was judged to be the best method of ascertaining the tractive force required to haul the train at different speeds, as the acceleration which would have been caused by altering the position of the regulator was entirely eliminated; and the gradients being very slight, it was possible to obtain readings at a constant speed for a mile or more. The mean result of the experiments is embodied in the formula $R = 2{\cdot}5 + \frac{V^{\frac{5}{3}}}{50{\cdot}8 + 0{\cdot}0278\,L}$, where R was the resistance in pounds per ton, V the velocity of the train in miles per hour, and L the length of the train, over coach bodies, in feet. Where the gradients admitted of it experiments were made to see on what incline a train would start by itself, and the results led to the conclusion that the starting resistance was about 17lb. per ton. The author had attempted to resolve the total resistance indicated by his formula into its components—viz., axle friction, atmospheric resistance, and miscellaneous resistances, the latter including resistance due to oscillation and concussion, flange friction, and rolling friction. Having explained the method of calculating the axle friction, he next dealt with the atmospheric resistance, comparing the results obtained with those of experiments made by Smeaton, Nipher, and Goss. Indicator diagrams were taken from the engine drawing the dynamometer car and train, but the results had not shown any well-defined relation between the indicated horse-power and that calculated from the tractive effort, as recorded simultaneously by the dynamometer, and the speed of the train. Notwithstanding that the experiments described above were made on an ordinary length of line, the author reminded his hearers that the ever varying nature of the conditions of running in practice rendered it almost impossible to find a formula which could be applied in every case. The paper was accompanied by an appendix giving in tabular and in graphic form the results obtained by a number of previous investigators.

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THE POST OFFICE TELEPHONE EXCHANGE FOR THE CITY OF LONDON.

The Postmaster-General, as is well known, has been organising for the past two years a complete telephone system for Greater London. The evidence of this has been apparent to the public from the fact that underground wires are to be used, and in consequence all the main streets have been opened out to receive the cable ducts. The system of laying these ducts has been described in our columns, and also the fact that paper and air insulated conductors are being used. We propose at the present time, therefore, only to refer to this fact in passing, and to devote our attention to that portion of the work which has not come under public gaze. Through the kindness of Mr. J. Gavey, the engineer-in-chief to the Post Office, we have been allowed to go over the central exchange in Carter-lane, and to interview Mr. J. H. Stanhope, who is the engineer in charge of the equipment at this exchange. Mr. Gavey also kindly provided us with diagrams of connections, which are given below, and which enable the connections both of the power plant and of the telephones to be understood.

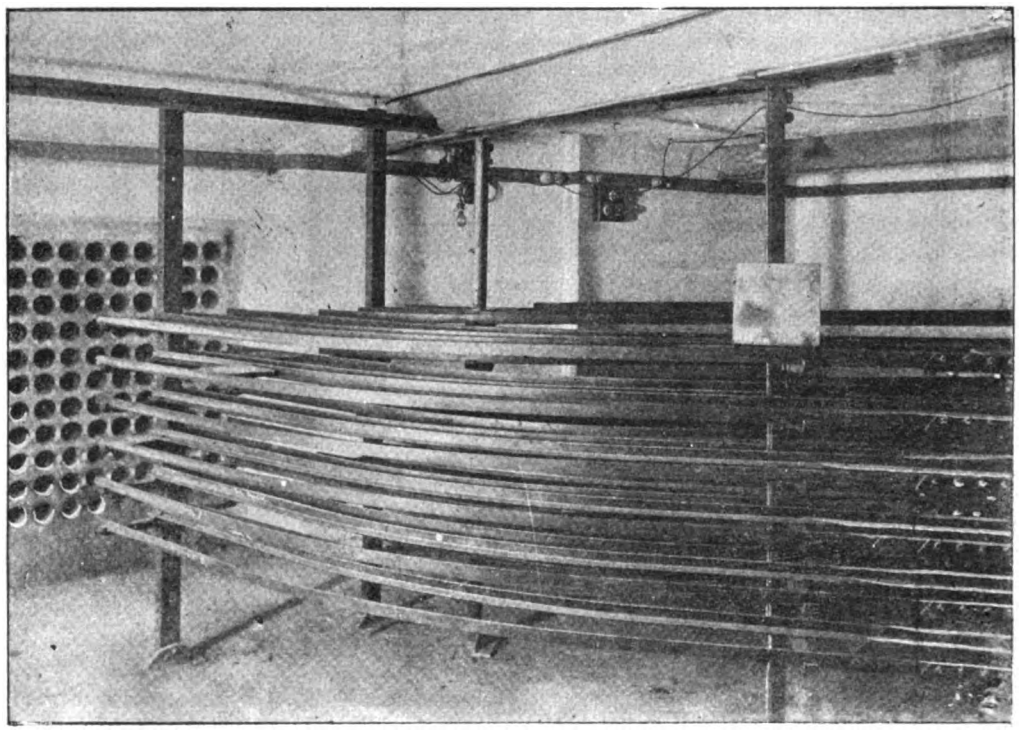

FIG. 1.—Post Office Telephones. View of the Cable Ducts going to Queen Victoria Street, and also of the Supports for Cables on way to Terminal Board.

The four exchanges which are now in course of completion are respectively this central exchange (described below), the Westminster exchange, the Kensington exchange, and the exchange at Paddington. These four exchanges will serve the bulk of the business subscribers in London. Naturally, however, the central exchange is expected to provide for the business men in the city of London, and it is being organised for 14,500 subscribers. The building in which the telephone plant has been placed in Carter-lane forms a part of a Government building previously devoted solely to the Post Office Savings Bank Department. The Telephone Department has now taken over the end of the two basements and also of the top floor. The switchboards are so arranged on this top floor that as the subscribers increase they can be extended in a straight line along the rest of the top floor, which at present is still left to the Savings Bank Department.

Commencing with the incoming cables from the street, we have to deal with the second, or sub-basement. There are three entrances for cables in this basement. The first consists of 110 ducts, which are laid in a straight line under and through the rest of the buildings out into the main ducts in Queen Victoria-street. Fig. 1 shows the point of entrance of these ducts into the basement. Besides these, there are 50 ducts by which cables can be led in from Dean's-court, and 54 ducts from Godliman-street. These ducts (which cannot be seen in Fig. 2) terminate at the top of the inclined way, which is shown in the background of that photograph. This makes in all 214 ducts, each of which can carry a cable of the standard size containing 217 pairs of wires. Thus the provision, as far as ducts are concerned, is made for 46,438 pairs of wires, from which it will be seen that there is ample allowance for future extensions. Of course, in comparing this number with the number of subscribers the switchboard is organised for, allowance must be made for a large number of junction wires to other exchanges all over Greater London. In view of the agreement between the National Telephone Company and the Postmaster-General, a large number of junction wires will have to be laid to each of the exchanges of the National Telephone Company as well as exchange and trunk wires to the Post Office. The next feature in this sub-basement to be noticed is the method of supporting the lead-covered paper and air-insulated cables on their way to the distributing frames on the next floor. For this purpose a number of iron pillars are provided, carrying cross-arms at intervals, as seen in Figs. 1 and 2. To these cross-arms at either side of the pillars are bolted longitudinal angle irons: two of these angle irons come on each side of the pillar and form chases, into which square slabs of slate, as seen in Fig. 1, can be dropped. Three of the large cables are then laid side by side along the slate causeway so made. These routes, leading to the up-going cables shaft to the next floor, are arranged with easy curves, so that there is no difficulty in bending the lead cables. The next point is that each of these cables is at some point of this rack spliced into a lead-covered cable, in which the wires are insulated with silk and cotton. The sleeve which unites the lead of the two types of cable is provided with a nipple on to which air-pipes can be connected. As the insulation of these air and paper insulated cables depends on absence of moisture, it is proposed to keep a 10lb. pressure always on the cables. Pressure gauges will then be attached to each, from which readings will be taken each day. A sudden fall in pressure will indicate a leak, and dry air will at once be forced into that cable and kept circulating until the leak has been located. In the front of Fig. 2 will be seen one of the motor-driven air-pumps used for this purpose. The whole of the silk and cotton insulated cables are grouped together in one end of the sub-basement and then passed vertically up to the next floor, which is the basement of the building.

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The point on this floor where these cables arrive is illustrated in Fig. 3, which shows well the circular guides round which these cables bend on their way to the testing and distributing frame. The cable terminals, to which the wires in these lead cables are connected, are at the back for each line wire from any subscriber. From these vertical lines of connections other cables, also of the lead-covered, silk and cotton insulated type, are led up to the top floor of the building. The rest of the space in the basement is devoted to the power plant for providing the direct and

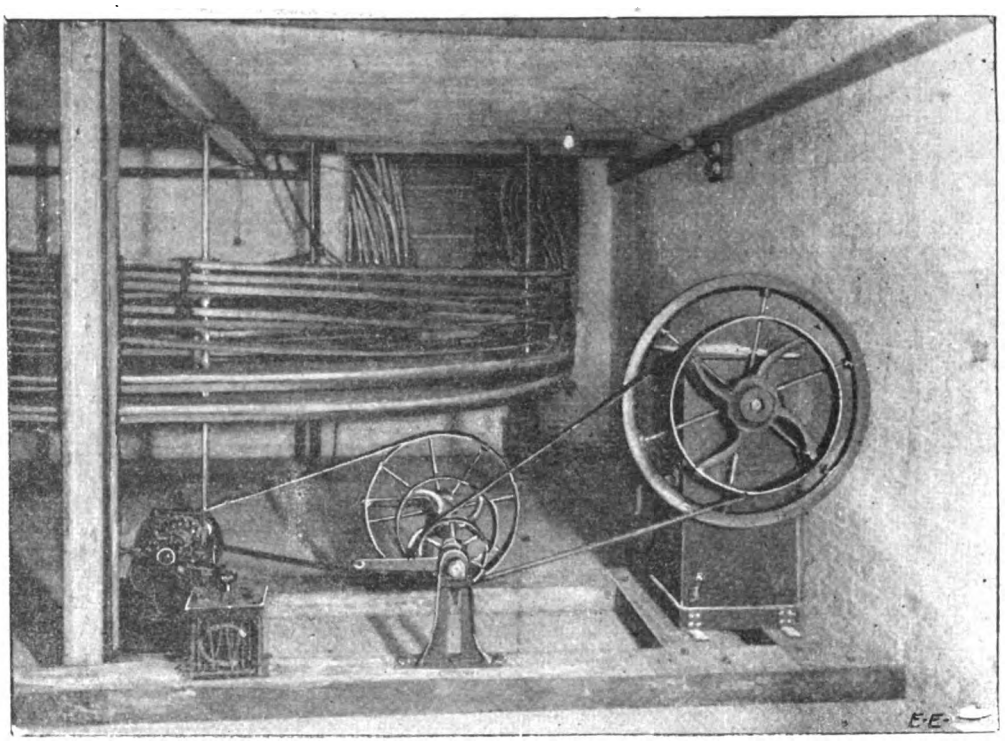

FIG. 2.—View of the Cables coming in from Godliman Street. A Motor-driven Air Pump is in the foreground.

of the frame, and cannot be clearly seen in the illustration. They are arranged, however, in horizontal lines. From these, on which the cable wire numbers appear, wires are led to the vertical lines of springs on the front of the racks which can be seen in the illustrations. Between

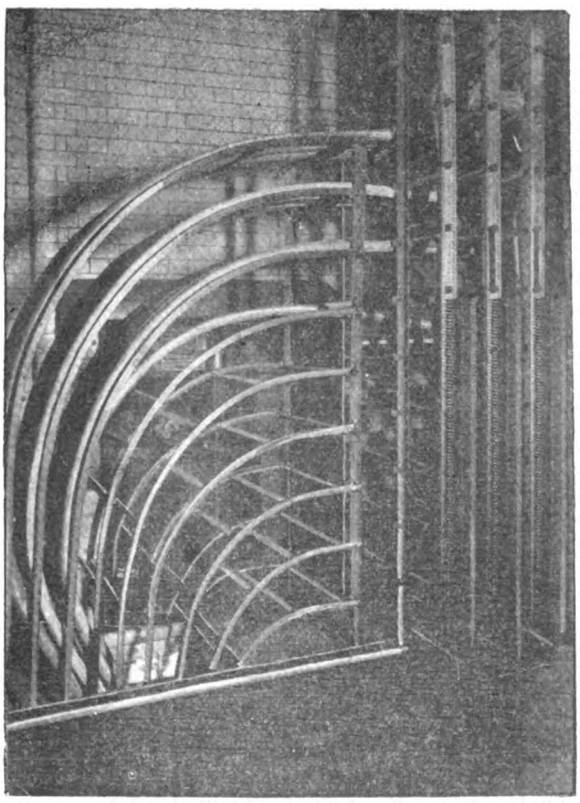

FIG. 3.—Cables turning into Terminal and Distribution Rack, which extends a long distance to the left.

these springs, which are arranged consecutively as regards subscribers' numbers, are placed the heat coils, which prevent large currents passing through into the switchboard. At the same point are also placed the lightning arresters, one of which, as well as one heat coil, is provided

alternating current required in the exchange. Hence, before proceeding to describe the telephone apparatus on the top floor, we propose to explain and describe both this power plant and its diagram of connections (Figs. 4 and 4A). We regret that in consequence of the length of this diagram we have been obliged to reproduce it in two halves. Thus the right-hand side of Fig. 4 joins on to the left-hand side of Fig. 4A. The lettering of the wires which have been cut is identical at each of these sides, so that connections can be readily traced from one to the other.

It must be borne in mind that the telephone switchboard at Carter-lane is of the "central" or "common battery" type; the latter is perhaps the better name, as not only is the current necessary for working the subscriber's instrument supplied from the central exchange, thus doing away with magneto generators and batteries at the subscriber's offices for "ringing-up" the exchange, but the whole of the current required for any line for calling up the exchange, ringing up the number asked for, speaking when through, and "clearing" when the conversation is finished, is derived from the same source of energy. The power plant consists of two motor-generators, each comprising a 25-h.p. motor of the four-pole type, shunt-wound and coupled direct by means of an insulated flexible coupling to a four-pole shunt-wound generator specially designed for telephone work, having an output of 500 amperes at 30 volts running at 650 revolutions per minute. The motor is controlled by a Cutler-Hammer starting box with an electromagnetic release which opens the circuit in case of overload or failure of current, automatically inserting the resistance in the field. The motor is supplied at 102 volts from the lighting installation in the building. Each generator is fitted with a Ward-Leonard rheostat for regulating the voltage, and is joined through the usual switches and 'bus bars to a battery, which consists of 11 cells of the C.B. type, made by the Chloride Electrical Syndicate, Limited. These cells, of which two complete sets are installed, have a normal output of 2,000 ampere-hours at a 250-ampere discharge rate. Fig. 5 is a view of these batteries.

The ringing current is supplied by two ringing motor-generators, each giving a ± current of 2 amperes at 75 volts running at 1,000 revolutions per minute. One is a series-wound motor designed to run from the power mains

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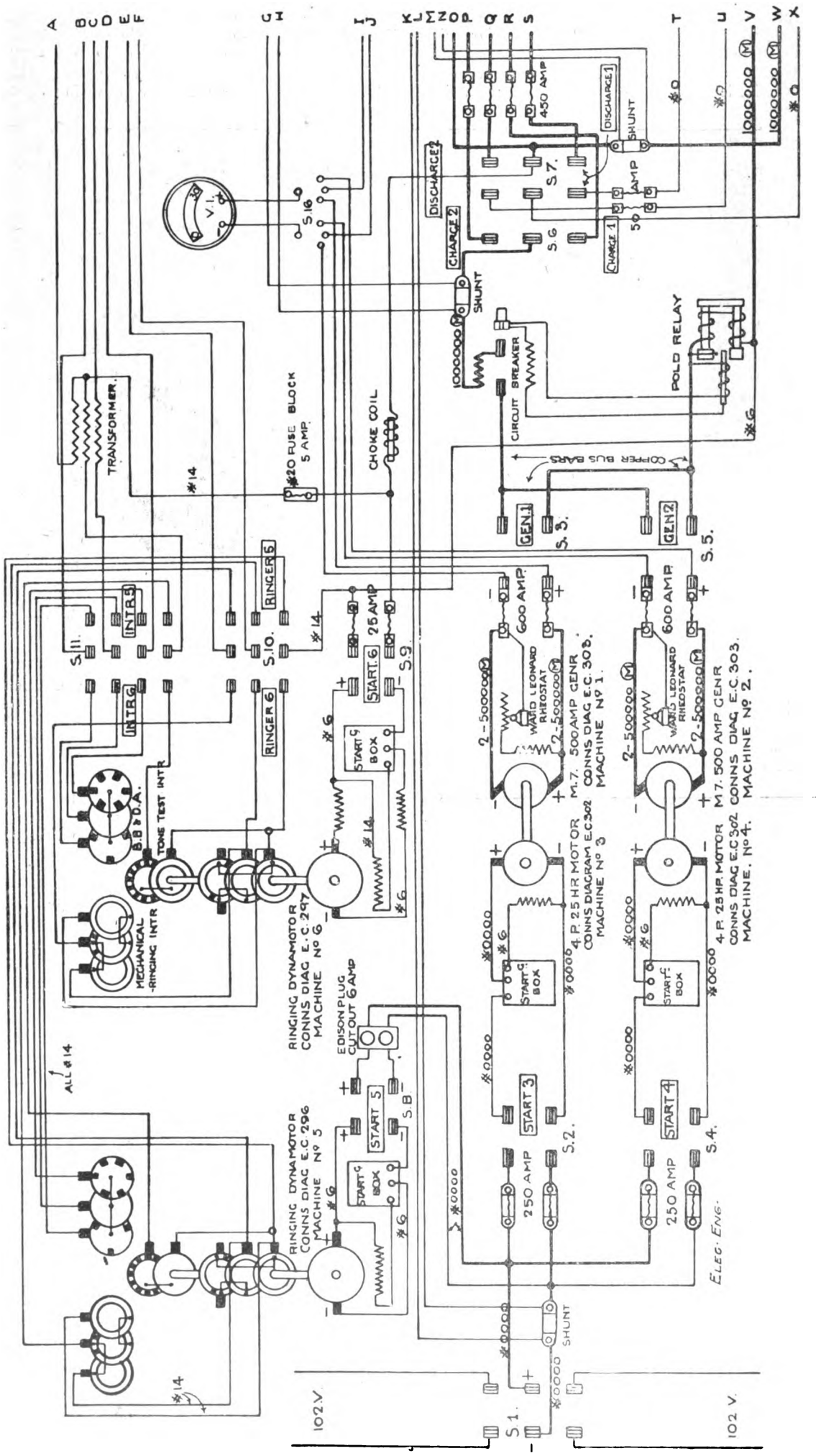

FIG. 4.—Connections of Power Circuits at the Central Exchange of the Post Office. The Right-hand side of this Diagram joins on to the Left-hand side of Fig. 4a.

at 102 volts, whilst the other is a differentially-wound shunt motor, designed to be run at 22 to 28 volts from the batteries, to which it is connected through a choke coil to prevent disturbances on the speaking circuits. The ringer

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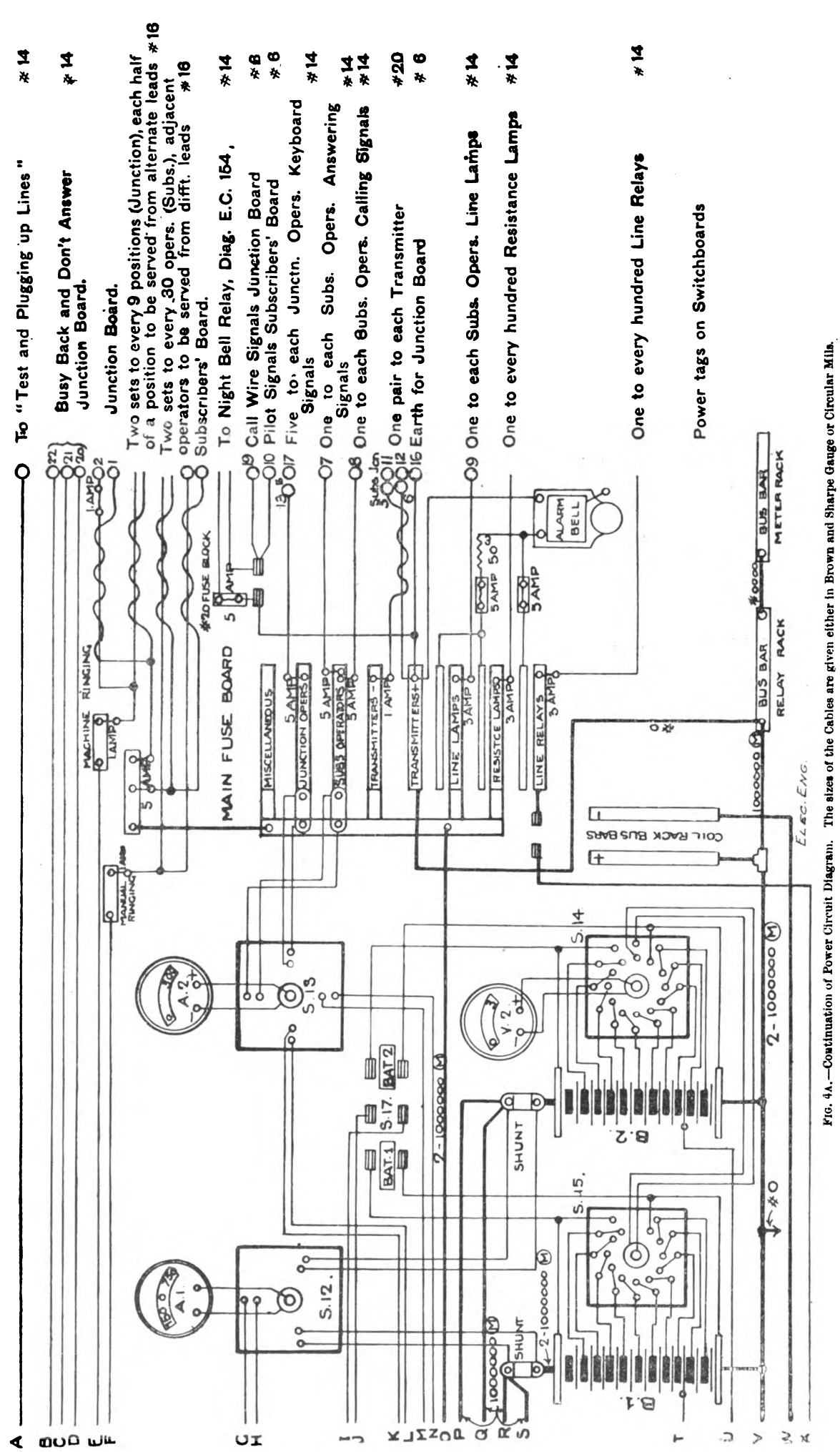

FIG. 4A.—Continuation of Power Circuit Diagram. The sizes of the Cables are given either in Brown and Sharpe Gauge or Circular Mils.

shafts carry, and drive by worm gearing, several commutators for supplying an interrupted ringing current for the automatic ringing keys on the incoming junction positions and the various "tone" signals, the circuits of which may

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be traced on the accompanying plan of "connections of power circuits." The various instruments and switches indicated on the plan are mounted on a three-panel switchboard (motor, generator, and battery panels) and on reference to the diagram it will be seen that by means of switches

supplied from the lighting mains to the motor, and the various currents passing out to the repeating coil rack junction, and subscriber's keyboard signals. The ammeters are of the shunt type, manufactured by the Weston Electrical Company. Switches 14 and 15 are 12-point volt-

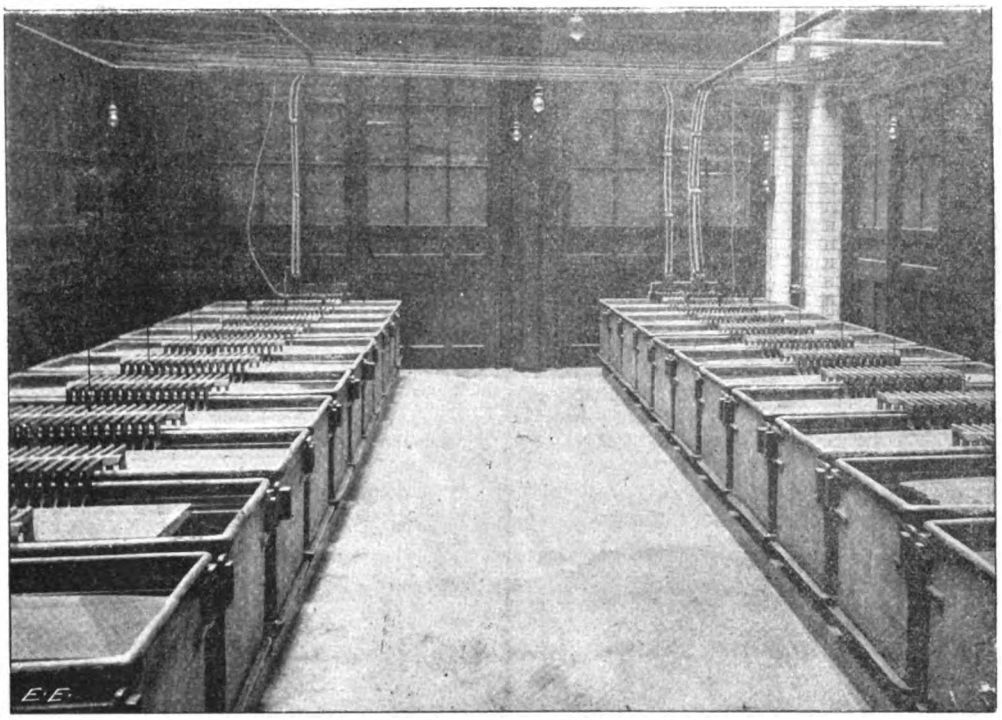

FIG. 5.—The Two Batteries of Accumulators at the Carter Lane Exchange.

3, 5, 6, and 7 either generator may be connected to either set of cells for charging purposes; further, that you may be charging one set and discharging the other, or have the generator on to the exchange 'bus bars with the battery shunted across the mains. Similarly, the ringing current may be supplied by either No. 5 or 6 ringer by closing

meter switches, by means of which the voltage of individual cells may be taken at the switchboard on the low-reading voltmeter, V2. The twelfth position on switch 14 connects switch 15 to the same voltmeter, whilst position 12 on switch 15 leaves the voltmeter circuit open. Voltmeter V1 reads from zero to 50 volts, and can be connected by means

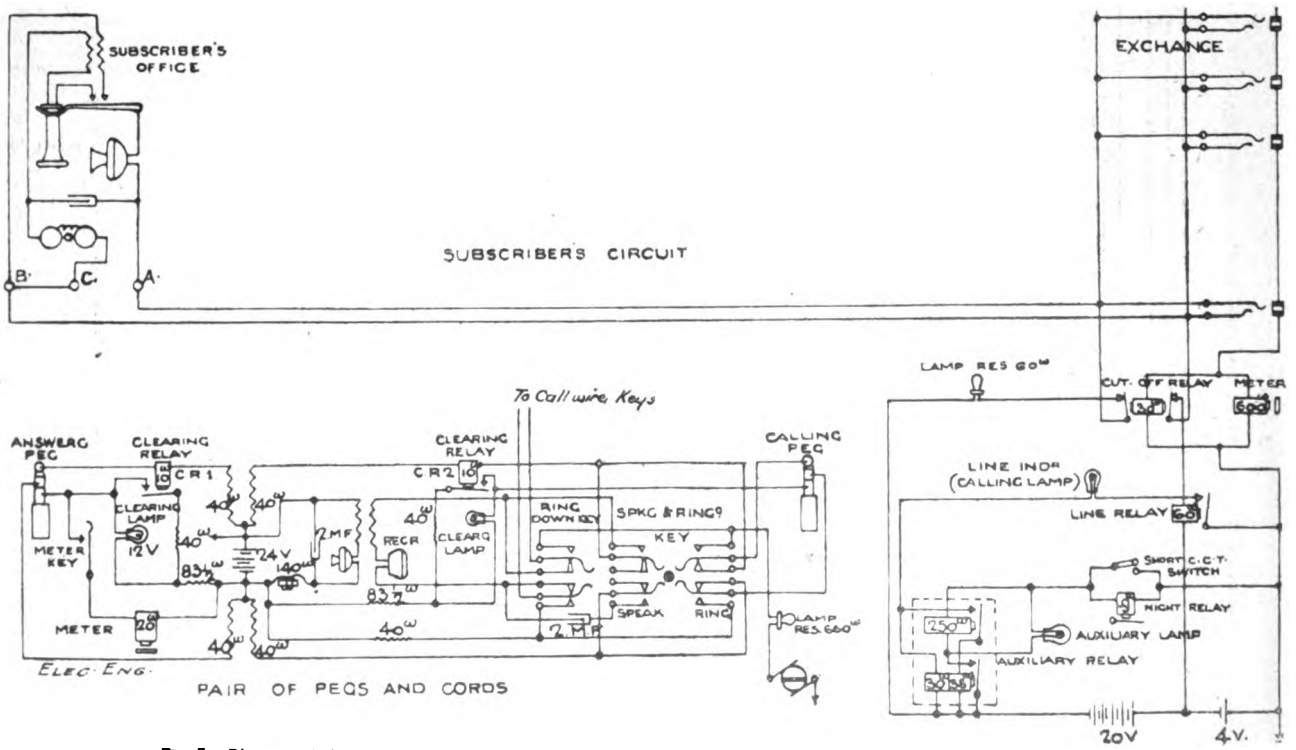

FIG. 7.—Diagram of the Connections of a Pair of Cords and Pegs.

FIG. 6.—Diagram of a Typical Subscribers' Circuit.

switches 8 or 9 and throwing over switches 10 and 11 to the corresponding position. Switch No. 12 is a three-point switch, by means of which the charging or discharging current on batteries 1 or 2, and also the current supplied by the generator, may be measured on ammeter A1. Switch 13 is a four-circuit switch, which in conjunction with A2 enables the switchboard attendant to measure the current

of switches 16 and 17 across the terminals of each generator and battery. A circuit breaker is inserted in the main charging circuit as a protection to the generators and batteries. It is designed, in conjunction with a polarised relay, to open the circuit in case of either overload or current reversal.

Having thus briefly outlined the source of current, it

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will be well to complete a description of the connections used in the telephones themselves and on the switchboard on the top floor. Referring to the diagram of the subscriber's circuit (Fig. 6), it will be seen that in the normal position of the switch-hook at the subscriber's office the lines A and B stand open to battery currents, but are bridged by a condenser and magneto bell in series, whilst at the exchange the negative pole of the battery is connected through a resistance lamp of 60 ohms, and one contact of the cut-off relay to the A line; the B line being connected through the other contact of the same relay, and the coil of the 60-ohm line relay to the ninth cell. There is thus a difference of potential of 20 volts between the two lines, and as soon as the subscriber removes his receiver from the switch-hook he closes the circuit through his transmitter and the primary winding of his induction coil. The current now flowing energises the line relay and closes the local circuit through the line indicator, or calling lamp, thus indicating that the subscriber requires attention. It will be seen that the line-lamp circuit includes the 30-ohm coil of the auxiliary relay; hence the armature is attracted, closing the circuit from the negative pole of the battery through the 250-ohm coil and auxiliary lamp in parallel, to earth through the short-circuiting switch, or coil transformer to the positive pole of the battery, which is earthed, whilst the ring is connected through a second coil in the transformer to the negative pole of the battery, which is also connected through the 83·5 ohms resistance and 12-volt clearing lamp to the sleeve of the peg. The connections of the "calling peg" are made in a similar manner, but, in addition, the A and B conductors pass through the ringing contacts of a combined ringing and speaking key. Suppose, now, the subscriber "calls up" by removing his receiver, the operator at the exchange inserts the answering peg of a pair of cords in the jack immediately above the lamp glowing, which puts the battery to earth through the clearing lamp, the sleeve of the peg, the bush of the jack, and the coils of the cut-off relay and subscribers' meter in parallel. The current now passing through the meter is not, however, of sufficient strength to actuate it until the operator presses her meter key on completing the call, thus shunting the clearing lamp and 83·5 ohms resistance with the 20-ohm coil of her meter. But the major portion of the current from the sleeve of the peg passes through the cut-off relay coil, the contacts of which are opened, thus breaking the circuit of the line relay and extinguishing the line and auxiliary lamps. The battery, however, is now bridged directly across the

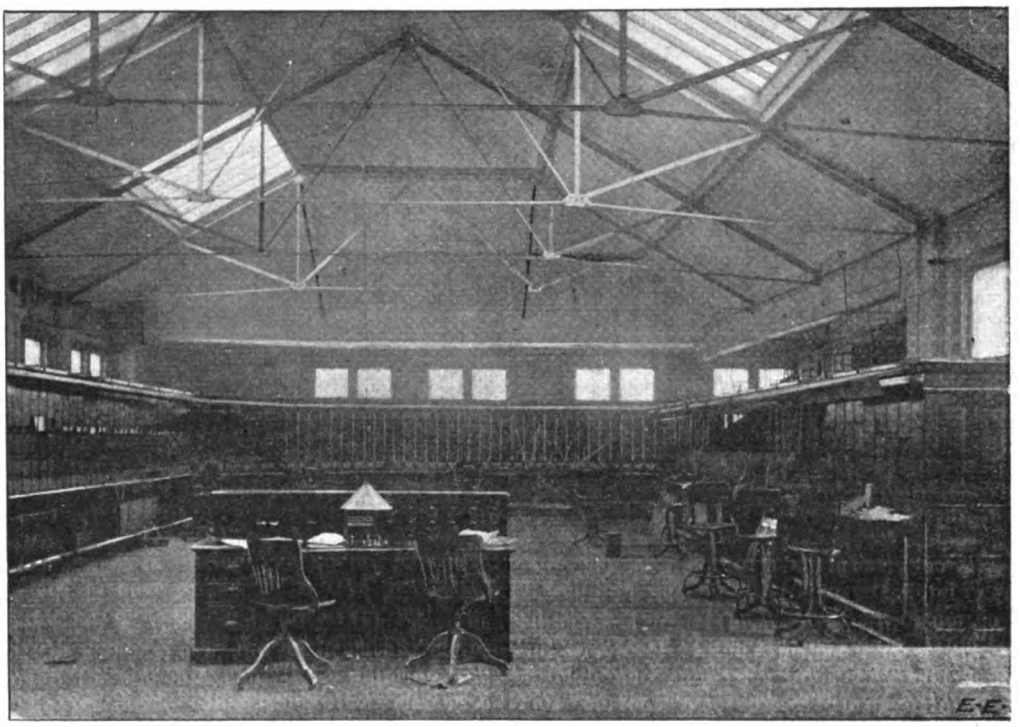

FIG. 8.—General View of the Central Exchange of the Post Office at Carter Lane.

of the night alarm relay, as the case may be. This current in turn energises the 250-ohm coil, and its armature closes the circuit through the ·38-ohm coil, thus shunting the 30-ohm coil. The reason for this somewhat elaborate shunting device is perhaps not very apparent, but if it be borne in mind that the wire from the auxiliary relay to the line lamp supplies the current for all the 60 line lamps in that panel, it is very evident that with several lamps alight at once the drop of potential through the 30-ohm coil would become appreciable, and the lamp would be dim. It is interesting to notice also that an "earth" fault on either A or B line, or a short-circuit or contact between them, would at once be apparent in the exchange, an "earth" on A causing the resistance lamp to glow until the fault is removed, whilst an "earth" on B will actuate the line relay owing to the 4-volt drop through the fault, thus giving a permanent "call."

Turning now to the diagrams of the cord circuits (Fig. 7), we see that the cords themselves have three conductors, which are joined to the "tip," "ring," and "sleeve," or shank of the peg. The "tip" and "ring" conductors make contact with the B and A lines respectively on inserting the peg in the switch springs or "jack." The "tip" or B conductor of the "answering peg" is connected through the coil of the clearing relay, CR1, and one coil of the repeating coil or subscriber's lines through the tip and ring of the peg and the local switch springs, and a current is flowing through the subscriber's primary coil and transmitter. This current also passes through and energises the clearing relay, the action of which is to shunt the lamp with 40 ohms; hence the lamp does not glow whilst the receiver is off the hook at the subscriber's instrument. Referring to the diagram, it will be seen that the operator's primary circuit is bridged across the whole 24 volts of the battery, and on this account a retardation coil of 140 ohms is joined in series with the transmitter and a 2-microfarad condenser bridged across it. The joint effect of these is to prevent cross-talk through the battery and by reducing the voltage across the transmitter to make speech more distinct. The operator's secondary circuit includes another 2-microfarad condenser in series with the receiver and secondary of her induction coil, and this combination is bridged across the tip and ring conductors of the "calling peg" by pushing over the speaking and ringing key to the speaking position. On speaking into her transmitter the operator sets up an induced current in her secondary circuit, which is completed through the calling half of the repeating coil, the low resistance of the battery forming practically a short-circuit. Here a further transformation takes place, high-potential vibratory currents being set up

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in the other half of the repeating coil, which are superimposed on the primary current already passing through the subscriber's transmitter. The course of these currents is through the primary and secondary coils of the subscriber's instrument in series, thence through the receiver and condenser to line. Having ascertained the subscriber's wants, the operator next proceeds to "test" the line required. It will be seen that the bushes of all the multiple jacks and the local jack on a line are connected to earth through the cut-off relay. The tip of the calling peg and tip side of condenser are also at zero potential; hence if the operator touches the bush of a disengaged line with the tip of her peg, no sound is heard in her receiver. If, however, a plug be in any of the jacks, all the bushes will be connected to the battery through the sleeve of the peg, and on touching any other bush the operator will get a "click" in her receiver, caused by the momentary rush of current through her secondary, due to the redistribution of potential in the condenser. Finding the line disengaged, the operator inserts her calling peg, and proceeds to ring the number up by pulling over the ringing and speaking key to the ringing position. The clearing lamp immediately

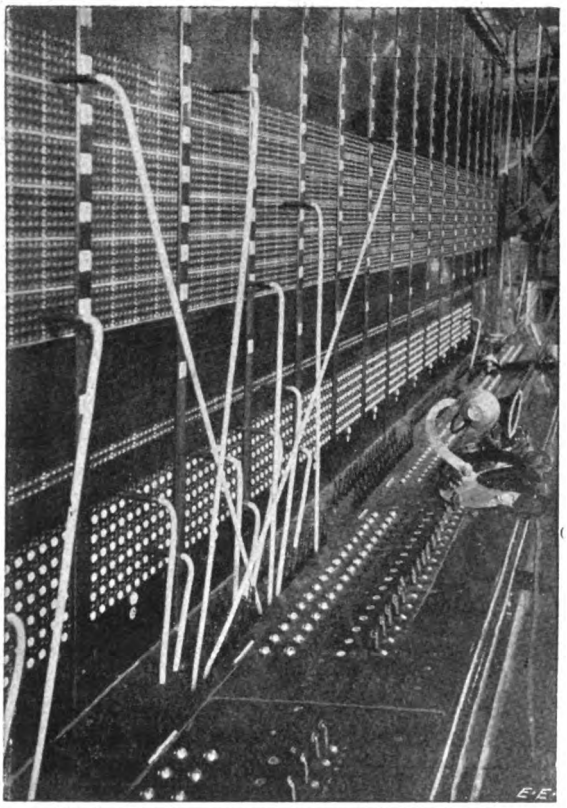

FIG. 9.—View along Main Switchboard, showing one Operator's Section, and also Head Gear for Telephones.

lights, and remains lighted until the subscriber answers the call, when he shunts it by means of CR2, and both lamps cease to glow whilst conversation is taking place. When it is finished, each subscriber hangs his receiver up, thus opening the clearing relay circuit, and causing the lamp to glow, indicating to the operator that the connection is done with.

When connection is required on to another exchange, the operator speaks to that exchange by means of a call wire button; the operator in that exchange allots a junction wire and then completes the connection. In the event, however, of the subscriber on the distant exchange not being available, the junction wire operator gives what is known as the "Busy back" signal. This indicates that the connection has not been made, and also the reason. Again, if the subscriber will not answer, the "Don't answer" signal is given, which also indicates that no connection can be made. It will be seen from the diagram of the power connections (Fig. 4) that the current for these "Busy back" and "Don't answer" signals is taken from special commutators, which give distinctive series of interrupted signals. In this way verbal explanations between the operators are avoided, and much time saved in consequence.

Having now got through the principal connections required in telephoning, we will resume the description of the station as a whole. The lead-covered, silk and cotton insulated cables are led up a vertical shaft from the basement to the top floor of the building. They are strongly clamped at intervals, so as to prevent the weight of the cables coming on the top support. In Fig. 7 we show a general view of the exchange switchboard, in which the main board for the central exchange commences at the left hand, and is continued round until almost the right-hand side of the photograph. The right-hand side of the rectangular space is occupied by the incoming junction board. It will be seen, therefore, that both the junction wire board and the main board can be extended in the direction from which the photograph was taken. At the farther end of this building there is a large space running out to the right. This has been utilised for the racks of meters, the relays, the incoming cables, fuses, etc. When the lead-covered cables come up to this floor, they are divided up on a rack, which is not unlike that shown in Fig. 3. On this rack the cables from the basement, each of which contain 102 pairs of wires, are split up into blocks of 20 on to terminals on the one side of the rack. On to

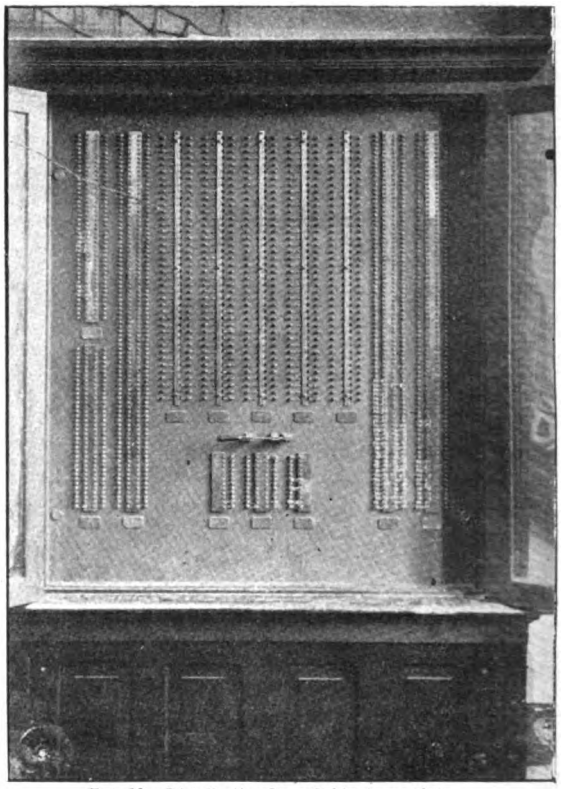

FIG. 10.—Distributing Fuse Cabinet, supplying Groups of Circuits.

these are connected wires which are bound up into cables containing 63 wires which are tee'd into the multiple-contact cables which run all round the main board. On the other side of the rack are the vertical lines of terminals from which subscribers are distributed to the various operators. The switchboard is designed for 180 subscribers to be looked after by each operator, who would then have to attend to all the calls made by this number. At the back of this rack, however, it is easy for a subscriber to be moved from one operator to another if found necessary. It would seem to us that this number of 180 subscribers is much too many for an exchange in the city of London, in which the telephones are used entirely by business people. Each operator has only 17 cords and pairs of plugs, so that she can only deal with calls from 17 subscribers out of the 180. This, of course, can be altered by connecting fewer subscribers on to each operator, but these alterations are of a somewhat permanent nature, and we could find no arrangement by which a girl could be temporarily relieved in the busy part of the day. In this respect the system is not so flexible as the one in use in Glasgow. Behind the rack referred to above are placed the relays and repeating coils described previously. These are mounted

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on a large framework, and are provided with dustproof covers to protect them from the dust which is always found in London buildings. Behind these again come what resembles a wall of meters, on which calls can be recorded. These meters, which, of course, will only be required as a matter of interest except by those subscribers who pay on the message-rate system, are exceedingly simple pieces of apparatus. They consist essentially of an electromagnet worked from the key opposite the cords on the operator's table. The armature of the electromagnet works by means of a pawl the first wheel of a train of counters. It will be seen, therefore, that with this system of recording the number of messages the subscriber will simply receive a statement that he is to pay for a certain number of calls successfully completed, and there is no record as to when or with whom the calls were made. Each operator also has a meter, which records the number of calls to which she attends. We trust that this system will be found satisfactory to subscribers, but it is open to the objection that it does not tell a subscriber that his office boy is regularly talking to the brother of his sweetheart, and laying the blame when questioned on the meter at the exchange. It will be seen from Fig. 9 that the multiple board is in this exchange arranged on the vertical pattern. The 14,500 subscribers are repeated on this multiple board at every 6ft. 3in. horizontal length. It is interesting to compare this with the Glasgow board, which is of the horizontal type, and in which 10,400 subscribers are got into 5ft. 5in. horizontal length. Of course, the Post Office board provides for a larger number of subscribers, but it seemed to us when sitting on the operator's chair that the Postmaster-General will require young ladies with a long reach if they are to get to all subscribers while remaining seated. In this illustration (Fig. 9) will be seen the arrangement of indicator lamps, plug cords and lamps, calling keys, and meter keys for each operator. The whole of the equipment of this central exchange has been supplied by the Western Electric Company, and it shows great care in detail.

It will be remembered that in this central exchange subscribers must either pay for unlimited calls, or else on the message-rate system. There are no party-line subscribers allowed. We learn, however, that on the other exchanges the arrangements for the two-party lines will be somewhat as follows: The subscribers will be rung up one with each line wire, but there will be no attempt at secrecy, so that when one subscriber is speaking, the other joint user of the line can hear the conversation by lifting off his telephone. On the 10-party line the question of distinctive ringing calls becomes more difficult. We understand that it is proposed in the first instance to cut up these 10 subscribers into two groups, by ringing one group on the one wire and the other group on the other. Then, when ringing up, say, No. 3 in one group of five, the operator will ring one, two, three, and then pause. Each of the other four subscribers will hear this signal, and, after consideration, will know that No. 3 is wanted and that they are not. Again, all calls made by subscribers on the 10-party lines will have to be booked by hand by the operator. The grave objection, however, to being rung up four times when you are not wanted for every time at which the call is really for you, tends, in our opinion, to put the 10-party line system out of court entirely.

In conclusion, we have to express our high opinion of the good work, both in design and execution, which the staff of the Post Office have secured in their central telephone exchange. Our thanks are due to Mr. Gavey and the other gentleman mentioned at the commencement of this article for the facilities for preparing the same.

GLASGOW SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Glasgow Local Section of the Institution of Electrical Engineers held their opening meeting for the session 1901-1902 at the Institute of Engineers and Shipbuilders, Bath-street, Glasgow, on the evening of the 19th inst., Prof. Magnus Maclean, president-elect, in the chair. The minutes of the last meeting having been read and approved, the CHAIRMAN referred to the flourishing condition of the section; 11 members, 16 associate members, 20 associates, and 7 students were added to the section during the last session. As regards the quality and interest of the papers, they, too, had been very successful; several of them had been published in the *Proceedings* of the parent institution, and the section had had the satisfaction of being the first, and up to the present the only local section, to secure an Institution premium for a paper read at a local meeting,* the Institution having awarded to Mr. Michael B. Field a premium for his paper on "A Method of Compensating Voltmeters for the Voltage Drop in Long Feeders," which was read at the meeting on Feb. 13 last. Prof. Maclean stated that as Mr. Field was unable to be in London to receive his premium at the hands of the President, the Council had consented to it being presented at that meeting, and he therefore had much pleasure in presenting Mr. Field with a planimeter and a bound set of the back numbers of the Institution *Proceedings*. Before proceeding to his address, the chairman said he would like to refer to one sad event that had taken place in their midst only last week—viz., the accidental death of Mr. George A. Clark, who contributed a paper to the section on "Electric Wiring" last session, and whose promising career had been suddenly cut short under most distressing circumstances, and he was sure that the sympathies of the meeting would be accorded to his widow and family in this bereavement.

Proceeding with his address, Prof. Maclean said: I desire to take this the first opportunity of thanking you for the honour you have done me in electing me as your chairman for this current session. Since we met in May last we have had meetings of a very large number of scientific societies in Glasgow, meetings at which papers of scientific importance have been read and discussed. To mention only three of them—the Society of Incorporated Municipal Electrical Engineers met in June last, and the International Engineering Congress and the British Association for the Advancement of Science in September last. At these meetings a considerable number of electrical papers were read. Indeed, at the Electrical Section of the Engineering Congress so many papers were prepared at the request of the Council of the Institution that there was no time given to some of the authors to even adequately summarise them to the meeting and none at all for discussing some of them. So much electrical information has been thus given to us during the last summer and autumn that you might reasonably expect us to spend this session in digesting it, and not aim at getting more papers read to us. But no. The committee of this Local Section of the Institution have had offers of papers as usual, and you will have noticed from the circular the secretary issued to you recently that we have had already promises of sufficient papers for this session. These papers are on a variety of subjects, such as laying electric mains, manufacturing of aluminium, construction of electromagnets to give very powerful magnetic fields, testing of electrical machinery, etc.; and we trust that in every case these papers will lead to valuable discussions and to the elucidation of difficult and doubtful theories, problems, and facts. Again, we had a successful international exhibition in our midst. A paper describing and discussing the developments and improvements that have taken place in electrical engineering apparatus during the last 13 years, as illustrated by the electrical exhibits in the 1901 exhibition and those in the 1888 show, would be most instructive.

1. *Electrical Generators.*—Generally speaking, improvements have taken place in every direction. In electric generators the tendency has been towards simplicity of type and uniformity in matters of detail. In continuous-current machines the commutator is becoming standardised both in materials and in manner of construction. Drum winding is superseding ring winding, and multipolar machines are almost universal for moderate and large outputs. The open-coil direct-current dynamo was not represented at the last exhibition at all. Alternating-current generators, both single-phase and three-phase, were shown by different exhibitors, as well as rotary and static trans-

* The chairman has been incorrectly informed on this point, as Mr G. Ralph, of the Newcastle Section, received a premium at the same time as Mr. Field.

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formers. By means of the latter one firm was showing the conversion of 500 volts continuous to 10,000 volts three-phase. There is no doubt this type of machinery is gaining favour with electrical engineers. Some electrical engineers who a few years ago were wedded to continuous-current generation, now loudly proclaim the advantages of alternating-current machinery.

2. *Electric Measuring Instruments.*—No greater advance in any department of electrical engineering has taken place since 1888 than in electric measuring instruments. Ampere-meters for direct currents are now chiefly constructed on the principle of (1) the electrodynamic action between two neighbouring coils carrying currents, or (2) the sucking action that a solenoid exerts on a suitably suspended soft piece of iron, or (3) the action of permanent magnets on a suspended coil carrying a current. There are different methods of balancing the electrodynamic and electromagnetic forces, and the most common are (1) the weight of a piece of matter, (2) the torsion of a wire or spiral or flat spring, and (3) the couple due to a bifilar suspension. Ampere-meters of the hot-wire type and the movable needle type were not shown to any extent. Volt-meters of the electromagnetic type are still in evidence, but they are giving place to other types, and more especially to the electrostatic type, because the latter consumes no energy, and can be used either on direct or on alternating current systems. Dynamometric wattmeters for direct, for single-phase, and for three-phase currents were shown by a number of instrument makers, also phase meters for showing the wattless component of the current in amperes. One firm at least had voltmeters, ampere-meters, and wattmeters for alternating current which depend on the mutual action of eddy currents in a light metallic pivoted disc, and in a metallic screen which partially shields the disc from the magnetic action. Instruments of the recording type are getting essential for supply stations. Hence there were exhibited by several firms recording ampere-meters, recording voltmeters, and recording wattmeters. In 1888 electricity supply meters were not much beyond the experimental stage. Now we have reliable meters of all types. The most common types of meters may be classified under four heads, depending upon which property of the current is utilised for recording its amount: (1) thermal meters; (2) chemical meters; (3) integrating or clock meters; and (4) motor meters. To illustrate the proportion of the different meters in use in the various supply stations in Great Britain, the following list is collated from the information given by the technical Press last January:

Name of meter.	Number of stations at which the meter is used.	Type of meter according to the above classification.
Chamberlain and Hookham...	116	4
Thomson	69	4
Ferranti	65	4
Aron	41	3
Shallenberger	40	4
Bastian	19	2
Schattner	14	2

Thus it appears that the motor meters have as yet the preference. Clock meters are, however, increasing in favour, on account of the great improvements recently effected on them. An electric measuring instrument which was not on view in 1888, and was on view in the last exhibition, is an oscillograph. This gives a continuous record of the current wave of an alternator, and by using a double oscillograph the potential difference curve and the current curve can be simultaneously traced. This instrument gives us a method of studying many problems of alternating-current machinery which were difficult of experimental solution by previous existing apparatus

3. *Practical Applications.*—The uses and practical applications to which electricity may be put were numerously illustrated. I shall only mention a few of them in passing: searchlight, pumping, surface-contact tramways, electric cranes, electric haulage for mining work, electric drilling, electric planing, electric locomotives with overhead supply, electric locomotives with accumulators, motor-driven printing machines, overhead conveyor for carrying luggage in railway stations, electric lifts, electrically-driven air pumps, electrically-driven ventilating fans, motor-driven centrifugal pumps, electrical coal-cutters, electric jacquard, etc. In connection with the application of electricity to electric lighting, I should mention the Nernst lamp, which was shown in actual operation in Scotland for the first time last September, when Lord Kelvin switched some of them on at the stand of the Electrical Company in the exhibition. Through the kindness of Mr. Buhler, samples of the Nernst lamp are on the table for your inspection. The material of the filament is composed of one or more of the rare earths zirconia, thoria, and tria, also magnesia. The filament only begins to conduct at a temperature of 500deg. C. From that temperature to 1,100deg. C. the conductivity increases in the ratio of 1 to 330. To give stability to the lamp a series resistance of iron is put in to balance the diminishing filament resistance with increase of temperature. The filament is raised in temperature by a spiral of platinum wire surrounding it, through which the current in the first place passes. When the filament becomes sufficiently hot or sufficiently conductive—and this happens in less than half a minute—the spiral spring platinum is automatically cut out of circuit by an electric magnet, and the refractory oxide filament becomes incandescent. The efficiency is given at 1·5 watts per candle-power. The filament is an electrolyte, and hence when the supply is continuous the current must be put through it in the proper direction. When the lamp is installed for the first time, care is therefore necessary in fixing it to the proper terminals. Afterwards, the filament renewals are so arranged that they can be put into the lamp only in the correct direction. On an alternating-current supply the lamp can be fitted any way. I am told that the filament lasts much longer when alternating currents are used. I expect a great future for lamps constructed on the Nernst principle. At the last meeting in May, Mr. Walter Jamieson showed those present some experiments on high-frequency oscillations by apparatus mostly of his own devising and all of his own construction. A desire was expressed that an opportunity should be given to him to repeat some of these experiments and show some others, the apparatus for which he had no time to prepare on the previous occasion. He is present this evening to experimentally illustrate some of the more elementary facts and results of observation and experiment in the subject of electric oscillations. The first reference we have to the discharge of a condenser being oscillatory is in a remark by Prof. Joseph Henry in 1842, and the second reference is in an essay by Von Helmholtz in 1847. The outstanding important date is, however, in 1853, when Lord Kelvin showed that the discharge would be oscillatory or continuous according as R^2 is less or greater than $\frac{4L}{K}$, where R is the resistance, L the inductance, and K the capacity of the circuit, and all the factors expressed in consistent units. Thus, when R^2 is greater than $\frac{4L}{K}$, the discharge is unidirectional, and when R^2 is less than $\frac{4L}{K}$, the discharge is oscillatory. (Illustrative curves were drawn on the blackboard.) Expressions for the capacity and inductance of simple circuits were then given by Dr. Maclean, and also illustrative examples of how to calculate the frequency and wave-lengths of commonly used oscillators. With the oscillators on the table, and used by Mr. Jamieson in his experiments, wave-lengths from a few miles long to a few inches were produced giving frequencies from a few hundreds to thousands of millions. Mr. Jamieson's experiments, carried out with a great variety of specially constructed apparatus, were followed with great interest and attention, as were also his explanations of the phenomena which he produced.

A hearty vote of thanks, proposed by Dr. MACLEAN, was passed in favour of Mr. Jamieson.

Mr. H. A. MAVOR, member, said that he wished in one word to propose a vote of thanks to Dr. Maclean for his address, which was none the less interesting and none the less appreciated because he had sandwiched it in between cursory remarks and explanations regarding the experiments which Mr. Jamieson had carried out before them. The speaker begged formally to move a vote of thanks to Dr. Maclean, which evoked a hearty response.

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THE ARMSTRONG-ORLING SYSTEM OF WIRELESS TELEGRAPHY.

We have had repeatedly to condemn the senseless articles on this system which have appeared in the daily papers. Our complaint has been that the inventors have tried to boom their system by means of the reporters of the daily papers, who were quite unable to understand what they saw at the demonstrations. Up to now, no technical editor has been allowed to see the system at work. We were last week invited by the inventors to inspect the receiver which they use, but on going to the offices of the company were shown instead an interesting experiment with a capillary electrometer. We were also given some German Patent Office drawings, two of which we reproduce herewith. The following extract from the Blue-book explains these drawings: "According to the simplest form of our invention, shown in Fig. 1, we employ a vessel, *a*, having two chambers, *b* and *c*, the former of which is shallow and contains dilute acid, *d*, while the latter is considerably deeper and contains mercury, *e*, the surface of which is maintained at a considerably higher level than that of the dilute acid in *b*. Above the chambers, *b*, *c*, is an inverted U-shaped siphon, *f*, which is filled with mercury, and is supported by a bracket, *g*, while its legs dip into the fluid contained by the chambers,

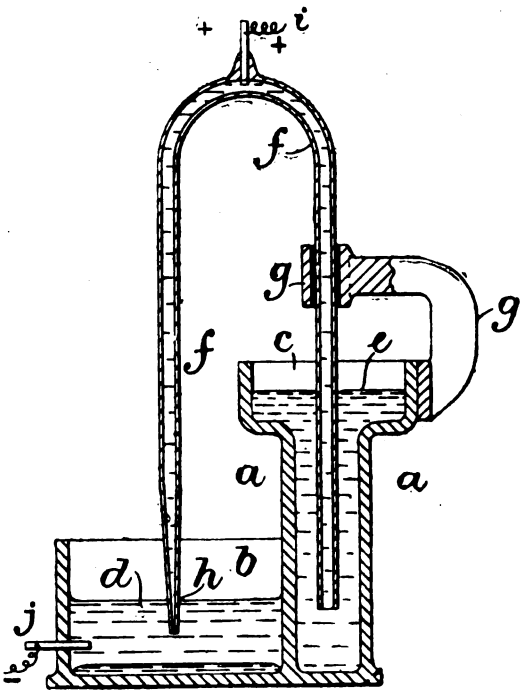

FIG. 1.

h, *c*. In order to prevent the mercury from continuing to flow through the siphon after the electro-capillary force set up by the passage of a current has ceased, the end of the delivery leg, *h*, is constricted. When, however, the current flows it is at this precise point that the electro-capillary force is set up, and displacement of the fluid in the direction from positive to negative takes place. In order, therefore, that this displacement may be in the same direction that the mercury flows through the siphon, the current enters the apparatus at *i*, where it enters the mercury flowing through it in the siphon into the dilute acid in the chamber *b*, whence it leaves the apparatus at *j*. It is, therefore, clear that the electro-capillary force acts to reduce the resistance which the constricted portion of the delivery leg, *h*, of the siphon, *f*, opposes to the flow of the fluid in its absence. In Fig. 2 is shown another form of our invention which is provided with a means of maintaining the level of the mercury in the chamber *c*, and is adapted to operate a relay. According to this arrangement a lever, *k*, is delicately poised at a point, *l*, adjacent to the delivery end of the siphon *h*, while one of its ends, *m*, extend beneath the surface of the dilute acid in the chamber *b*, in order that any mercury delivered by the siphon *f* may fall upon it and so cause its other end, *n*, to make contact at *o*, and thereby close a relay circuit, *p*, by means of which a telegraph instrument, *q*, or any other apparatus or mechanism may be operated. According to the construction shown in this figure, both ends of the siphon are constricted for the same purpose as the one shown in Fig. 1. In order to preserve the level of the mercury, *e*, in the chamber *c* a reservoir, *r*, is provided. This reservoir is provided with two tubular legs, *s t*, the former of which extends beneath the surface, where its lower extremity may be constricted to prevent a too rapid supply of mercury; while the other leg, *t*, is shorter, and terminates with an oblique or V-shaped aperture, *u*, in order that it may be gradually opened as the level of the mercury falls. The mercury in the reservoir, *r*, is retained by a partial vacuum that is gradually destroyed by the admission of air through the leg, *t*, as the level of the mercury in the chamber *c* falls. Thus by this means sufficient mercury is allowed to leave the reservoir to maintain the level and close the vent."

We have not reproduced the other alternative forms, because they do not, in our opinion, represent as drawn practical instruments. At the head of the paper handed

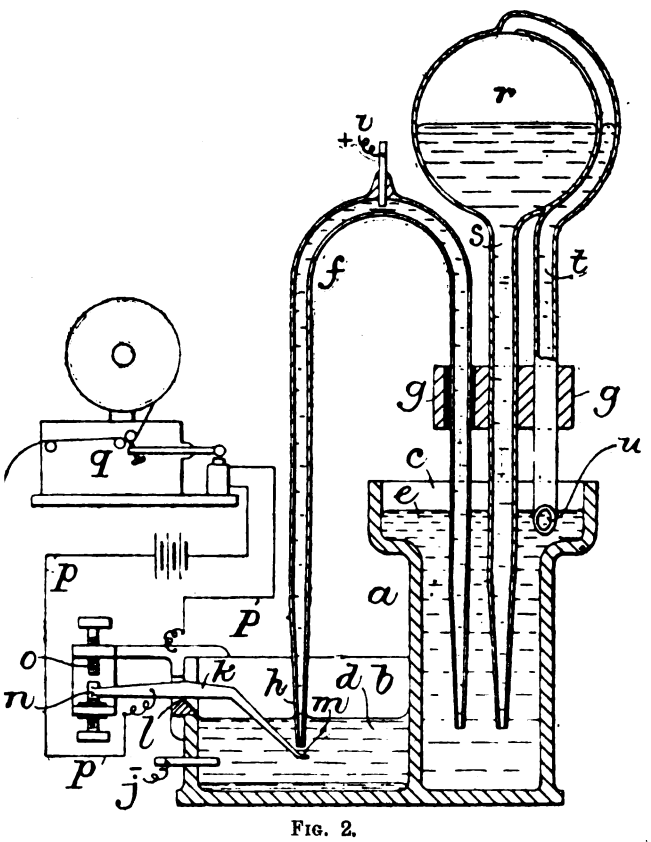

FIG. 2.

to us the following paragraph appears: "One of the reasons for the remarkable results that have been attained by the inventions of Messrs. Axel Orling and James Tarbotton Armstrong is the substitution of an entirely new and very effective receiver for the coherer. Up to the present time it has always been considered that the telephonic receiver is the most sensitive to electric currents, but by the adoption of this new receiver it has been proved that far weaker currents may be detected. It is in reality an electro-capillary relay, by means of which the most feeble impulses are able to effectively operate a receiving apparatus."

We do not know anything of the Armstrong-Orling system of wireless telegraphy, and until it has been described it is impossible to criticise it, but the loose language in the above paragraph does not give one a high opinion of the scientific accuracy of the inventors. For instance, we are told that the capillary electrometer is more sensitive to electric currents than a telephone. The inventors might as well have compared chalk with cheese, as the one instrument depends on the E.M.F. at its terminals, while the other depends on current passing through it. In fact, the great use of the capillary electrometer has been to detect small differences in E.M.F.

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One of the gentlemen we saw at the company's office seemed to think that E.M.F. could not exist without current. In reply to a question as to whether they had measured what the current was which was required to work their receiver, the expert said that they had not done so, but that it must be smaller than the minimum current which would affect the telephone, because they could receive with their instrument when the ordinary telephone gave no audible sound. We shall be pleased to criticise at some future time the comparison made between the Armstrong-Orling receiver and a coherer, but this cannot be fairly done until more information is given as to what method the inventors use for transmitting signals, and what their receiver is used to receive.

NOTES ON PRACTICAL ELECTRICAL INSTRUMENT MAKING.

BY JOHN C. BAGOT.

(Continued from page 732.)

When, however, greater delicacy and sensitiveness is required than can be obtained with the instrument already referred to in a previous article, a class of instrument is employed in which the needle system is free to move in the azimuth only, suspended either between pivots, or by a fibre of unspun silk, or poised on one single pivot by means of an agate cup, in which case, however, the needles have to be of a special design, to admit of the pivot passing through one of them. In the case of an astatic pair the multiplying action of the current is here utilised to a much greater extent, and further, the directive force of the earth's magnetism is, by the arrangement of the moving magnets, either completely counteracted or considerably reduced. The action of the current, and the consequent deflection of the needles on the passage of a current in the direction shown by the arrow heads, will be sufficiently illustrated by Fig. 5. Then, providing the suspended magnets are exactly similar both in dimensions and magnetism, and are placed so that one lies vertically above the other, with their opposite poles in the one direction, the system will come to rest in any position when not influenced by the current. But an astatic pair of needles is an ideal condition very seldom attainable, but a near approximation may be got by carefully selecting the steel and filing both needles together, so that they are exactly the same shape when finished, and by magnetising them

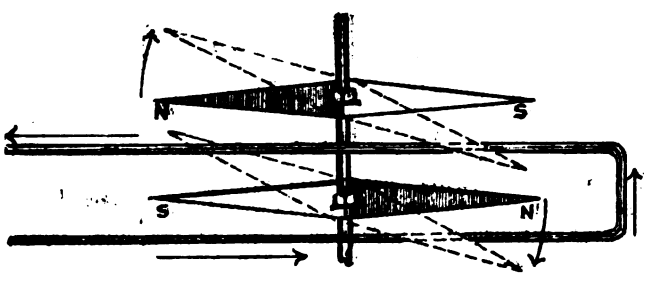

FIG. 5.

in the opposite direction, which when finished will obviate any slight irregularity that may have occurred in the shape.

In regard to the coils, the best forms are those built up with brass pillars, and flanges of either brass or ebonite, so that the coil is free from metal in the inside. These may be secured in the ordinary way by means of a lug to the base or false bottom of the instrument in the manner illustrated in Fig. 4. Although the coils of many such instruments are constructed in the manner shown in Fig. 6, the inside of the coil being in the form of a flattened brass tube, in which there is left a gap in the direction of the length, the object of this longitudinal slot being to decrease as far as possible the damping influence of the currents set up in the brass tube by the moving magnets inside. The coil flanges should therefore be of some non-metallic substance, or the object of the slot, to a very great extent, will be defeated by soldering the flanges across the gap made for a specific purpose. This damping influence, as regards the actual deflections, may be a decided advantage in preventing vibrations, but the same damping action prevents the needle returning to zero, as it would otherwise do under other conditions.

These currents set up in the coil frame are not dependent on the current passing through the wire, but simply on the velocity with which the magnetic needle within them moves. Thus, although such instruments are perfect in many respects, yet for the indication of very weak currents, such as the balancing point, when measuring resistance by Wheatstone bridge, they will be found

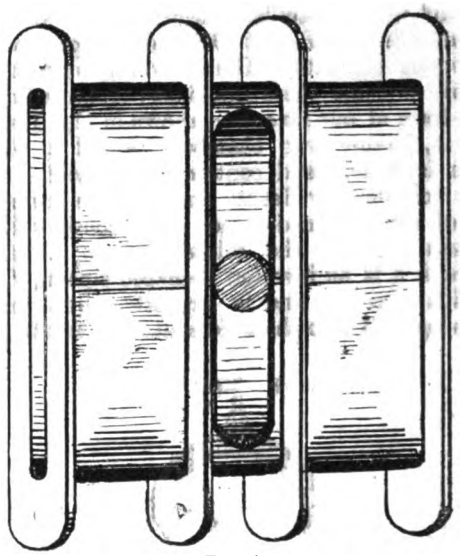

FIG. 6.

not so reliable, for at that instant the current passing through the coil tending to cause a slight deflection is not greater than the opposing current that would be set up on the movement of the magnetic needle, consequently on making contact the needle makes a faltering movement, finally settling down somewhere about zero without the balance being perfect. There does not appear to be any advantage either from a mechanical or financial point of view in building up the coils in the above manner, for the coils should be wound in opposite directions relative to their position, so that they require moving on the mandrel and winding independently. The most delicate astatic instruments are those in which the coils and dial plates are non-metallic.

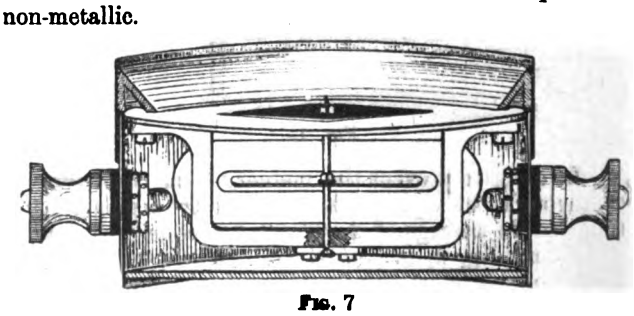

FIG. 7

A very good form of circular case astatic galvanometer is shown in Fig. 7, where part of the case and the bezel is cut away, and with the top bridge and one of the coils removed also, showing the axle and bottom jewel plate in position. One great advantage of this form will be obvious—that is, on the removal of the bezel, the dial, together with the bridge, axle, and coils complete, with all the working parts, can be "with the exception of the terminal connections," removed free from the case, which make adjustment and repairs comparatively easy. With the bottom jewel hole being attached to the back of the large bridge, "through which there is a clearance hole," it is a very simple matter to set the axle in a vertical position. Also by this form of instrument there is no necessity for a slot in the dial plate. It will be noticed in the figure that the ends of the screws which secure the coils and large bridge are arranged so as to be out of sight under the bezel flange.

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The one important property of a magnetic field, whether of a permanent magnet or a solenoid, is the resistance it offers to the interference of another magnetic force, and the determination of the amount of this interfering force, or resistance offered, is the principle upon which many of the most accurate and important measuring instruments depend. The original instrument of this type was designed by Deprez and d'Arsonval. In the first place some permanent and invariable magnetic field is necessary, in which is suspended the coil through which the current that is to be measured passes. This magnetic field is maintained by a large permanent horseshoe magnet, the form of which is shown in Fig. 8, along with the suspended coil, which takes the place of the suspended magnets in the previous illustrations. In order that the space between the magnet poles should be more permeable, there is a block of soft iron supported in position so as to leave a clear space for the movement of the coil; if this iron were not as shown, a great number of the lines of magnetic force would leak out without passing through the coil. The action of this instrument is identical with that of a motor having a separately excited field, and, therefore, the forces acting on the coil are proportional to the number of magnetic lines which are embraced by the coil, and to the number of turns of wire in the coil, or, in

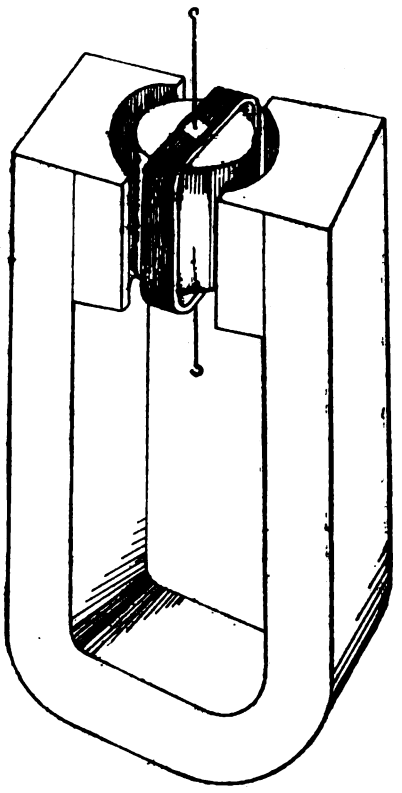

FIG. 8.

other words, proportional to the strength of the field and ampere-turns. The coil in the illustration is shown deflected to its maximum position, to which it is not advisable to work it, but this is easily obviated by placing a rubber band round the poles so as just to come in contact with the coil and arrest its movement.

The important property of this instrument, which is again identical with the motor, is the cause of the instrument being what is termed "dead beat," which is the result of the back E.M.F. generated in the coil when moving in the field of the magnet. Now, this back E.M.F. depends on the speed with which the coil moves, the number of turns of wire on the coil; and since this back E.M.F. tending to force the coil in the opposite direction depends upon the resistance of the circuit in which the instrument is worked the number of turns and the strength of the field, the amount of this damping action is to a great extent in the hands of the maker. By the resistance of the circuit is here meant whatever is connected in series with the coil of the instrument. Since the velocity depends upon the current, therefore the damping action is always proportional to the deflecting current for any particular instrument. In order that the movement of the coil may be slow, the field of the permanent magnet should be considerably stronger than that set up by the coil when influenced by the current. The two electrical conditions which determine the sensitiveness of these instruments are: (1) the number of turns of wire on the coil; (2) the strength of the field in which it is suspended.

The essential mechanical points of the instrument in respect to the coil and its suspension will be seen from Fig. 9. The coil is suspended by a fine wire, or tape, of either silver or phosphor bronze, which also serves the purpose of conveying the current through the coil. The method of securing this suspension, and the means adopted so as to keep it under tension, is also made clear in the illustration. The soft-iron block in this case is shown fixed in position, in which it is held by means of two iron screws from the back of the brass block, shown at B. The large brass plate which is fitted with the pillar, "which also supports the top suspension and regulating devices," is fastened on to the poles of the magnet by means of iron

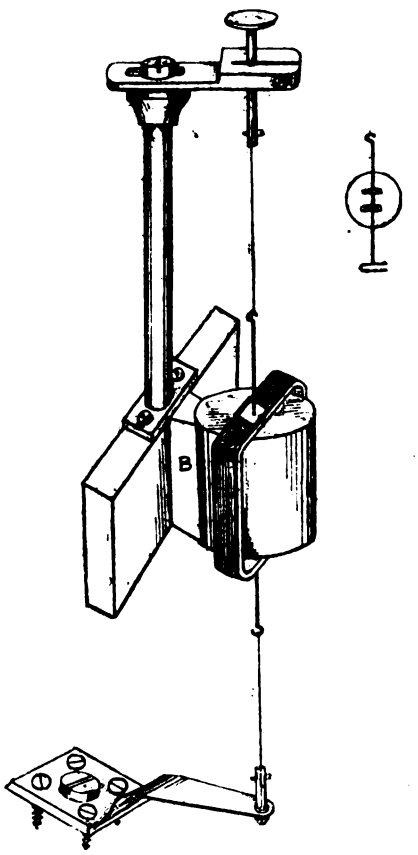

FIG. 9.

screws, which are not shown in the illustration. The small figure to the right shows a small disc, made either of brass or copper, which is capable of sliding down the suspension clamp by means of the two loops shown. The actual mirror is fixed on this copper disc by means of any kind of cement, such as Chatterton's compound. This disc has the advantage of gripping the mirror round the edge, which prevents the common accident of the mirror becoming detached, leaving part of the silvered surface stuck to the support.

The above class of instrument in a great variety of forms is now being passed into general use in the way of ammeters and voltmeters, extra resistance being added to them in the latter case, whilst the greater part of the current is shunted in the former instance, so that only from $\frac{1}{10}$ to $\frac{1}{10000}$ passes through the coil, which in portable instruments is suspended between pivots.

(To be continued.)

Eastbourne.—The low level road to Willingdon is to be lighte by electric lamps, for which 34 posts are to be erected.

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TO CORRESPONDENTS.

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LONDON COUNTY COUNCIL TRAMWAYS.

We had hoped this week to deal with the important document which we have received from the London County Council on the construction of shallow underground tramways. This document is a joint report by the Council's tramway manager and the electrical engineer (Mr. John H. Rider) on the construction and working of the Boston subway and on the rapid-transit subway in New York. With this report is given an addendum by Mr. J. Allen Baker, the vice-chairman of the Highways Committee, who accompanied the other two gentlemen on their American tour. Owing, however, to pressure on our space we have to hold over an abstract of this report, and in the meantime would only allude to it as an instance that the Highways Committee are aiming at intercommunication between the tramways systems north and south of the Thames. The suggested solution of this difficult problem also is intended at the same time to relieve to a certain extent the congestion of traffic in the streets. What we propose to consider now is the report on the London tramways owned by the London County Council both north and south of the Thames for the year ending March 31. The figures of this report will be found on p. 787 of our last issue, and it was brought up for criticism at the meeting of the Council on Tuesday. There was, of course, in the Council the usual party criticisms, in which it was attempted to be proved that the Highways Committee was not so successful in managing the tramways on the south of the Thames as they should have been, and that it would be more advantageous if these tramways were leased, as are the tramways on the north of that river. Any comparison between the systems north and south of the Thames must be carefully made to be fair to all parties, and Mr. Benn, the chairman of the committee, showed in his reply that if the Council had leased the tramways on the south of the Thames on the terms which they had been offered, the profit last year would have been practically the same as had obtained. His committee, however, had made this net profit of £14,325, and had also reduced the fares, given the men one day's rest in seven, and raised the wages in certain departments. The other charges brought by the members of the Council was that the allowances made to reservists who had been called up for active service, and also the parliamentary charges, had been put to the capital account. It would seem to us that while there is a reason for the latter course, the allowances made to reservists should have been charged amongst working expenses. As regards the question of the working hours of the drivers and conductors, and also their remuneration, we find no reference to this by the opposition speakers at the Council meeting. While we have frequently had to object to the labour policy of the Council, we think that the long hours which these men had to work under the company *régime* were a disgrace to the community. We are accordingly pleased that the improvements in this respect made by the Highways Committee have not seriously affected the net profits. We have received from our contemporary *Electrical Investments* an advance proof, with its editor's compliments, of the remarks which this gentleman has to make on the London County Council tramways. It is headed "Leasing *v.* Working," and the first paragraph states that, to avoid misconception, "We think it advisable to place the facts before the public in a form which can be readily understood." The facts given are a comparison of the results obtained on lines of the Council leased with those obtained from the southern lines which the Council actually work. The first line of comparison deals with the net profit of the Council, which on

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the northern lines was £40,151, as against £14,325 for the southern lines. Our contemporary says that we may fairly suppose that the southern lines, if leased, would have resulted in an equal profit of £40,000. Mr. Benn, who has had before him the proposed terms of lease for these southern lines, contradicts this, and the two statements must be taken for what they are worth. It must be remembered that *Electrical Investments* is a kind of financial or semi-financial paper issued practically as a medium of communication between certain tramway promoters and interests and the general body politic which it reaches. The information given cannot be assumed to be unbiassed, nor to deal generally with all phases of tramway work. We are of the opinion that a publication whose management is connected with company work and undertakes the position of intermediary in buying and selling stocks and shares, is not a publication whose opinion should have weight with the public. Every shoemaker swears by leather, and so long as it is known that a shoemaker is swearing, no harm is done. The harm comes when an ignorant public believes the opinions uttered are unbiassed. Instead, therefore, of this being a journal dealing with electrical investments from an independent standpoint, our contemporary is strongly associated with a certain set of company promoters. The standpoint of these promoters as regards electric traction has always been that municipalities, by reason of their restricted areas, are not capable of effectively arranging large systems of electric tramways. This argument falls to the ground when applied to the London County Council, because that Council is busy organising a complete system of tramways for the whole county. Our contemporary's editor is compelled, therefore, to take up a new line of argument, and falls back on a statement that the London County Council tramways will fail because they have not expert management. Looking into this argument with facts obtained from our contemporary, we find as follows: During the year ending March 31 last the London County Council on the southern line ran 10,399,058 car miles, carrying 118,281,320 passengers. The receipts average out to ·89d. per passenger and 9·99d. per car mile. The company, on the other hand, running on the northern lines leased from the Council provided 16,279,490 car miles, and carried 160,676,347 passengers. The receipts averaged out to 1·13d. per passenger and 11·16d. per car mile Accepting these facts as true, it is interesting to see the deductions which our contemporary puts forward in order to prevent the public from having any misconception. It states that "further evidence of more expert management (on the part of the company, of course) is to be found in the fact that while the company only received 0·24d. per passenger more than the Council, its receipts per mile run were higher by 1·17d." The absurdity of this statement will be seen by reading the following equivalent statement taken from the same figures. Our contemporary says in other words: "Further evidence of more expert management is to be found in the fact that while the company only received 27 per cent. higher fares than the Council, its receipts per mile run were higher by 11½ per cent." This equivalent statement, expressed only in percentages instead of pence, completely reverses the misconception which otherwise would arise from our contemporary's article. Thus, to be fair, the management of the Council, under the able supervision of Mr. Alfred Baker, is, on the showing of *Electrical Investments*, of a more expert character than obtains with the lessees of the northern lines. Such interested misrepresentation as is exposed above does no good to the electrical industry. We do not favour certain tramway ventures of the London County Council, but we have not yet come to that point when in our opinion any stick is good enough to beat the dog. The figures given need considerable extension before they lead to a true conclusion, and the surrounding conditions of any two systems must be fully considered before damnifying the management of one and praising that of the other.

ERRATUM.

It is extraordinary how simply an error arises in printing, and we have an instance of it owing to a printer's error in Mr. Cramp's article of Nov. 29, pp. 768-9, where "revolutions per minute" should read *revolutions per second.*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LIGHTNING CONDUCTORS.

SIR,—The concluding paragraph of Mr. Dalby's letter explains much. If the routine of his occupation extends back to 1858 or 1860, and during the past 40 odd years he has never seen or heard of a case of equal interest to the one he refers to at Nottingham, I presume that his opportunities of studying the subject from Nature have been limited. During the past 16 years I have found that cases of equal interest to or surpassing that one have been of almost yearly occurrence, and published records lead me to suppose that they were not less frequent before that. I cannot spare the time to look up dates and names, but I think the following list of churches is correct, and will serve as an illustration: Kea, near Truro, and Dalston, London, this year; Upton-on-Severn, last year; Crawley, 1898; Rochester-row, Westminster, 1895; Warrington, 1893; Worksop, 1892; and Needwood, 1891. There are plenty of others, but I am unable to give dates from memory.

I have been trying to reconcile the ninth to twentieth lines in Mr. Dalby's letter in your issue of Nov. 15 with the fifteenth to nineteenth lines in that of Nov. 29, and I do not consider it necessary to give my deductions, but I may say that I think that if he quite understands the laws of divided current appropriate to these conditions, sparking or side flash from a well "earthed" lightning conductor to other well "earthed" conductors near it, like gas or water supply pipes, should not be beyond his comprehension.

In order to obtain a clearer insight into the question, I examined nearly every case of damage by lightning in this country that I heard of for nearly 10 years, and if Mr. Dalby had been a younger man, I should have recommended him to do the same. Then he would, perhaps, be able to speak definitely instead of using the sublimely vague terms which he appears to think I ought to use.

He would have saved himself very much trouble if he had confined his remarks to what I have said instead of discussing at length what he erroneously thinks I mean. I can assure him that I have not altered my views in any respect. These are based on observation and experiment, as well as study of all that has been written on the subject. In my remarks as to side flash I am not saying anything startlingly new. The same thing has been said or implied in every work of importance on the subject, such as Snow Harris's "Thunderstorms," "The Lightning-Rod Conference Report," and Dr. Lodge's "Lightning Conductors." That inductance need not be taken into account is a practical point, and as regards abrupt bends not increasing self-induction, as Mr. Dalby has not troubled to show any scientific reasons why they should, nor answered my argument why they do not, it appears to be unnecessary for me to discuss the matter further.

I have never said a word against the importance of a good "earth," but this is only one of the many important things for consideration, and quite secondary to the importance of not having an alternative path, or, in fact, any metals near enough for destructive sparking or side

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flash to occur, and as long as the good "earth" theory is allowed to override and eclipse every other consideration, cases of so-called failure of lightning conductors will continue to occur. In protecting a building it is necessary to study it inside and out, and to bring common sense, as well as scientific knowledge, to bear on the question, otherwise success will be merely a matter of chance.—Yours, etc.,

ALFRED HANDS.

EICKEMEYER WINDING.

SIR,—We have in the past wound some of our smaller motor armatures with that particular type of form winding known as "Eickemeyer," and have inserted a description of same as one of our alternative windings in our catalogue.

We learn, however, from Messrs. Parker and Co., Limited, that they are the owners of the patent in this country for this type of winding, and on looking into the matter find this is correct.

We naturally have settled amicably with Messrs. T. Parker and Co., Limited, and regret having inadvertently given them cause for action.

The Eickemeyer winding must be distinguished from the barrel winding. In the latter case, though form wound, the winding is all on the one plane, and is the alternative type of form winding to that of the Eickemeyer.—Yours, etc.,

D. BRUCE PEEBLES AND CO.

Edinburgh, Nov. 22, 1901.

APPRENTICESHIP.

SIR,—I wish to go in for electrical engineering as a trade: can you give me the names of some electrical companies (in or near a large town, London preferred) who take working apprentices on wages, or perhaps you may be able to advise me as to the best way in which to go in for it. I have gone through a theoretical course of electricity, but have had no practical experience. Kindly reply in next week's *Electrical Engineer's* "Answers to Correspondents" to "C. E. P."

Abertillery, Nov. 29, 1901.

[If we were to mention the names of electrical firms in or near London who take ordinary apprentices, we are afraid we should not earn the thanks of the firms in question. It is usually found that in such engineering works the sons of the present workmen employed are always given the preference when vacancies arise for ordinary apprentices. This seems to us to be a correct policy, and if we were to give the names of firms who do this, they would be immediately besieged by a large number of applicants who wish to get their sons into electrical engineering without premiums. We think that "C. E. P." should look for a firm in or near his own district where he could get ordinary engineering experience, and at the same time he should keep his knowledge of electricity and electrical engineering well up to date. At the expiration of his term he will then find that he is quite as well equipped for any position as an apprentice who has been in an electrical works for the same time.—ED. *E. E.*]

THE PHYSICAL PROPERTIES OF CERTAIN ALUMINIUM ALLOYS, AND SOME NOTES ON ALUMINIUM CONDUCTORS.

BY ERNEST WILSON.

[*Abstracted by the Author.*]

This paper deals with tests made for the British Aluminium Company, Limited, at King's College laboratory, London, upon commercially pure aluminium and 24 different aluminium alloys. The specimens were in the form of wire ·126in. (3·2mm.) diameter. The commercially pure aluminium (containing ·31 per cent. Fe and ·14 per cent. Si) has a specific resistance of $2·76 \times 10^{-6}$ legal ohms at 15deg. C.; its temperature coefficient is ·00393 and linear coefficient of expansion ·000023 per 1deg. C. between 16deg. C. and 100deg. C. As received, it has a breaking load of 12·6 tons (28,200lb.) per square inch, a limit of elasticity 8·65 tons (19,376lb.) per square inch, and a percentage extension of ·19 with 7·2 tons (16,250lb.) per square inch applied stress. Taking the specific resistance of copper at $1·696 \times 10^{-6}$ ohms at 15deg. C., it follows that for a given length of conductor carrying the same electric current with the same dissipation of energy, the relative weights would be as 1 of this copper to $\frac{1}{2}$ of this aluminium. The effects of annealing are stated.

The following remarks refer to what may be termed the impurity, which is varied, although the silicon and iron, which are always present, are not constant.

Copper.—As soon as the proportion of copper (1·5 to 2 per cent.) is sufficient to give a breaking load of 40,000lb. and limit of elasticity 33,000lb. per square inch, the specific resistance rises to $3·3 \times 10^{-6}$ at 15deg. C. The temperature coefficient falls to ·0030, and the linear coefficient of expansion is ·000024.

Zinc.—It cannot be said that the addition of zinc up to 2 per cent. improves the tensile properties of the commercially pure aluminium. For the same proportions the conductivity of the zinc alloy is greater than with copper.

Nickel.—This metal has a marked effect upon the breaking load, but the limits of elasticity remain low. For instance, 2·2 per cent. Ni gives a breaking load of 38,600lb. and limit of elasticity 20,300lb per square inch.

Nickel-Copper.—The alloy containing 1·29 per cent. Ni and 1·08 per cent. Cu gives a breaking load 45,900lb. and limit of elasticity 36,600lb. per square inch. This is a marked increase. This alloy is characterised by its comparative low percentage extension (·146 with 16,250lb. per square inch), its high coefficient of expansion (·0000252), and its low temperature coefficient (·00178). Its specific resistance is $5·41 \times 10^{-6}$ ohms at 15deg. C.

Nickel-Iron.—The alloy containing 2·6 per cent. Fe and 1·39 per cent. Ni gives a breaking load 42,200lb. and limit of elasticity 24,400lb. per square inch. Its temperature coefficient (·0032) is nearly double that of the alloy last quoted. The coefficient of expansion is as small as any of the series (·0000222). Its specific resistance is $3·24 \times 10^{-6}$ ohms at 15deg. C.

Nickel-Zinc.—Five of these alloys have been tested. The greatest breaking load is 36,000lb. per square inch, and the limits of elasticity are low. The alloy containing ·83 per cent. Ni and ·90 per cent. Zn gives a comparatively low specific resistance — namely, $3·03 \times 10^{-6}$ ohms at 15deg. C.

Copper-Zinc.—These alloys reveal nothing remarkable.

Iron-Manganese.—The alloy containing ·56 per cent. Fe and 1·78 per cent. Mn has a breaking load 35,300lb. and limit of elasticity 24,400lb. per square inch. The specific resistance is high.

The properties of the elastic catenary, together with the superposed effect of change of temperature have been examined, and they show that the greater lightness and greater percentage extension counteract the effects of greater linear coefficient of expansion in aluminium as compared with copper. The effect of wind pressure, snow, ice, etc., on aerial conductors is next dealt with, and reference is made to 15 miles of aluminium telegraph line erected by the Post Office. A gale produced eight to ten breaks in a wire ·124in. diameter. The breaks did not occur at the insulators or the joints, and it is probable that the cause of the trouble is due to want of uniformity in manufacture, which is now improved. The author inclines to the opinion that smallness of diameter may also have something to do with the breaks which occurred. It is significant that in the long power transmission lines stranded conductors (·75 inch external diameter) are used with success. It is suggested that nickel-copper or copper alloys could be used in cases where greater tensile strength is required.

The paper, which was read at the last meeting of the Institution of Electrical Engineers in London, concludes with a note on the subject of corrosion and cost of aluminium.

Commercial Pacific Cable.—We are informed that the Commercial Pacific Cable Company, of New York, have placed the contract for their cable from San Francisco to Honolulu with the India Rubber and Gutta Percha Company, of Silvertown. The amount is stated to be about 3,000,000dol.

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FORTHCOMING EVENTS.

FRIDAY, DEC. 6.

Institution of Junior Engineers.—At 8 p.m., Westminster Palace Hotel, ordinary meeting. Paper: "Street Railway Construction for Electric Traction," by Mr. F. S. Pilling.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper: "Gas-Engine Construction," by Mr. R. W. A. Brewer.

Northampton Institute (St. John-street-road, Clerkenwell, E.C.).—At 6.30 p.m., presentation of prizes and certificates by the Marquis of Northampton.

SATURDAY, DEC. 7.

Institution of Electrical Engineers (Students' Section).—At 11 a.m., visit to the Fulham electricity supply works, Thames Embankment.

Manchester Association of Engineers.—Ordinary meeting. Paper: "Workshop Management," by Mr. A. P. Loscher.

MONDAY, DEC. 9.

Institution of Electrical Engineers.—Annual dinner, Grand Hall, Hotel Cecil.

TUESDAY, DEC. 10.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., ordinary meeting. Paper: "Aluminium—Notes on its Production, Properties, and Use," by Mr. W. Murray Morrison.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "Train Resistance," by Mr. J. A. F. Aspinall. Paper to be read: "Motive Power from Blast-Furnace Gas," by Mr. Bryan Donkin.

WEDNESDAY, DEC. 11.

Northern Polytechnic Institute.—At 7.30 p.m., distribution of prizes and certificates by Mr. Sidney Webb.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "Aluminium," by Prof. E. Wilson.

London Chamber of Commerce (Electrical Trades Section).—At 3 p.m., meeting at Botolph House, Eastcheap, E.C., to consider the following matters: Light Railways Bill, 1901; Power Mains Regulations, Committee's Report; the Telephone Service; and the Factory and Workshops Act, 1901.

Institution of Electrical Engineers (Birmingham Section).—At 7.30 p.m., ordinary meeting. Papers: "On the Power Factor of Alternate-Current Circuits," and "On the Workshop Testing of Dynamos and Motors," by Dr. W. E. Sumpner.

Institution of Civil Engineers.—At 3 p.m., students' visit to Messrs. Maple and Co.'s new electrically-driven cabinet factory in Highgate-road.

THURSDAY, DEC. 12.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Discussion on papers on "The Physical Properties of certain Aluminium Alloys and some Notes on Aluminium Conductors," by Prof. E. Wilson. Paper to be read: "Some Principles Underlying the Profitable Sale of Electricity," by Mr. Arthur Wright.

FRIDAY, DEC. 13.

Physical Society.—At 5 p.m., ordinary meeting. Papers: "On Circular Filaments and Circular Magnetic Shells equivalent to Circular Coils, and on the Equivalent Radius of a Coil," by Prof. Thomas R. Lyle; and "A New Hygrometric Method," by Mr. E. B. H. Wade, etc.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 (in Sunderland), second general meeting.

Electro-Harmonic Society.—At St. James's Restaurant (Banqueting Hall), smoking concert.

SATURDAY, DEC. 14.

Institution of Junior Engineers.—At 3.15 p.m., visit to the Croydon combined electric light and traction works.

MANCHESTER SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address.

BY C. H. WORDINGHAM, M.I.C.E., M.I.MECH.E. (MEMBER), CHAIRMAN.

(Concluded from page 743.)

Having extolled our virtues as electrical engineers, it is only right that I should turn to our faults. It seems to me that two stand out prominently. One is a tendency to rush to extremes, the other is a want of foresight. The former of these faults showed itself in the early stages of the industry, one of its most noteworthy manifestations being the once notorious conflict between the advocates of high-pressure alternating and low-pressure continuous current; feeling actually ran high over such a purely technical matter, but now controversies involving wide issues are conducted with positive acrimony, and the views are as extreme as those held by opposed political parties. Indeed, some of the controversialists have forgotten the traditions of science, and have descended to invective misstatements and other discreditable weapons of the hustings. There seems an entire absence of a judicial attitude of mind, and it is rare to find on either side the admission of the possibility of reason on the other. One example will at once occur to everyone—namely, the question of municipal *versus* private enterprise. In its essence this is purely political consideration, and with politics and their attendant prejudices and intrigues, it is well for engineers to have nothing to do so far as their work is concerned. To some of us it may seem that Tennyson's words have a wider application than that implied by their context—that

"Our little systems have their day.
They have their day and cease to be"

applies to all forms of government, that all are "broken lights" of true and equitable rule, and that probity and uprightness in individuals are far "more than they." In other words, that people may be justly and well governed by the unbridled autocrat and by the latest socialistic community, provided that in each case the individuals bearing authority are single-minded and seek the good of the governed. Be this as it may, it cannot be denied by those who have had experience of undertakings managed both by a Board of directors and by municipalities that both can attain excellent results and that both can produce abject failures. It is no more fair to brand every member of a municipal council as a Bumble, a fool, a seeker after his own ends, and blinded by prejudice, obstructiveness, and ignorance, as it is to look upon every member of a Board of directors as an unscrupulous company promoter, a selfish grabber of dividends, and an enemy to the public. Both views are absolutely unjust, and able, upright, conscientious, and straightforward men will be found directing the operations of both classes of the undertaking. No fair-minded man can deny that some local authorities have adopted tactics of the most unfair obstruction, and have sought to prevent others carrying out work which they themselves have refused to do; but, on the other hand, it must equally be admitted that some companies have been worked solely in the interests of the shareholders without any regard to the welfare of the public, while others, in order to gratify the greed of the promoters, have been overloaded with capital to such an extent as to render it impossible for them to satisfactorily serve the public.

Having glanced at the extreme views so constantly reiterated, let us endeavour for a moment to look at the question impartially. Judged by results, as shown by the returns in the excellent manual compiled by Mr. Garcke, who certainly cannot be accused of unduly favouring municipal enterprise, the municipalities have done better than the companies, for they have made a profit on their capital only ½ per cent. less than the companies, while the average price they have charged is over 22 per cent. less. The subject must, however, be considered from other points of view, for the side issues are of far-reaching importance. Admitting for a moment the principle of municipal trading, what is its proper sphere and what are its limitations? for very few, except professed communists, would advocate its indefinite extension. The city of Glasgow may be looked upon as the apostle of municipalisation, and, therefore, in order to find the case fairly stated from the municipal point of view, I cannot do better than quote the Lord Provost of that city. In defining what, in his opinion, were the conditions necessary to render an industry a proper one for a municipality to take up, he stated that it must be monopolistic in its nature, must be a necessity for the inhabitants of the district, and must cause interference with the streets. Such a definition, while allowing a large field for municipal enterprise, imposes well-defined limitations. For example, it effectually cuts at the vicious principle of municipalities becoming manufacturers; by no possibility can any kind of manufacture fulfil all three conditions of being a monopoly, a necessity, and of causing interference with the streets. If municipalities stop short at the point indicated, and confine themselves to employing plant manufactured by private companies, and using it for the supply only of public necessities, the manufacturing portion of the electrical engineering profession, at all events, has nothing to lose and everything to gain by the establishment of undertakings for which capital is found at a low rate of interest.

The danger, however, cannot fail to be ever present that the bounds will be overstepped. For example, a large tramway undertaking must of necessity have extensive repair shops for both its cars and its motors. How great will be the temptation to keep these shops busy by making new cars and new motors? It is sound policy from a purely trading point of view, and those responsible for the financial success of the undertaking would be more than human if they let ideal considerations of the ethics of municipal trading stand in their way. It is this danger of overstepping the bounds that leads many to disapprove of all municipal trading on the principle actuating the ardent temperence reformer when he will have nought of the moderate drinker; but less prejudiced persons hold that, if a thing is good in itself, it is a pity to condemn it for fear of abuse. However satisfactory properly-regulated municipal trading may be to the manufacturer, there are other issues affecting the industry generally that cannot be so regarded. The charge is often brought against municipal undertakings that they are of necessity parochial in character, and that in consequence, unless private trading is introduced, no large schemes, such as those of power distribution or comprehensive tramway schemes, can be worked. This contention is based on two fallacious assumptions. In the first place, there is nothing to prevent local authorities combining for a large scheme. An example of such combination for lighting and power supply is seen in Manchester, where some eight or ten neighbouring authorities have agreed to take their supply of electrical energy from the city, while an even larger scheme for the tramways has been successfully negotiated, if one overlook the temporary secession of Salford.

The second fallacious assumption is that with trading companies the parochial difficulty will disappear. Those who have tried to arrange comprehensive schemes find that the difficulties of satisfying all requirements often prove insuperable, and the enterprise has to be dropped. That there are inherent weaknesses in municipal management cannot, I think, be denied, and first among these I should place the liability to an entire change in the constitution of a committee, not on account of any inability to manage the undertaking, but purely from political reasons. Nothing can be worse for any undertaking

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than sudden and erratic changes of policy, and this want of continuity often produces disastrous results. A most noteworthy instance occurred recently in a metropolitan district, in which an extensive and useful lighting and tramway scheme was projected, carried through its initial stages, and then, owing to a change in the constitution of the committee, suddenly dropped. Next, the large size of most municipal committees tends greatly to hamper the work and to preclude the prompt action necessary in commercial undertakings while the class of man preponderating on town councils tends each year to deteriorate, and men whose business is confined to the keeping of a small shop find themselves called upon to direct large undertakings, requiring for their conduct a very Napoleon of commerce. Again, there is a fatal tendency on the part of members of municipal committees to seek to shine as technical experts, often deriving their knowledge from some friend who has a smattering of the subject. These men insist upon interfering with their paid advisers, frequently marring their carefully thought out plans. Lastly, there is the danger, and it is a very serious one, of political considerations being allowed to influence the policy of municipal trading committees. More especially is this the case where any question of labour arises. Many members are in abject terror of the working-class vote, and will go to almost any length to avoid losing it, with the result that the undertaking is severely handicapped. Other charges, such as a tendency to corrupt practices, to favouritism of individuals, and so forth are frequently brought against municipalities; but, the tendency to these vices is inherent in human nature, and is quite as rife among directors of public companies as among members of municipal committees.

In spite of the drawbacks I have enumerated, excellent results, as we have seen, are produced under municipal management, and the reason for this is, I think, to be found in the class of man who has been attracted to the work. Municipal electrical engineers have shown themselves to be of quite a different stamp to the proverbial municipal official, and, as a body, they have displayed a spirit of independence, a keen enthusiasm for their work for its own sake, and an ardent desire to improve their undertakings in every possible direction. Central-station practice owes much to municipal engineers, and one cannot but contrast the open manner in which they publish their results and experience with the policy of secrecy pursued by most of the officials of public companies, who have fallen very short of the ideal set up a good many years ago by Colonel Crompton, who was, I think, the first to urge upon electrical engineers the necessity for full publication in the interests of the industry at large, a doctrine which he was one of the first to put into practice.

Let me now leave this instance of the tendency to rush to extremes, and turn to another in which zeal has been allowed to outrun discretion and common-sense. During the past year much commotion has been caused by the action of certain gas and water companies in the matter of possible danger from electrolysis arising from the operations of traction systems. The tendency mentioned has been evinced by both parties to the controversy. On the one hand, the gas and water companies, not satisfied with protecting their property, have sought to impose conditions which would make it commercially impossible for electrical engineers to carry out their work; while on the other, electrical engineers have sought to repudiate responsibility altogether. Let us look at the position impartially for a moment. Immense sums of money belonging to communities or to individual shareholders are invested in gas and water pipes laid underground, on the due maintenance of which depends the distribution of such a vital commodity as water and of such a universally employed agent as gas. There arises a new industry which necessitates the passing of electric currents through the soil in which these pipes are laid. It is known that under certain conditions these currents may damage the valuable property already in existence. Is it to be wondered at if those responsible for such property become alarmed and seek to ensure themselves against loss if damage should occur? It is urged that if the promoters of electric traction comply with certain arbitrary regulations drawn up by the Board of Trade when the state of knowledge of the subject was far less complete than now, they should be exempt from all liability for damage caused, no matter how great this may be. Is this position consistent with common fairness? The gas and water companies have, with the sanction of Parliament, expended their money in order to meet public wants. Is it just that another company, which no less, but no more, than they serves the public, should be allowed to conduct its operations in such a manner as to destroy their property? All parties should be granted the free use of the soil, but no one of them should be allowed to damage any other. Surely, the only reasonable position is that the traction companies should be allowed to carry out their work in the manner sanctioned by the Board of Trade, but if damage can be proved to have been done by them, then they should bear the cost. If the traction companies have the confidence in the Board of Trade regulations which they profess to have, they surely cannot object to this because they will do no damage. On the other hand, if they do the damage they ought to pay for it. It is objected that many bogus claims for ordinary corrosion will be made on the electrical companies. This may be so, but, after all, the onus of proof of damage lies upon the gas and water companies, and the electrical engineering profession has not hitherto proved itself lacking in either ingenuity or ability, and may safely be relied upon to take care of itself. At all events, such a consideration ought not to affect the broad question. In this controversy, the disastrous effect to electric traction generally that would arise from a wholesale destruction of gas and water pipes, if such destruction should take place, seems to have been lost sight of, and I venture to think that those who point out the danger and enforce attention being paid to it now are far greater benefactors to the profession than those who vociferate that there is no danger, and urge on traction companies to what might be ultimate ruin. There is no doubt that if the danger is recognised now it can very well be avoided, for a much lower limit of drop of potential than that allowed by the Board of Trade can easily be worked to.

The second of our failings to which I have alluded is a want of foresight. A striking instance of this is the recent extensive promotion of Bills for the establishment of companies to generate electrical energy and distribute it over large districts. I do not wish for the moment to say one word upon the merits of these schemes. No doubt there are circumstances under which they may advantageously be undertaken, while in other instances it is difficult to see any justification for them. In this case, however, it is certain that they will require for their carrying out enormous quantities of plant of very large calibre. This demand is suddenly sprung upon our manufacturing firms; can we expect they will be ready to undertake the work? Surely the better plan would have been to have provided the capital first to extend existing companies, or even establish new ones for making the plant, and then to have promoted the power companies to purchase this plant. Looking at the subject from a commercial point of view, there is, after all, but little advantage to the electrical industry as a whole in extending the use of electrical appliances if the manufacturers cannot share in the development. I greatly fear that the course adopted will result in the orders going abroad, through the unfortunate want of foresight in thus putting the cart before the horse, the labour and enterprise expended by the promoters of the schemes availing thus only to increase the prosperity of our commercial rivals. I might adduce many examples of want of foresight, but I will only allude to one other which has particularly struck me, probably on account of my long connection with central-station work. I refer to the way in which central stations are so often designed. In the early days of public supply, it was not surprising that the demand should be underestimated, and stations be put down on a totally inadequate scale, but now, in the light of accumulated experience, it is astonishing to see the initial instalment arranged for apparently without any regard to future increase, or if such increase be allowed for at all, it is of extremely limited extent. Over and over again one sees designs such that it is physically impossible for the station to grow, and within a few years an entirely new station will have to be provided. Only a few months since, I read a description of a station concerning which it was naïvely remarked that the first instalment, in which a capacity of 1,000 h.p. was allowed for, would be self-contained and independent of further extensions later on, as though this were a merit of the design, and this in face of the efforts that are being made to centralise the supply even at the expense of costly long-distance mains. The two self-contained stations might almost as well have been a couple of miles apart as far as cost of management is concerned, while there would have been the benefit of such advantage as might arise from cheapening the distribution. In the same station the entrance to the repair shop was through the battery-room! More want of foresight.

In concluding this address, time will only admit of my touching very briefly on one or two of the problems most likely to occupy our attention in the near future. One matter which was mooted in the very early days of the electrical industry has come into great prominence in this country during the last two years—namely, the supply of electrical energy over large areas, including small and scattered towns and villages. It does not appear, however, as though the method by which this is to be accomplished has received the consideration it deserves. In place of the problem being gone into thoroughly, it seems to have been assumed that a few enormous generating stations supplying in some cases to distances of 20 miles must be the right thing, and there has been vague talk in which coal-gas engines, gas producers, recovery plant, revision of Board of Trade regulations, and so forth, have figured obscurely. These hazy ideas, eked out with violent vituperation against everyone venturing to offer opposition, have given the impression that the difficulties have all been solved, and that it only remains to carry out the work. No explanation has been vouchsafed as to how the superposition of a number of similar demands, each with a low load factor, is going to give as a resultant an improved load factor, or why a number of inherently unprofitable towns, when connected together by mains, the interest charges on which represent a large proportion of the total probable revenue, will be converted into a gold mine by the use of the magic words "supply in bulk." Granted that gas-engine driving with producer gas in conjunction with recovery plant gives the cheapest production of electrical energy, what evidence have we that such engines will enable alternators to be run in parallel satisfactorily under working conditions? and it must be borne in mind long-distance transmission must almost of necessity be by alternating currents. Recovery plant no doubt gives excellent results on a 100 per cent. load factor, but its successful working requires nice adjustments among all its parts, and its capital cost is high. What will be the effect of the sudden fluctuations of demand incidental to a central station, and how will the question of cost be affected when the interest charges have to be earned in an actual station with a load factor very much below 100 per cent.? Again, is it remembered that in order to get the steam necessary for the recovery plant at a low cost, about one-fourth of the generating plant must be run by non-condensing engines, and this proportion must be preserved at all loads? I do not say that these difficulties cannot be surmounted: I think they can, but I do say that we have heard little of the way in which they are to be met, and that meanwhile great mischief is wrought to less ambitious schemes by the utopian pictures which have been presented to the public of power supplied to consumers at prices no greater than the actual cost of generation, the cost of distribution and other essential charges being left out. That gas-engines driven with producer gas will in the future supplant steam in electrical generating stations there can be very little doubt, but their use will not be confined to stations of abnormal size, for their inherent advantages are very great. The consumption of fuel is but little more than half that of steam-driven plant, and the cleanliness and compactness of the system, coupled with the reduction of radiation and stand-by losses, render possible great strides in the direction of cheapening electrical energy even in very small stations.

There is one method of supplying small towns and villages which

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has not, I think, been put forward, but which might prove a cheap and easy solution of giving to them the advantages of electrical energy. There are few towns so small as not to have a gasworks. Why should not the gas company establish producer plant and sell the gas to a locally-formed electrical company or to the local authority to use for driving electric generators? I should deprecate the gas company undertaking the electrical portion of the business themselves, partly because their staff would not have the necessary experience, partly because they would be tempted to stifle the electrical work. On the other hand, if the course I suggest were taken, each portion of the work would be looked after by those most competent to deal with it, and it would be to the interest of both parties to make the electrical undertaking succeed, for the gas company could make as great a rate of profit on the producer gas as on the ordinary lighting gas, while still enabling the electrical company to produce cheaply. In considering this matter, it must not be forgotten that the preparation of producer gas for gas-engines is by no means a simple matter, and if to this be added an ammonia recovery plant, a considerable amount of skill is required on the part of those looking after the manufacture. This skill is available in gasworks, and for this reason it would pay to put down recovery plant for producers working on a much smaller scale if the operations are carried on in connection with such works than if the plant were isolated. This extension of the gas company's make would not be at the expense of their existing business, for it is a matter of experience that the introduction of the electric light sets a higher standard of illumination, and actually increases the demand for gas for ordinary purposes; hence the introduction of the electric supply would be a clear gain to the gas company. Gas engineers who are not wilfully blind to events must recognise that the public likes electric light and power if it can get them at a reasonable cost. It would be far wiser for them to accept the inevitable, and by joining hands with those they now look upon as enemies participate in this new outlet for their enterprise. Electrical engineers on their part would do well to recognise that gas engineers can help them, and to invoke their assistance in the application of gas for the production of electrical energy.

Perhaps the most important question of all at the present time is what has been so infelicitously called the "electrification of railways"—that is to say, the application of electrical energy to the propulsion of ordinary railway trains over long distances. Electric tramways have now become firmly established in this country, and there can be little doubt they will shortly become practically universal. The horse as a rival was easily beaten; the steam locomotive is one more difficult to displace, but the problem is already being vigorously attacked, and it looks as though for underground railways the battle is already won. The invasion will not, however, stop here, and already the application of electric traction to the main lines of railway is receiving serious consideration. What the result will be is by no means certain, but the present tendency to higher speeds is wholly in favour of electric traction. Though there is unquestionably yet much to be worked out as regards details, the future is distinctly promising. This problem is in reality closely allied to the one to which I have already referred—namely, the supply of large areas of country, and the satisfactory solution of one problem will go far to help that of the other. Much depends upon the question of the pressure of supply to the motors on the trains, and on whether direct or alternating currents will be the more satisfactory. These are matters that must be gone into closely in each individual case with full data, but that a solution will be found can hardly be doubted.

I am compelled to leave untouched many matters that I might well include, but I have already trespassed far upon your patience, and I will therefore conclude with the expression of a hope that the session before us may be full of profit and interest to our members, and that many of the matters which I have so briefly touched upon will be fully discussed and ample consideration be given to widely differing views.

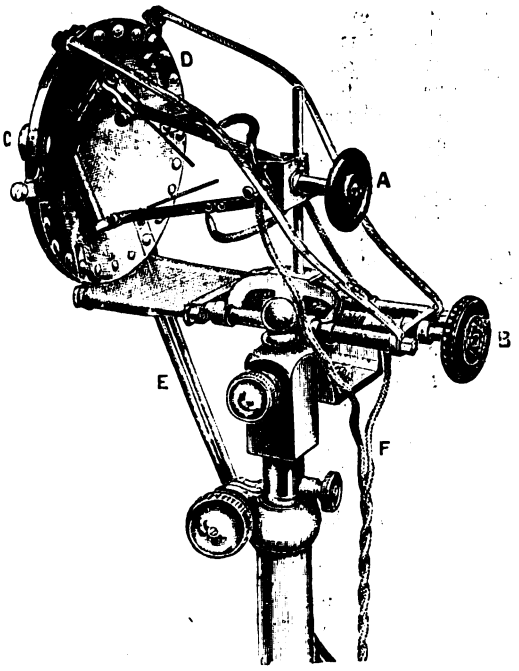
TRADE NOTICES AND NOVELTIES.

Telephone Accessories, etc.

Messrs. Falk, Stadelmann, and Co., Limited, have issued a bulky supplement to their "Bell Catalogue," edition 112. In this supplement telephones, electro-medical apparatus, and portable electrical specialities are illustrated and priced. Numerous diagrams of connections are given in the section devoted to telephones, including connections for domestic installations.

Hospital Lamps.

From Messrs. Marshall and Woods, 2, Gray's-inn-road, Holborn, London, we have received a catalogue of improved electric lamps for the light treatment of lupus and other skin diseases. The London Hospital lamp (open pattern), an illustration of which we give herewith, was, we are told, designed by Mr. Thos. Smith, the chief engineer of the London Hospital. The object of the design is to enable the electric arc to be used within a short distance of the patient's skin. It will be seen that the arc is of the hand-feed type, and can be easily taken out for cleaning or fitting new carbons. This construction enables the lamp to be used either with continuous or alternating currents. With continuous currents about 10 amperes per lamp are required, and with alternating currents 16 amperes. An enclosed pattern of this lamp is also made, in which the body of the lantern forms a water jacket, the lenses through which the light passes forming a part of the jacket. Cold water is circulated constantly through the jacket and between the lenses to carry away the heat generated by the arc. Referring to the illustration, A is the handwheel for regulating the arc: B the handwheel for operating the lamp slide screw, which enables the lamp to be moved slowly up to the lens whilst the operation is in progress, or set at any fixed distance; D is the shield, which is hollow, and through which water circulates; C is the lens, which also has water circulation, and is easily

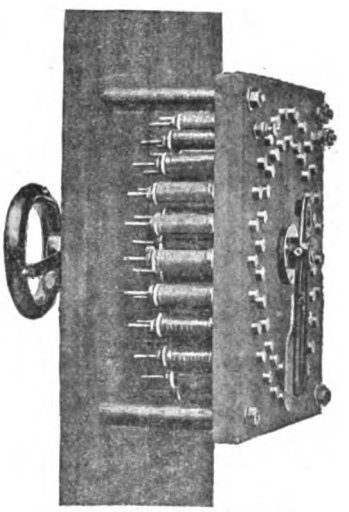


Improved Hospital Lamp.

removable; E are the tubes carrying circulating water; and F, flexible electric wires.

High-Resistance Field Rheostat.

We herewith illustrate a new form of high-resistance field rheostat introduced by Messrs. Geipel and Lange. It is claimed that this rheostat meets the demand for a satisfactory high-resistance shunt regulator for use in connection with boosters, motor-generators, and balancers, enabling the field to be reduced practically to infinity if required. The illustration shows that the resistance is mounted in the form of small units on the back of a slate panel, on the front of which are contact studs travelled over by a lever, which varies the resistance as desired. The resistances are of the Ward-Leonard enamel pattern,


New Form of Field Rheostat.

consisting of pottery tubes wound with the resistance wire and covered with porcelain enamel, which effectually protects the wire from contact with the atmosphere. This construction enables the resistance wire to be kept small and run at a high temperature without injury. The pattern of switch shown is for the back of the switchboard. It can be made with either 25 or 50 steps, and with resistances up to 10,000 ohms. One of the most noteworthy features of the rheostat is its great compactness, the slate front being only 12in. square.

APPOINTMENTS VACANT.

Junior Assistant Electrical Engineer, Hanley, £100 per annum, Dec. 18. Full particulars in our advertisement columns.

Clerk, Hackney, £200 per annum, Dec. 16. Full particulars in our advertisement columns.

Shorthand Clerk and Typist, Hackney, 35s. per week, Dec. 16. Full particulars in our advertisement columns.

Switchboard Attendant, Carlisle, 25s. per week, Dec. 16. Full particulars in our advertisement columns.

Surveyors of Electrical Plant, the National Boiler and General Insurance Company, Limited. Full particulars in our advertisement columns.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

435. What is the cheapest method of reducing the light given by incandescent lamps?—R. V. L.

436. What is the action of soda and of sulphuric acid in water resistances? Why are they used, and which of the two is the best to use?—F. E. H.

ANSWERS.

Question No. 430.—Explain why the polarity of a shunt-wound dynamo is liable to be reversed when temporarily short-circuited.

[N.B.—We have received such a large number of correct answers to the above that only a tithe of them can be inserted.—ED. *E. E.*]

Answer to No. 430 (*awarded* 7*s.* 6*d.*).—In the case of all self-exciting dynamos—shunt, series, or compound—the polarity of the magnets, and, consequently, of the brushes, is not a permanent and fixed property of the machine, but is, on the contrary, easily reversed under suitable conditions. As shown by Figs. 1 and 2, it is immaterial, as

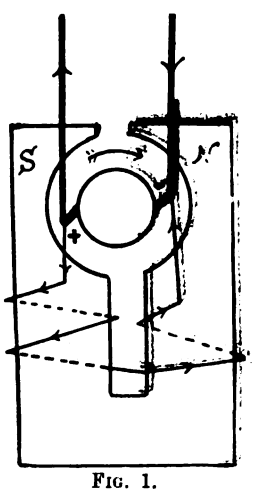

FIG. 1.

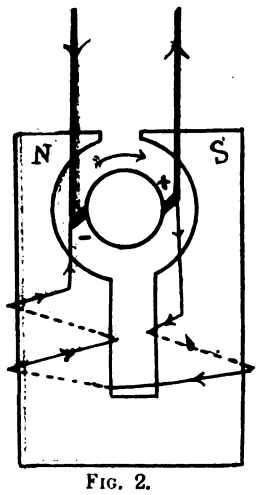

FIG. 2.

far as the connections are concerned, which pole is north and which brush positive, for a change in either only leads to a corresponding change in the other, and the connections still remain correct. If, however, a battery is being charged or several machines are running in parallel, a reversal in polarity of one machine would, of course, lead to disastrous results. When a machine is first tested in the factory its polarity is an open question, and one brush or the other becomes the positive one, according to the bias of any small amount of residual magnetism existing in the iron, towards north polarity in one or the other magnet. Sometimes no such residual magnetism exists, and then it becomes necessary to temporarily separately excite the machine and so polarise it. Once a machine has been excited with a given polarity, it will retain that polarity for the future unless some definite disturbing cause occurs.

The short-circuiting, temporary or otherwise, of a shunt machine is one such disturbing cause which often results in a reversal of polarity in the following manner: As soon as the short-circuit occurs, the current of the machine first rises rapidly to a definite maximum and then falls more slowly to zero, and remains at zero until the short-circuit is removed. It is when re-exciting itself after the short-circuit has been removed, that the reversal in polarity mentioned is sometimes found to exist. The first rapid rise in current, together with a corresponding drop in terminal volts, continues until the armature back ampere-turns are nearly equal to the shunt ampere-turns at some voltage far below the normal. This voltage is just sufficient to pass the large current through the resistance of the mains, and that of the more or less complete short-circuit. If the magnets were stable at this point, a steady state would have been reached, but as with a real short-circuit this voltage is a very low one, the unstable straight part of the magnetisation curve of the machine has usually been reached, and, therefore, the terminal voltage continues to fall, and the current drops off again. On this descent towards zero the fall in current lags, due to self-induction, slightly behind the fall in voltage which causes it, and consequently when the voltage (or the magnetic flux) has reached zero the current still has some small value for an instant. The armature back ampere-turns due to this small final current are often quite sufficient to completely wipe out the previously existing residual magnetism, and replace it by a trace of residual magnetism of reversed polarity. On removing the short-circuit and allowing the machine to re-excite itself, reversed polarity of brushes then naturally results.—Q.

Answer to No. 430 (*awarded* 7*s.* 6*d.*).—The reversal of polarity of a shunt-wound generator is of rare occurrence, if the iron which is used to form the field magnets is of suitable quality. In cases where the poles have been reversed, the iron was found to be too soft or of inferior composition. Supposing, for instance, a switch be placed in the shunt of the dynamo, so that the field coils can be disconnected when required. Then when the dynamo is working at full load, if the field coils be disconnected by means of this switch, a current will be immediately set up, due to the self-induction of the shunt coils. The current is in a reverse direction to that which was flowing before the circuit was broken. The amount of current which is thus set up can be calculated from the formula

$$C = \frac{L}{R} \times \frac{C_1}{T},$$

where L represents the coefficient of self-induction of the circuit;
R the whole resistance of the shunt;
T a short interval of time;
C_1 the decrease of the main current in the shunt coils during this interval.

When a dynamo is self-excited, directly the current ceases to flow around the shunt coils the field magnets only retain a portion of the magnetism imparted to them. Now, this current, which is set up by the self-induction of the circuit, is of sufficient strength to overcome this residual magnetism if it is weak, and thus reverse the polarity of the magnets. The same action occurs when the generator is short-circuited, because directly the short-circuit occurs, practically no current flows round the field coils on account of the very low resistance of the alternate path. This sudden cessation of the current produces the same effect as when the field coils are suddenly disconnected.—S. M. G. T.

Answer to No. 430 (*awarded* 7*s.* 6*d.*).—The tendency of the shunt-wound dynamo to reverse its polarity when temporarily short-circuited is due to its peculiar "characteristic curve," the demagnetising action of the "back ampere-turns" of the armature, and the "cross magnetising" effect of the armature current. The "external characteristic"—*i.e.*, the curve of output at a given speed—of the shunt-wound dynamo takes the well-known form shown in Fig. 1, where ordinates are a measure of the volts, V_1, and abscissæ are proportional to the amperes, A_1, in the external circuit. Commencing at *e*, the volts are at a minimum, as the whole of the current generated in the armature passes through the shunt coils and the external amperes are nil. On lowering the external resistance by putting load on the machine the volts at once begin to drop, the action following Kirchoff's law relating to current in parallel circuits. The shunt

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coils being in parallel with the external circuit, and the shunt resistance remaining practically the same, the reduction of the external resistance by the load coming on the machine causes less current to flow round shunt, the strength of the magnetic field decreases in consequence, hence the fall in voltage. The curve continues to drop as more and more current is drawn from the machine, slowly at first, but more rapidly as the knee is reached, at the lower bend of which is a critical point, X, beyond which any further decrease in the external circuit resistance causes the curve to at once double back to the zero point, 0, and renders the field magnetism very unstable, and liable to fail altogether. The demagnetising action of a

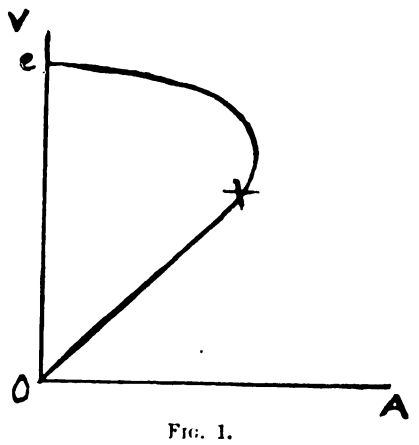


FIG. 1.

short-circuit in the external circuit of a shunt dynamo, which is the first step in the phenomenon in question, can thus be understood.

The next cause which tends to the reversal of polarity under the conditions mentioned — that due to the demagnetising effect of the "back ampere-turns" of the armature when under load — may be gathered from a consideration of Fig. 2, where, following a familiar illustration, the arrow shows the direction of the rotation of the armature, and the current may be taken as flowing upwards to the top brush. In the conductors to the right of the line, *n n*, looking at the figure, the current is supposed to be flowing from the reader and towards him in those on the left of it. The line *n n* represents the neutral axis of the field, which has been advanced from its normal position to obviate sparking, due to the distortion of the field by the "cross-magnetisation" of the armature; *a a* and *b b* are lines drawn perpendicularly to the horizontal diameter of the armature and through the points of the brushes. A moment's thought will show that the effect of the layer of conductors between the lines *a a* and *b b* will be to magnetise the armature core in such a way that it will oppose the main field and tend to demagnetise them. Under the conditions being discussed, a sudden large current being suddenly drawn from a shunt

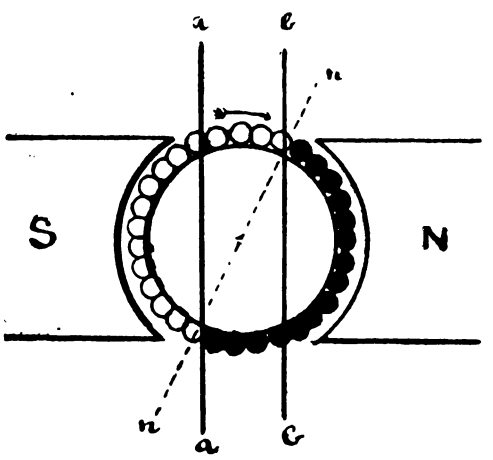
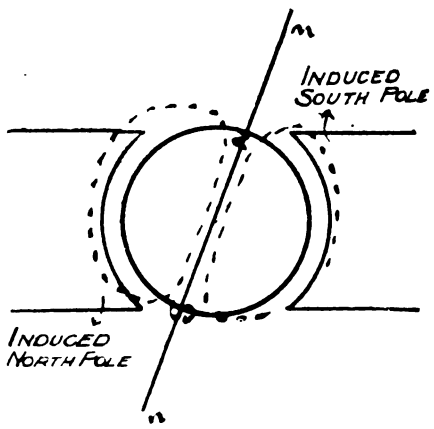


FIG. 2

machine, this demagnetising effect of the "back ampere-turns" between *a a* and *b b* will greatly accelerate the failure of the field as soon as the critical point, X, in the curve of Fig. 1 is reached, and in the event of the armature current lagging slightly as it and the shunt current die away to zero, due to a difference in their self-inductive actions, the tendency would be for the opposing magnetism of the "back ampere-turns" to reverse the main field, and residual induced magnetic charge would have the consequence of the machine building up again with opposite polarity. This effect may conceivably be accentuated by the action of the "cross-magnetism" of the armature in the following manner: Referring to Fig. 3, and supposing the shunt excitation to have failed on short-circuit in the external circuit, and the armature current to be dying away slightly behind the shunt current. A field will be main-

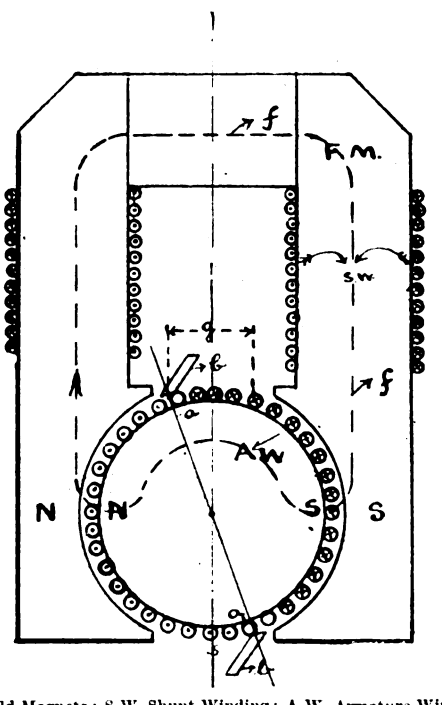


Main Field Failed. Armature Current Decreasing to Zero.

FIG. 3.

tained in the armature core by this dying current, with its poles under the brushes and the directions of flow being the same as in Fig. 2. This armature cross-magnetism will have poles, as labelled, N S, and its lines of force will cut the magnet pole horns, as shown by the dotted curves, and tend to induce a magnetic charge in them of opposite sign to the old field, with the same result as that of the previous action noted. The residual magnetism due to one or the other or both of these reversing effects would mean the machine building up with reversed polarity. The momentary sequence of these actions may be the explanation of the question asked.—E. A. P.

Answer to No. 430 (*awarded* 5*s.*).—The reason why the polarity of a shunt-wound dynamo is liable to be reversed from a short circuit is that, owing to the excessive current



F M, Field Magnets; S W, Shunt Winding; A W, Armature Winding; *b*, Brushes; *a a*, Diameter of Commutation

traversing the armature conductors due to the short-circuit, the "back ampere-turns" on the armature may exceed the number of ampere-turns producing the useful

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flux on the field magnets. This can be more fully explained with the aid of the preceding sketch, where the armature shunt winding is shown in section, and the direction of the magnetic field set up by the shunt winding indicated by the dotted line marked *f*. Now, it will be seen that, in addition to the shunt winding, a certain number of turns on the armature—namely, the wires contained in the gap *g*, which are determined by the angle of lead given to the brushes—are magnetically in the same condition as the wires on the field magnets: but it will be observed that the current in these wires is flowing in the opposite direction to that on the field winding. "Esson calls these the back ampere-turns." It is therefore obvious that a magnetic field will be set up in the opposite direction to that produced by the field winding tending to form N and S poles on the armature as shown. Under normal conditions of working the back ampere-turns on the armature are from 4 to 8 per cent. of the field excitation, and their only disadvantage is that they must be compensated for by adding more turns on the field magnets than would be necessary if these back turns did not exist when designing the machine.

The formula given by Kapp for the back ampere-turns in his book on dynamos is

$$X_b = \tau \times c \frac{g}{\pi (d \times 2\delta)},$$

where X_b = back ampere-turns;
τ = number of conductors on armature;
c = current through one armature conductor;
g = gap shown in sketch;
d = diameter of armature;
δ = length of air-gap.

Now, to reverse the polarity of the dynamo when short-circuited it is necessary for the number of back turns given by this formula to exceed the number of ampere-turns on the field magnets, which may be quite possible if the short-circuit is a serious one and the resistance of the armature very low; such a case came under the writer's experience once. But in well designed machines where the angle of lead given to the brushes for full load is small, it needs such a tremendous current flowing through the armature to reverse the polarity, that before this has had time to take place the belt will have been thrown off the machine, or the engine pulled up dead if direct driven, consequently the voltage of the machine will drop to zero, when no harm can be done.

For further particulars on the subject the writer would refer to Fisher-Hinnen's book on "Continuous-Current Dynamos," published by Biggs and Co., from which some good information can be obtained.—R. F. W.

LEGAL INTELLIGENCE.

A QUESTION OF SUBWAYS.

An important case affecting the question of how far a local authority is entitled to use its powers against rival traders was heard in the Chancery Division before Mr. Justice Farwell on Friday last. The suit was brought at the instance of the Walker Urban District Council against Messrs. Wigham, Richardson, and Co., Limited, claiming a declaration that they were entitled to pull down "or otherwise deal with" a tunnel which the company had constructed under the roadway of Fisher-street. It appeared that in the concrete floor of the tunnel the defendants had laid four iron pipes, two of which contained electrical mains, and on the Council claiming to exercise their powers under the Public Health Act, 1875, and pull down the tunnel, the construction of which they alleged was in contravention of that Act, the company filled the tunnel up with ballast and concrete, but they did not remove the concrete floor or their electrical mains. The Council were not satisfied, and brought this action for a declaration in the terms mentioned. The company brought a cross-claim for an injunction to restrain the Council "from cutting, disturbing, or injuring the company's pipes or mains or electrical wires" in question. An interim injunction in these terms was granted some days ago by Mr. Justice Buckley.

After hearing the arguments of counsel on both sides, **Mr. Justice Farwell**, in giving judgment, said the case had resolved itself into the question of fact whether the company's pipes were part of or placed in any structure which the local authority were entitled to remove. In his view, where the pipes now were was not part of the floor, or of the structure, and he agreed with the company's witness that the whole tunnel could be removed without interfering with the pipes. It was not necessary on that view of the facts to consider the question of *bonâ fides*, but a serious question might hereafter arise how far a local authority was entitled to use its powers against rival traders. As the general result the Council was entitled to the declaration it claimed, while the injunction granted by Mr. Justice Buckley in favour of the company would continue. The Council must pay the costs of the action by the company, and the company the costs of the other action.

ELECTRICITY METERS — ALLEGED INFRINGEMENT OF PATENT.

On Friday last, in the Court of Appeal, consisting of Lords Justices Vaughan Williams, Romer, and Cozens-Hardy, the arguments in the case of Chamberlain and Hookham, Limited, *v.* the Mayor, etc., of Bradford were concluded. The case, which was one for the infringement of the plaintiffs' patent relating to electricity meters, came before the Court on the appeal of the plaintiffs from the judgment of Mr. Justice Farwell in the Chancery Division in favour of the defendants. The complicated nature of the litigation may be gathered from the fact that the arguments in the Court of Appeal lasted altogether for 10 days, and were only brought to a conclusion last Friday. Shortly stated, the plaintiffs' case is that they are the owners of letters patent, dated March 21, 1887 (No. 4,225), granted to George Hookham, for "improvements in electricity meters, parts of which improvements are applicable to dynamo-electric generators and motors." It was alleged that the defendants had infringed their patent by using electricity meters constructed in accordance with the invention described in the specification, and that the meters so used by the defendants were constructed and operated substantially in accordance with the invention described in the plaintiffs' specification, and claimed in the first and third claims thereof. They further complained that the defendants used meters constructed by the Thomson-Houston Company, using the same upon circuits of constant potential for the purpose of measuring current supplied to customers of the defendants.

The defences relied upon were non-infringement and invalidity of the patent by reason of insufficiency, want of utility, prior publication, and disconformity. It appeared that the plaintiffs had previously obtained a certificate of validity of their patent in an action brought by them against Messrs. Johnson and Phillips, electrical engineers, in February, 1897, before Mr. Justice Wills.

In the present case, Mr. Justice Farwell held that the defendants had not infringed the plaintiffs' patent, but expressed no opinion as to the validity of the same. He accordingly dismissed the action. Hence the present appeal of the plaintiffs.

Mr. Fletcher Moulton, K.C., Mr. A. J. Walter, and Mr. Gray appeared for the appellants; and Mr. Cripps, K.C., Mr. Bousfield, K.C., and Mr. Graham for the respondents.

To a great extent the case turned upon the question of the form of magnet used. **Mr. Moulton**, in the course of his address on behalf of the appellants, argued that the absence of knowledge as to how to make permanent and powerful magnets was the obstacle of success in other meters, and his case was that the defendants had taken the form of magnet described in the plaintiffs' patent.

Mr. Cripps, K.C., in support of the judgment in the Court below, submitted that the principle on which the plaintiffs' meter depended was known, and was known as applied to meters before the date of the patent, and the magnetic brake, which was nothing more than the retarding power of a magnet on a rotating copper disc, was also known.

Lord Justice Vaughan Williams said the Court would like to hear what the appellants' counsel had to say upon Mr. Cripp's first proposition, that the plaintiffs were not using anything which was not common knowledge at the time of Hookham's patent.

Mr. Moulton submitted that there was an absolute lack of any public knowledge which would suffice to make a practicable meter on Hookham's scheme in 1887. This was a case in which the plaintiffs had always admitted that the theory of a meter of that kind was known at that time, but what they said, and against which there was not a particle of evidence, was that nobody had made or could make a meter according to that theory till Hookham showed how it could be done. It was clear, he contended, that the defendants had taken the particular form of magnet which Mr. Hookham had adopted.

Lord Justice Vaughan Williams said the Court would consider this part of the argument, and let the parties know whether they would require to hear further arguments on the other points raised in the case.

EASTBOURNE ELECTRIC LIGHT.

On the 28th ult. the case of the Attorney-General *v.* the Mayor and Corporation of Eastbourne came before the Court of Appeal, consisting of the Master of the Rolls and Lords Justices Stirling and Mathew, on the appeal of the Corporation from a decision of Justices Kennedy and Phillimore, deciding a question of stamp duty in favour of the Crown.

From the statement of counsel it appeared that in 1899 the Eastbourne Electric Light Company, Limited, entered into an agreement with the Mayor and Corporation of Eastbourne for the sale of the undertaking to the Corporation. In order to carry out the agreement a conveyance was executed, and the question before the Court was the amount on which the stamp duty should be calculated. The Crown claimed it on £88,749, which they said was the real purchase money given for the company's concern, whereas the Corporation said that no duty was payable on £37,929, which was part of the larger sum, as it was the price of the personal property sold by the company, and that under Section 12 of the Finance Act, 1895, real property alone was chargeable, with an *ad valorem* duty of 5s. in every £50. The Divisional Court held that the contention of the Commissioners was right, and that the instrument should be stamped with £443. 15s. From that decision the Corporation appealed, contending that the capital value had been wrongly estimated, and that the stamp ought to be reduced by nearly £150.

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Counsel addressed the Court on both sides, and on the conclusion of their speeches

Their Lordships upheld the decision below, and dismissed the appeal with costs.

COMPANIES' MEETINGS AND REPORTS.

WESTMINSTER ELECTRIC SUPPLY.

An extraordinary general meeting of the shareholders of the above Corporation was held at the registered office, Eccleston-place, Belgravia, S.W., on Wednesday, when the following resolution was considered: "That the capital of the Company be increased from £550,000 to £800,000 by the creation of 50,000 new shares of £5 each, such shares to be called preference shares, and to carry a cumulative preferential dividend at the rate of £5 per cent. per annum on the capital for the time being paid up thereon, with a preferential right over the ordinary shares of the Company in the distribution of the assets in case of the winding-up of the Company, such shares to be issued in such series at such times and prices and in such manner and with such regulations as to times for payment of dividends and otherwise, as the directors may from time to time determine." The resolution will be submitted for confirmation to a second extraordinary meeting which will be duly convened for the purpose.

DIAMLER MOTOR.

Presiding at the annual general meeting of the shareholders in this Company at the Holborn Restaurant on the 28th ult., **Sir E. G. Jenkinson** said the present directors had appointed a works manager, who had come to the Company with a very high character, and who had had a thorough scientific training both in America and Germany as an engineer and in the organisation and working of shops. The good results of that gentleman's management were already apparent. With respect to the Company's present position, he was glad to say that, notwithstanding the difficulties which they had had to contend with, the business went on steadily improving. The present Board did not desire to take too much credit for the improvement; the full results of its labours could not yet be seen. Having mentioned the sale and cash receipts in the past three years, he stated that the profit and loss account for the year 1897-8 showed a loss of £1,424; for 1898-9, a period of 15 months, there was a profit of £1,045; and for the following two years the profit further increased to £4,430 and £6,742 respectively. By degrees the accumulated stock would be worked up into cars, and profitably sold. There was nothing in the accounts to make them despondent as to the future; and they had a fine business. Automobiles had come to stay, and before long there would be a large demand for cars from corporations and local bodies, private firms, and others throughout the country. They had decided to make an issue of 5 per cent. mortgage debentures, repayable at 105, and the shareholders would have the first chance to take them up on the underwriting terms. For some time negotiations had been going on with the Board of the Motor Manufacturing Company for an amalgamation of the two companies, but on going into details they had failed to come to a satisfactory arrangement. Perhaps negotiations might be reopened.

He then moved the adoption of the report, and the motion being seconded it was carried unanimously.

NEW COMPANIES REGISTERED.

Electric Equipment and Securities, Limited. — Capital, £100,000. Objects: to acquire and deal in railways, buildings, etc., mortgages, charges, annuities, patents, licenses, shares, stocks, debentures, to act as an electric light company generally, and to carry on the business of electricians, electrical, mechanical, gas, and general engineers, etc.

Liquid (Electric) Register Syndicate, Limited. — Capital, £9,000. Objects: to adopt an agreement with G. S. Hertslet and E. S. Morris, and to carry on the business of electricians, electrical and mechanical engineers, manufacturers of all apparatus and things connected with the generation, distribution, supply, accumulation, and employment of electricity, etc.

Electrical Machinery Developments Company, Limited.—Capital, £10,000. Objects: to carry on the business of financiers, promoters, contractors, constructors of railways, tramways, electric and other works, builders, etc.

Tuck's (Ireland), Limited.—Capital, £50,000. Objects: to acquire the business of engineers and manufacturers hitherto carried on by Tuck and Co., Limited, at 19-22, Lower Abbey-street, Beresford-place and Montgomery-street, all in Dublin, and to carry on the business of electrical and mechanical engineers, etc.

Washington and Co.—Capital, £6,000. Objects: to acquire under a certain agreement the business of a mechanical and electrical engineer and machine maker as now carried on at Stanley-street and Old Causeway, Sowerby Bridge, as Washington and Co., with the assets and liabilities thereof, to develop and extend the same, etc.

Grant's Drill and Trolley Company, Limited.—Capital, £7,000. Objects: to adopt an agreement with R. G. Grant, P. C. Pope, and J. F. Simpson for the acquisition of any patents relating to improvements in boring drills, or of holding or driving the same, and in the manufacture of electric tramway equipment, etc.

PROPOSED NEW BILLS AND ORDERS.

The following additional notices have appeared in the *London Gazette* of intention to apply for Bills or provisional orders:

Electric Lighting.—Chiswick (U.D.C.), Paignton (U.D.C.), Chepstow (Co.), Paignton (Provincial Electric Supply and Traction Co.), Dover (Corporation).

Electric Tramways and Railways.—Torquay and Paignton (Co.), Leeds (Corporation), Pontypridd (U.D.C.), Chiswick (U.D.C.), Wolverhampton (Corporation).

Applications will also be made to the Light Railway Commissioners as follows: Luton, Dunstable and District (J. Fell, W. J. Kershaw, and C. Osborn), Warrington (Corporation), Dudley and Rowley Regis (Dudley Corporation and Rowley U.D.C.), Watford and District (Tramway Co.), Selby and Goole (Co.), Barnsley and Doncaster (Sir H. Trueman Wood, T. W. H. Mitchell, W. H. Chamber), Southend and District, Bradwell-on-Sea and Colchester (Railways and General Construction and Maintenance Co., Limited), County of Hertford (Bushey) (Hertford C.C.), Middlesex (London United Tramways Co.), Canterbury and Herne Bay (O. W. Bowen and W. J. Kershaw), West Manchester (Co.), Walthamstow and District (U.D.C.), Wakefield and District, Dewsbury and Castleford (Extensions) (Co.), Mansfield and District (Co.), Nottingham Suburban (Co.), Derby and Nottingham (Sir J. Kenneth Douglas Mackenzie, John Fell, and J. Kershaw), Halesowen (R.D.C.), Crystal Palace (Co.), Ramsbottom, Edenfield, and Rawtenstall (C. L. Bovet, J. Thornton, and A. Wart), Torquay and Paignton (Provincial Electric Supply and Traction Co.).

NEW COMMITTEES.

The following new committees have been selected:

HAMMERSMITH.—*Electricity and Lighting*: Councillor Bendon, chairman, and Councillor Johnson, vice-chairman.

ISLINGTON.—*Lighting*: Councillor Samuel Lambert, chairman, and Councillor Usher, vice-chairman.

GRAVESEND.—*Electric*: Alderman Paine, chairman; the Mayor (Mr. Alderman Cooper); Aldermen Wood and Willis; and Councillors Rose, Rhodes, Cobham, Walter, Davis, Acworth, Mason, Naylor, Cosh, and Hooper.

LEICESTER.—*Telephonic Exchange*: Councillor Squire (added).

DONCASTER.—*Electric Lighting*: Councillor Dowson, chairman; Aldermen Athron and Wainwright; Councillors Birkinshaw, Bennett, Gyles, Halmshaw, Manwaring, Smith, Theobald, Tovey, and Whiteman. *Tramways*: The Mayor (Councillor Windle); Councillor Smith, chairman; Aldermen Clark and Wainwright; Councillors Armitage, Bennett, Brightmore, Dowson, Gyles, Manwaring, Robinson, and Tovey.

NORWICH.—*Tramways*: Aldermen Bagshaw, G. M. Chamberlin, Cunnell, Green, Hackblock, G. White, M.P., Wild; Councillors A. C. Havers, D. Havers, Moore, and Tillett.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Stirling.—The Town Council will receive tenders for motors for hiring purposes by Dec. 16.

Maidstone.—The Corporation invite tenders for wiring and fitting various buildings by Dec. 19.

Leigh.—The Electricity Department of the Town Council invite tenders for boilers, condensers and dynamo feeder panels by Dec. 16.

Oban.—The Burgh Commissioners will receive tenders for three 60-kw. steam dynamos, with two boilers, economiser, etc., by Dec. 18.

Paris.—The Under-Secretary of Postal Telegraph, Rue de Grenelle, 103, will receive tenders for 11 magnetic apparatus by Dec. 10.

Brussels.—The Government Railways invite tenders for steel and copper wire, cables, insulators and telegraph instruments, etc., by Dec. 11, at 11 a.m.

Horsham.—The Urban District Council invite tenders for the supply of meters (direct current) and cut-outs. Tenders by Dec. 15. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the mason and brick work and the smith and founder work of the electric generating station to be erected off Dunnikier-road. Tenders by Dec. 14.

Brussels.—The administration of the Belgian Government Telegraphs will receive tenders for 7,300 telegraph posts by Jan. 8, 1902. Specification No. 12 may be obtained at the office of the department, Brussels.

Barrow-in-Furness.—The School Board invite tenders for the lighting of the new school at Vickerstown. Specifications, etc., may be seen at the office of the architect, Mr. H. T. Fowler, Ramsden-square. Tenders by Dec. 10.

Hampstead.—The Metropolitan Asylums Board invite tenders for the installation of an electric fire-alarm system at the North-Western Fever Hospital, Lawn-road, Hampstead, N.W. Tenders by Dec. 19. Details in our advertisement columns.

Bedford.—The electrical engineer has been instructed to obtain two sets of steam indicators and a planimeter for testing engines, and also a resistance for Kelvin balance for testing alternators, at the estimated prices of £22. 10s. and £17. 10s. respectively.

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Sunderland.—The Corporation invite tenders for the supply and erection of cast-iron condenser and water pipes, and some copper steam piping, valves, etc., for their Hylton-road electric lighting station. Tenders by Dec. 20. Details in our advertisement columns.

Maidenhead.—The Town Council invite tenders for the laying of stoneware conduits for electric mains, the provision of arc lamp-posts, and other work incidental thereto. Specification, etc., may be obtained at the office of the Borough Surveyor. Tenders by Dec. 13.

Hornsey.—The Urban District Council invite tenders for the supply and erection of steam, exhaust, water, and other pipes, valves, tanks, footplates, and accessories, and elevator and transporter, electric motor and switch gear. Tenders by Jan. 15. Details in our advertisement columns.

Southampton.—The Director-General of Ordnance Survey invites tenders for the supply of motors, motor-generators, cables, switchgear, etc., and fixing and adapting the same to existing machines in the Ordnance Survey Office. Tenders by Dec. 14. Details in our advertisement columns.

London.—The London County Council invite tenders for wiring and fittings for the electric lighting of the Bishopsgate, Brompton, and Manchester-square fire brigade stations. Specifications, etc., may be obtained at the Chief Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Dec. 12.

Pontypridd.—The Urban District Council invite tenders for water-tube boilers, stokers, and economiser, three steam-engines, two 300-kw. and one 150-kw. dynamos, balancing set, switchboard and test-room, workshop, travelling crane, and arc lamps. Tenders by Dec. 14. Details in our advertisement columns.

Madrid.—Tenders are invited for installing and working the electric light at a prison. After 15 years the installation is to become the property of the Government, who will contribute a maximum of 40,000 pesetas per annum. Particulars may be obtained from the Junta local de Prisiones, Madrid. Tenders by 3 p.m. on Dec. 26.

Louvain (Belgium).—The contract for the lighting of Louvain by gas will expire on Jan. 1, 1905. The Municipality are therefore prepared to receive, before Dec. 31, 1901, proposals for lighting the city, either by gas or electricity, or by the two systems combined, from gas or electric light companies. Address the Burgomaster, Louvain, Belgium.

Glasgow.—The Corporation invite tenders for the supply of the following material: 2,000. 3,000 or 4,000 tons steel straight track rails; 200. 300. or 400 tons steel curved rails; 100. 150 or 200 tons steel fishplates. Specification, etc., can be obtained on application to Mr. John Young, general manager, 86, Renfield-street, Glasgow. Tenders by Dec. 20.

Liverpool.—The Midland Electric Corporation for Power Distribution, Limited, invite tenders for the supply and erection of two-phase motor-generators, boosters, high and low-tension switchboards, etc., and the supply and erection of a battery of accumulators, to be installed in their sub-station at Bilston, Staffs. Tenders by Dec. 20. Details in our advertisement columns.

Nantwich.—The Urban District Council invite tenders for the supply and erection of boiler-house plant: one water-tube tube and one Lancashire boiler, fittings, steam and exhaust pipes, etc.: engine-house plant: continuous-current steam dynamos, pumps, etc.; switchboard, etc., underground mains, lamp posts, etc., accumulators, meters, crane, etc., dust destructor. Tenders by Jan. 6, 1902.

Bideford.—The Urban District Council invite tenders for lighting the district comprised in the borough, for three years certain, commencing from March 31, 1902. Each tender to include the cost of lighting and extinguishing. It is requested that each tender may be based on the terms and conditions, which may be seen at the office of Mr. Wm. B. Seldon, town clerk, Bideford. Tenders by Dec. 11.

Madrid.—The Public Works Department invite tenders for an electric tramway from San Sebastion to Toloso, with power to work same for a maximum of 60 years, after which the undertaking becomes Government property without compensation. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Maidenhead.—The Corporation invite tenders for the supply and erection of steam, exhaust, and other pipes, pumps, condensing plant, etc., balancing transformers and motor-generators, storage batteries, switchboard, arc lamps and fittings, cable work, and travelling crane. Specifications and all information may be obtained at the office of Messrs. Burstall and Monkhouse, consulting engineers to the Corporation, 14, Old Queen-street, Westminster, S.W. Tenders by Dec. 13.

Huddersfield.—The Corporation invite tenders for the supply and erection of one vertical cross compound condensing engine, 750-kw. traction generator, boosters, one Lancashire boiler and fittings, steam and boiler feed pipes, mechanical stoker and conveyor, economiser, switchboard, overhead line equipment and car-sheds, wiring, cables, etc., cable conduits, car bodies, trucks, and electrical car equipment. Specifications, etc., may be obtained on application to Mr. K. F. Campbell, M.I.C.E., borough engineer. Tenders by Dec. 9.

Reading.—The Corporation invite tenders for the supply and erection of water-tube boilers, superheaters, and mechanical stokers, fuel economiser, piping, feed pumps, etc., compound condensing direct-coupled engines, surface condensers, air pumps, circulating pumps, piping, etc., electric generators, switchboard and connections, electric lighting, overhead travelling crane, motor trucks, motors and electrical equipment for cars, car bodies, trolleys, and miscellaneous minor works and fittings. Tenders by Dec. 28. Details in our advertisement columns.

Rockhampton (Queensland).—The Municipality invite applications from companies desirous of undertaking the construction and working a system of electric tramways under the Queensland Tramways Act of 1882 and the Amendment Act of 1890, within the municipality of Rockhampton aforesaid. Rockhampton, with a population of 15,461, is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882 and the Amendment Act of 1890, copies of which may be seen at the office of this paper. Applications to be forwarded to Mr. H. W. Johnson, mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31.

RESULTS OF TENDERS.

Hammersmith.—The Borough Council have purchased a travelling jib crane, to be driven by electricity, of Mr. T. Smith, of Leeds, at £735.

Holwood House, Bromley.—The complete electric lighting of this mansion has been placed by the Earl of Derby in the hands of the National Electric Wiring Company, Limited.

Edinburgh.—The tender of Messrs. D. Brown and Co. for wiring the second portion of Colinton Mains Hospital for electric light, amounting to £593. 8s., and 18s. for each additional lamp, has been accepted.

Manchester.—The tender of the Electrical Company, Limited, at £113,000, has been accepted for the supply, delivery, and erection at Stuart-street station and the several sub-stations in connection therewith of two 6,000-h.p. slow-speed (Wallsend Slipway Engineering Company) engines, three-phase generators, and motor-generators.

Leeds.—The Lighting Committee have accepted the following tenders for works in connection with the extension of electric lighting mains: for construction of five transformer chambers, £2,295; for supply of cables, £10,595. 17s. 3d.; for 26 transformers at £108, £2,808; for switch gear, £817. 1s. 10d. Tenders for the supply of 60 standards for electric arc lamps for the lighting of East-parade, Infirmary-street, Park-row, Cookridge-street, and Woodhouse-lane, at the price of £7. 19s. 6d. each, are being considered.

Plymouth.—The Corporation have received the following tenders for the supply and delivery at Plymouth of about 300 tons rails, fishplates, etc.: H. Gielgud, 140, Leadenhall-street, London, rails £6. 6s. 6d. per ton, fishplates £6. 17s. 6d. per ton (informal); Dick, Kerr and Co., 110, Cannon-street, London, rails £6 5s., fishplates £6. 15s. (informal); P. W. Maclellan, 129, Trongate, Glasgow, rails £6. 8s., fishplates £7. 0s. 6d. (informal); W. Scott, Limited, Leeds, rails £7. 12s. 6d., fishplates £9. 2s. 6d. (accepted); Bolckow, Vaughan and Co., Middlesbrough, rails £7. 17s. 6d., fishplates £9. 7s. 6d. (informal); A. Penney and Co., 107, Fenchurch-street, London, rails £7. 19s. 6d., fishplates £9. 19s. 6d.

Aberdeen.—The Tramways Committee have received the following tenders for the supply and erection of overhead linework, the supply and laying of cables, and the bonding of rails (bonds supplied by the Corporation) for the equipment of their Union-street and Holborn-street tramways: Western Electric Company, North Woolwich, London, E.; Siemens Bros. and Co., 12, Queen Anne's-gate, Westminster, S.W.; Telegraph Manufacturing Company, Britannia Works, Helsby; R. W. Blackwell and Co., 59, City-road, London, E.C.; British Insulated Wire Company, Prescot, Lancashire; Macartney, McElroy, and Co., 53, Victoria-street, Westminster, London, S.W. (accepted for all work except bonding); Anchor Cable Company, Leigh, Lancashire; W. T. Glover and Co., Trafford Park, Manchester.

Hull.—The Electric Lighting Committee have received the following tenders for six rotatory transformers for continuous-current transformation, 2,000 volts to 220 volts, 90 kw. each:

Siemens Bros. and Co., London	£3,270
British Schuckert Electrical Company, London	3,280
Newton Electrical Works, Taunton	3,495
Bergtheil and Young, Manchester	3,883
T. Parker, Limited, Wolverhampton	4,230
International Engineering Company, London	4,450
Sunderland Forge Engineering Company, Sunderland	4,836
D. Bruce Peebles and Co., Edinburgh	4,940
Electric Construction Company, London	5,310
Lahmeyer Electrical Company, London	5,400
Johnson and Phillips, Old Charlton	6,000
F. Suter and Co., London	6,360
Sir W. G. Armstrong, Whitworth, and Co., Newcastle	10,830

Barking (Essex).—The Urban District Council have received the following tenders for electric locomotive crane and permanent way at the Council's wharf:

Crane.

Francis and Spilsbury, 20, Bucklersbury, E.C.	£955
Royce, Limited, Hulme, Manchester	950
Wimshurst, Hollick, and Co., 11 and 12, Clements-lane, E.C.	850
Hunter and English, Bow-road, E.	720
Chaplin and Co., Govan, Glasgow	695
Jessop and Appleby, Leicester	690
Carrick and Ritchie, Waverley Works, Edinburgh	595
T. Smith, Rodley, Leeds	585
Rushworth Bros., Colne	575
Carrick and Sons, Dalry Ironworks, Edinburgh	557
J. Booth and Bros., Rodley, Leeds	550
Lahmeyer Electrical Company, 109-111, New Oxford-street, W.C.	550
J. G. Statter and Co., Colmore-row, Birmingham	532
Chatteris Engineering Company, Chatteris, Cambs	445

Permanent way.

Carrick and Sons	245
Chatteris Engineering Company	397

Surveyor's estimate, £202. 11s.

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BUSINESS NOTES.

TRACTION.

Eastbourne.—The question of the introduction of electric tramways in this place has been postponed.

Perth.—Consideration of the proposal of the Corporation to acquire the undertaking of the tramways company has been delayed for a week.

Stapleford.—A committee of the whole Council is about to take in hand the proposals to establish a light railway between Derby and Nottingham.

Grimsby. — Major Druitt, a Board of Trade inspector, has examined and approved the remaining portion of the new electric tramways at this place.

Walker.—The Urban District Council have decided to oppose the Tyneside Tramways Company's application for powers to construct a a tramway in Shields-road.

Penge.—A report is being prepared for the Urban District Council as to how the tramways scheme proposed by the British Electric Traction Company affects their own proposals.

Wolverhampton.—The Corporation have given public notice of their intention to apply to the Board of Trade before the 23rd inst. for powers to lay down new tramways in the town.

Llandudno.—The tramway to Orme's Head will probably be opened next Easter. The engineer to the Town Council has submitted a scheme for an electric tramway on Marine-drive.

Gorton.—The Tramways Committee of the District Council recommend that it is expedient that a double set of rails should be laid in Hyde-road, to facilitate traffic by the electric cars.

York.—The City Council have passed the proposal to apply to Parliament in the next session for powers to reconstruct the existing tramways for electric traction and to lay down new lines.

Metropolitan Railway.—Owing to ill-health, Mr. John Bell has resigned the chairmanship of the Metropolitan Railway Company, and Colonel J. J. Mellor has been elected to the vacant chair.

Gravesend.—Designs submitted by the British Electric Traction Company for poles and feeder pillars to be used in connection with the new tramways have received the approval of the Town Council.

St. Annes.—Negotiations are proceeding between representatives of the Blackpool and St. Annes Councils respectively with reference to the latter body supplying current for the tramways in their district.

Saddleworth.—As at present drawn up the Saddleworth Tramways Bill makes no mention of the inclusion of Diggle in the scheme. The Council have now decided to also obtain powers in respect of this place.

Burnley.—A trial trip with one of the new electric cars was successfully made over a section of the tramways which has been converted. It is hoped to commence regular traffic over certain portions of the line a fortnight hence.

Brighton.—Colonel von Donop paid another visit to Brighton on Friday to inspect the Ditchling-road and the Drove and Beaconsfield-villas sections of the new electric tramways, which have now been completed for public traffic.

Appointment.—Mr. Charles William Shepherd, late traffic manager of the Harpurhey section of the Manchester Carriage and Tramway Company, has been appointed traffic superintendent on the Bradford Corporation electric tramway.

Southampton.—Three more electric tramcars are to be purchased for use next spring. It appears from a statement made at the last meeting of the Town Council that the new system of 1d. sections is being attended with the success anticipated.

Wakefield.—The light railway company intend applying to the Light Railway Commissioners for authority to extend their lines to Dewsbury, Ossett, Rothwell, Oulton, Methley, Whitwood, Warmfield, Crofton, Sharlston, Featherstone, and Normanton.

Aberdeen.—Having just placed the contracts for the electrical equipment of the Union-street tramway (as reported in another column) the Tramways Committee will next consider the question of applying electric traction to the lines in Albyn-place.

Liverpool.—A proposal to introduce universal 1d. fares on the tramways from Jan. 1 next has been rejected. The Tramways Committee recommend the adoption of a new set of by-laws with regard to the use of the cars by the public which have been approved.

Accrington.—The Parliamentary Committee report with reference to the proposed Burnley and Accrington light railway, which is intended to connect the two towns, that the project is one deserving of support subject to the interests of the borough being protected.

Beckenham.—The District Council have received formal notice of an application proposed to be made to Parliament by the British Electric Traction Company for powers to construct electric tramways in the district. Much local opposition is being offered to the scheme.

Nottingham.—The municipality has just introduced into the town a street-sweeping and watering machine to be run upon the tramlines and provided with motive power through a trolley arm from the overhead wire, in the same fashion as the trams themselves get their power.

Leigh.—Work has just been commenced by the South Lancashire Tramway Company, who have secured powers to construct an electric tramway from St. Helens through Leigh to Bolton and other parts of Lancashire. The main generating station is being built at Howebridge.

Middlesex Tramways.—The Middlesex County Council and the North Metropolitan Tramways Company have arrived at an agreement for the purchase and electrical equipment by the Council of the tramways from Finsbury Park to Wood Green, subject to parliamentary sanction.

Halifax.—A special meeting of the Town Council will be held to consider a proposal of the Holmfield and Southowram light railway promoters for the Corporation to advance to the company, by way of loan, or as part of the share capital of the company, a sum not exceeding £10,000.

Rickmansworth.—The Urban District Council have passed a resolution of protest against the action of the County Council in opposing the tramway scheme, and requesting them to cease their opposition to it, except so far as may be necessary to safeguard the interests of the district.

Birmingham.—At their meeting on Tuesday the City Council, after long discussion, approved the clause in the omnibus Bill to be promoted next session, which asks for powers to carry out the Edgbaston and Harborne scheme. The method of electric traction to be used is left undecided for the present.

Dewsbury and Batley Tramways.—The purchase of the Dewsbury, Batley, and Birstal Tramways Company by the British Electric Traction Company has now been finally completed by the shareholders transferring their shares to the new company. Only six or seven shareholders have declined to sell.

Douglas.—A committee of the Manx Legislature have heard evidence on the application of the Douglas Corporation for power to purchase the horse and cable sections of the Isle of Man tramways from the liquidator of the tramway company for £50,000. The committee are considering their report.

Elsenham Light Railway.—The Board of Trade have confirmed an order made by the Light Railway Commissioners authorising the construction of a light railway in the county of Essex, to join the proposed Elsenham, Thaxted, and Bardfield light railway with the Colne Valley and Halstead Railway.

Colne and Trawden Light Railway Co.—At the first general meeting of the Company held this week it was reported that the negotiations for the construction of the line were making satisfactory progress, it being expected that the main line would be completed well within the time limited by the order.

Darlington.—The Corporation have deferred for further consideration the provisional order which has been secured from the Imperial Tramways Company. Borrowing powers to the extent of £100,000 for tramway purposes have been obtained. One provision is that trams for workmen are to be run at ½d. per mile.

Cardiff.—A special meeting of the Town Council has adopted the recommendation of the Tramways Committee that a final offer of £50,000 (inclusive) be made to the tramways company for the whole of their interest in the tramlines up to the doors of the depôt. This offer has now been accepted by the company.

Leyton.—The District Council are reported to be very favourable to the proposal of the Walthamstow District Council to construct electric tramways in the district, and will grant the necessary permission, but that the Tottenham District Council and the Middlesex County Council have imposed conditions difficult of fulfilment.

Warrington.—A resolution was carried at the meeting of the Town Council on Tuesday that application be made to the Light Railway Commissioners for an order authorising the construction of a light railway from Wilderspool Causeway to Stockton Heath, and from the market place at Stockton Heath to Knutsford-road.

Torquay.—For the present the Town Council are withholding their consent to either of the two tramway schemes for the town which have been submitted by companies. It is thought probable that the Council may go in for a tramway scheme themselves, but at the last meeting consideration of the question was deferred.

Birkenhead.—The tramway returns for four weeks ending the 17th ult. show that on the six routes 632,500 passengers were carried, the total receipts being £3,116. The Birkenhead Lighting Sub-Committee recommend that 165 transparent street name plates be fixed on lamps at street corners on the various electric car routes in the borough.

Rotherham.—The Tramways Committee recommend that Messrs. Kennedy and Jenkin be instructed to prepare specifications and report as to the cost of laying a system of tramways in the town. A sub-committee is to be appointed to consider and decide upon the scale of charges to be made for the supply of energy for motive power purposes.

Worthing.—Being of opinion that the establishment of a system of electric tramways within the borough is desirable, the Town Council have favourably received the proposal of the Brighton and Shoreham Tramways Company to apply in the next session of Parliament for such powers. The matter is now in the hands of the Parliamentary Committee.

Hammersmith.—The Council have decided to establish an accumulator station at the electricity works for charging the accumulators of motorcars. In the opinion of the Council's electrical engineer, an additional profit from their electrical undertaking is to be expected from this source. It is proposed that petrol car batteries shall be charged at the rate of 8d. per unit, and electric cars at the rate of 3d. per unit.

South Shields.—A ratepayers' and property owners' meeting has decided to oppose the Corporation Tramway Bill on various grounds, but principally because it is thought inadvisable to borrow so large a sum as £300,000 on the security of the rates "to embark on an

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undertaking of so technical a character." At another meeting of ratepayers held on Tuesday night a resolution was carried in favour of the scheme.

Lancaster.—The Board of Trade have provisionally approved the system of electric traction proposed by the Corporation. A sub-committee of the Corporation has been appointed to meet representatives of the company and report. Another sub-committee has been selected to deal in the first instance with the tenders which have been received for the materials for road construction and the overhead equipment.

Ayr.—A conference between the Tramways Committee of the Ayr Corporation and representatives of the Ayr District Committee has resulted in the points at issue between the parties with reference to the proposed extension of the electric tramways to Burns's Monument being amicably arranged. It is understood that the construction of the line to the monument will be pushed forward in order to be ready for next summer's traffic.

Exeter.—On the question of the introduction of electric tramways in the city the Council have adopted the report of their experts, Messrs. R. Hammond and Alfred Dickinson, which appeared in our last issue. There is a strong feeling in the town that, whether the municipality or a company undertake the matter, there should be no tramways in High-street, Queen-street, or Fore-street. A post-card poll is to be taken on the subject.

Stourbridge.—A memorial has been sent to the Urban District Council from tradesmen in the High-street asking the Council to enforce their terms with the British Electric Traction Company as to the running of the cars in the High-street. It appears that the tradesmen object to anything more than a 20-minute service, and also to there being two cars in the portion of the High-street between Foster-street and the "Clock" at one time.

Rapid Transit.—A conference under the auspices of the National Association for the Extension of Workmen's Trains and Trams will be held to-day (Friday) at the Memorial Hall, Farringdon-street, to consider "what practical action can be taken to relieve the pressure on housing accommodation in congested districts by increasing and cheapening the means of transit on all railways and tramways between the central districts and the outer suburbs of the Metropolis."

Bristol.—At the last meeting of the Tramways Purchase Committee the committee had before them the tramway company's figures and report, a report from the city accountant, and one from the city engineer on the plant, etc. These were considered for some time, but without any decision being come to. It is stated that the committee and the directors of the company are at present rather wide apart in their respective ideas of the price to be paid by the Corporation for the undertaking.

Shipley.—Another conference has been held with a view to solving the difficulty between the Tramways Committee of the Bradford Corporation and the Shipley Urban Council respecting the price to be charged for the electric current necessary for running the cars on the Keighley-road within the Shipley area. Terms were not agreed to. The Bradford Committee offer 1d. per unit, the same as they pay to their own Electricity Committee, but the Shipley people assert that that would involve them in loss.

Rothesay.—Operations will be begun shortly for converting the existing horse tramways to Port Bannatyne to electric traction, as authorised by the provisional order of 1900. The company are also making application for a second provisional order to enable them to extend the system to Craigmore on the one side, and to Ettrick Bay on the other. Should their proposals be passed there will then be a continuous line of electric tramways from Craigmore to Ettrick Bay, a distance of about seven miles in all.

Manchester-Liverpool Express.—The London correspondent of the *Liverpool Courier* learns that the plans for the proposed Manchester and Liverpool Electric Express Railway are to be submitted to the Board of Trade within the next fortnight. Since the Bill was passed last season the engineers—Mr. Behr and Mr. Cooper—have been hard at work on them with a view to getting them sanctioned by the Department before Christmas. It will be, however, some time in the new year before the detailed plans necessary for the advertising for tenders will be completed.

Glasgow.—The Corporation tramways financial half-year, which closed on the 30th ult., shows that the six months' revenue is £327,317, an increase over the corresponding period of last year of £82,047. Towards this gratifying result the International Exhibition has undoubtedly largely contributed. It is estimated that the electric tramways earn about 2d. more and cost about 2d. less per car mile than the horse tramways. The extension of the system along New Keppochhill-road, forming a connection between Possil-road and Springburn-road, has just been completed, and a service of cars has been commenced.

Paddington.—The strong opposition to the proposal of the London County Council to lay down a tramway in Edgware-road continues unabated. A meeting of the executive of the Paddington Opposition Committee having the matter in hand has been held, when it was stated that the object of the committee is not only to oppose the proposal of the London County Council to establish tramways from the Marble Arch along Edgware-road to Cricklewood, but also to oppose the proposals of the London United Tramways Company. Early in January it is proposed that a deputation shall be sent to the Borough Councils of Marylebone and Paddington.

Salford.—At the meeting of the Town Council on Wednesday a discussion took place as to the policy to be adopted in placing contracts, for which foreign firms tender at prices largely below those of British firms. It was stated that the Leeds Steelworks had sent in a tender of £7 per ton for 850 tons of steel rails, this being the lowest British offer. The Tramways Committee had a Belgian tender at £6 per ton, and it was pointed out that if they accepted the English tender they would have to pay £850 more. The committee wished to get 200 tons at once from the firm at Leeds, and give an order for 600 tons to the Belgian firm, because the latter could not supply the rails within eight weeks. A motion that the lowest tender of the English firms should be accepted was rejected, and eventually the recommendation of the Tramways Committee was approved.

Middlesex Light Railways.—At the last meeting of the Middlesex County Council the report of the Light Railways and Tramways Committee was brought up, containing a draft agreement with the London United Tramways Company. The proposed agreement is to the effect that the county of Middlesex shall be divided into two parts by a line drawn from Willesden to Uxbridge. The company agree not to promote or support any application for the construction of light railways to the north of this line, and the County Council agrees that the portion of the county south of this line shall be regarded as appropriated exclusively to the London United Company, and the County Council further agrees not to promote or support any application to construct any light railway or tramway in the same part of the county, and the agreement is to last until 1919. The report was adopted after some discussion.

Mid-Suffolk Light Railway Co.—The prospectus of this Company has been issued. The public are asked to subscribe a capital of £225,000, divided into half ordinary and half preference shares of £10 each. The lines of railway, for which powers are taken, will be over 42 miles in length, and are to be constructed and maintained on the 4ft. 8½in. gauge. The proposition embodies several favourable points, amongst others that the cost of construction is estimated at only £5,300 per mile. The Company will have connections with the Great Eastern Company's system at Haughley and Westerfield, thus enabling traffic to be carried to and from other systems without transhipment of goods. The district through which the Mid-Suffolk light railway will pass comprises about 190,000 acres, whilst on the line are several important small towns and villages, all of which are at present many miles from a railway station.

Motor Lorry Trial.—A trial was commenced at Aldershot on Wednesday last, under the supervision of the War Office Committee on Mechanical Transport, of some self-propelled lorries for army purposes. The competition is limited to five lorries, two of which are provided by the Thornycroft Steam Wagon Company, of Chiswick, one by Messrs. Edwin Foden and Co., of Sandbach, one by the Straker Company, of London and Bristol, and one by Messrs. Milnes and Co., of Oxford-street, London. Preference will be given to the vehicle that may be taken over soft ground or across rough fords without risk of damage to the lower portion of the machinery when wheels sink into soft mire or deep ruts. It will be remembered that the Government have offered three prizes—one of £500, a second of £250, and a third of £100—to the makers or inventors of the three self-propelled lorries adjudged to be best suited to military purposes.

Edinburgh.—The announcement made on Saturday that the tramways company intended to run the cars on Sunday caused considerable excitement in the city. The Corporation hold that the lessees have no right to run cars on Sundays without their sanction. In order to prevent interference with their design the lessees on Saturday entered a caveat in the bill chamber of the Court of Session by which it would be necessary to give 24 hours' notice to them before an injunction could be granted. This secured at least one experiment. Accordingly the cars appeared for the first time on Sunday, and were largely patronised. Denunciatory pulpit references were made, and an indignation meeting of 1,200 men protested on the ground that the cars were run without the sanction of the Council and its citizens. Further proposals put forward by the tramways company with reference to the dispute with the Corporation about arrears of rent have been rejected by the Town Council, who have decided to press for payment and to proceed with the action for interdict of the Sunday running of cars.

Newcastle.—A deputation representing the wards in the west of the city waited on the General Purposes Committee of the Tramways Committee on Monday to urge the pressing importance of the completion of Scotswood-road section of the tramways. The Chairman assured the deputation that it was a matter of deep anxiety to the committee to push on the West-end portion of the tramways with all celerity, but there had been difficulties, which, he was glad to be able to say, were now practically overcome; and if the fine weather prevailed, there was a strong expectation that Scotswood-road portion would very soon be opened for traffic. In relation to the parliamentary Bill which is being pushed forward, the estimated probable cost of the 21 miles miles of the proposed tramway line from Gosforth to Seaton Burn, to Walker, Benwell, and elsewhere, amounts to £200,000. Mr. Rossignol, the manager, puts the estimated probable cost of the electric portion of the work, including cars, etc., at £196,000 for such extensions, making a total of close on £400,000 for construction and equipment. In addition to this, £77,000 is proposed to be spent on 100 new cars and £51,000 on extra generating plant required. These estimates were approved by the Council on Wednesday. The proposed extensions are to Seaton Burn from Gosforth, to Walker, from Heaton, and to Benwell.

Manchester.—On Tuesday, Colonel von Donop, one of the Board of Trade inspectors, inspected the Regent Bridge and Albert-square to High-street tramway route, and the public service of cars commenced next day. It is expected that the Hyde-road and Stockport-road routes will be opened for electric traction at the end of next May, the southern routes at the end of next November, and the Oldham-road, Ashton Old-road, and Ashton New-road routes in March, 1903. The following are the new lines of tramways, powers to construct which will be sought next session: a double line in Egerton street and Dawson-street from Chester-road to Water-street; a single

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line, with passing places in Water-street, from Quay-street to Bridge-street and King-street West; a single line along Booth-street West from Oxford-street to Higher Chatham-street; a single line along Higher Chatham-street from Booth-street West to Coupland-street. Powers will further be asked for to authorise the Corporation to generate electrical energy on land belonging to them at Queen's-road, Cheetham, and Hyde-road, Ardwick; to authorise the purchase of tramways in Bury Old-road, Salford, and to confer running powers over tramways in Bury New-road, Salford, and to confer powers in reference to the making of agreements and generally in reference to the tramways undertaking of the Corporation.

The Proposed "Tubes" in West London.—Brief mention was made in these columns last week of an announcement which had been given to the effect that application will be made in the next session of Parliament for powers to construct "underground railways from Shepherd's Bush and Hammersmith and Barnes, Charing Cross, Clapham Junction, and Marble Arch." The promoters of the scheme, it seems, are the London United Tramways Company, who propose to make a new departure in tramway working and go in for electric "tubes." In the first place, it is proposed to run a surface line of electric tramways from Shepherd's Bush, by Holland Park-avenue, High-street (Notting Hill), and Bayswater-road to the Marble Arch. From this point the scheme is to take a "tube" due south under Hyde Park (dipping beneath the Thames at Battersea), and beyond Battersea Park it will turn west to Clapham Junction, where it will terminate. The stations on this line will be at Marble Arch (Park-lane), Chelsea (Bridge-road), Battersea, Queen's-road (Battersea), Lavender-hill (Town Hall), and Clapham Junction. A second "tube" is also proposed, which will have its western terminus in the parish of Barnes, and run into Shepherd's Bush, going under the Thames near Hammersmith Bridge. It will pass under Hammersmith-road, Knightsbridge-road, up to Hyde Park Corner, under Constitution-hill and the Mall to Charing Cross, where a loop line will be formed for the return journey. The stations will be at Barnes (corner of Lonsdale-road), Hammersmith (Bridge-road), Hammersmith-broadway, Shepherd's Bush (Rockley-road), Kensington (Warwick-road), Kensington High-street, Albert Hall, Knightsbridge (Sloane-street), St. James's Park, and Charing Cross. The total length of the two projected "tubes" is just about 13 miles. In addition to and in connection with these, the London United Tramways Company are proposing to obtain powers to make 21½ miles of tramway and 13½ miles of light railway extensions. At present there are 16 miles of line in operation, 12 miles under construction, and 30 miles authorised, making a grand total of 106 miles of tramways, light railways, and "tubes," either in operation, under construction, or projected. By means of the proposed tube railways it is hoped to bring the tramway system in West London in connection for the interchange of traffic with the whole subterranean electric railway system in London which is proposed by the various "tube" schemes which are being promoted at the present time. It is also to be noted that if the proposals of the London United Tramways Company are sanctioned, the system generally will describe a circle although an irregular one. Beginning at Charing Cross, the network of light railways, tramways, or "tubes" embraces Clapham, Sompters Town, Lower Tooting, Merton, Norbiton Common, Hook (the most southerly point), Surbiton, Thames Ditton, Hampton Court and Bushey Park, Hanworth, Hounslow Heath, Cranford, Southall, Hanwell, Ealing, and Willesden. The only district in this great stretch not actually joined up by the London United Tramways Company will be that between Clapham and Lower Tooting, a distance as the crow flies of about four miles; but the contemplated extensions of the London County Council will ultimately fill up this and other gaps within the county of London boundaries.

London County Council.—At the usual weekly meeting of the London County Council next Tuesday there will come up for consideration a report of the Highways Committee relative to the reconstruction for electric traction of a further portion of the Council's tramways on the south side of the Thames. The committee state that the total length of the tramways for the cost of the reconstruction of which they now propose that provision should be made is equal to 19¼ miles of single track; and they are laid between (*a*) the junction of Kennington-road with Westminster Bridge-road and St. George's-circus; (*b*) the Elephant and Castle, along New and Old Kent roads, New Cross-road, and New Cross-gate; (*c*) the Elephant and Castle *via* Newington-causeway and St. George's Church, Borough, and thence *via* Dover-street to the junction of New and Old Kent roads; (*d*) the Elephant and Castle *via* Walworth-road, Camberwell-road and green, Peckham-road, High-street, and Queen's-road, and New Cross-gate; (*e*) Camberwell-green *via* Camberwell New-road, Kennington-road, and Harleyford-road, and the terminus near Vauxhall Bridge; (*f*) Kennington Park-road and Brixton-road. The reconstruction of the tramways (*b*) will probably involve the rebuilding wholly or partially of the bridge carrying Old Kent-road over the Surrey Canal, and this has been provided for in the estimates which have been submitted to them. They are advised that the total amount which would probably be required for reconstructing, for electrical traction, the tramways above specified is £644,350, which might be roughly divided under two heads—namely, (*a*) new buildings and bridge construction, £68,000, repayment of which might be spread over the full term of 60 years; and (*b*) lines, machinery, generating plant, rolling-stock, electrical equipment, and alterations to existing buildings, £576,350. They recommend: "That the estimates for £68,000 and £576,350, submitted by the Finance Committee, be approved, and that the expenditure on capital account of sums not exceeding those amounts respectively be authorised in respect of (1) new buildings and bridge construction, and (2) lines, machinery, generating plant, rolling-stock, electrical equipment, and alterations to existing buildings, for the purposes of the reconstruction, for electrical traction, of the London County Council tramways between (*a*) Kennington-road at its junction with Westminster Bridge-road, and St. George's-circus; (*b*) the Elephant and Castle, *via* New and Old Kent roads and New Cross-gate; (*c*) the Elephant and Castle and St. George's Church, Borough, and thence to the junction of New and Old Kent roads; (*d*) the Elephant and Castle *via* Walworth-road and Camberwell-road, and New Cross-gate; (*e*) Camberwell-green and the terminus near Vauxhall Bridge; and (*f*) Kennington Park-road and Brixton-road." These lines include the whole of the remaining sections of the system on the south side of the Thames for reconstruction with the exception of the two portions between New Cross-gate and Greenwich and the cable line between Kennington and Streatham. With regard to the latter length, the Board of Trade have renewed for a period of one year the license for the use of cable traction. In the case of the New Cross-gate and Greenwich line there are certain difficulties in way of reconstruction at present owing to the headway of four railway bridges over roads being insufficient. The Highways Committee also report that the directors of the South-Eastern Metropolitan Tramways Company are willing to recommend the shareholders to sell their undertaking to the Council, by agreement, for £50,000, which the committee are advised is a fair and reasonable price. The company's tramways are at one point in close contiguity to the Council's tramways. The undertaking would not become compulsorily purchasable until 1909. It is proposed that the Council meeting on Jan. 21, 1902, be made special for the passing of the necessary resolutions for the acquisition of the undertaking. On the question of shallow underground tramways, the committee refer to the report of the Council's tramways manager and electrical engineer on the construction and working of the Boston (U.S.A.) subway, and they recommend, "as we consider that the report will be of special interest to the Council and of great use for future reference," that copies be distributed among its own members and the members of the City Corporation, the Metropolitan Borough Councils, and the Westminster City Council. The report is also considered of sufficient importance to be placed on sale for the general public.

LIGHTING AND GENERAL.

St. Annes.—Sanction has been obtained to a loan of £7,221 for electric lighting extensions.

Luton.—The School Board have appointed a small committee to deal with the matter of electrical fittings.

Worthing.—Mr. Frederick Fernie, of West Hill-road, Brighton, has been appointed assistant electrical engineer.

Western Telegraph Co.—The directors have declared an interim dividend of 3s. per share for the quarter ended Sept. 30.

Gorton.—It is suggested that the District Council's electric lighting order should be transferred to the Manchester Corporation.

Asiatic Cable.—Attention is being drawn to the desirability of better telegraphic communication with many ports along the Persian Gulf.

Commercial Cable Co.—A quarterly dividend of 1¾ per cent. and a bonus of 1 per cent. on the capital stock have been declared, payable Jan. 2.

Elland.—The District Council on Wednesday decided to apply for sanction to borrow £16,000 to provide an electric installation and refuse destructor.

Removal.—We are informed that Mr. George R. Peers, A.I.E.E., is removing his offices to 11, Princes-chambers, John Dalton-street, Manchester.

Southport Telephones.—The West Lancashire Rural Council have appointed a committee to consider their inclusion into the area to be supplied by the proposed municipal telephones.

Ilfracombe.—The Council have sealed the supplemental agreement and transfer of the electric lighting to the Edmundson's Electric Lighting Corporation, the Board of Trade having agreed.

Dover.—The agreement between the Council and the electric light company provides for the purchase at £129,000, which will give the ordinary shareholders a premium of 50s on their £5 shares.

Eastern Extension, Australasian, and China Telegraph Co.—The Hon. Arthur Grenville Brodrick has been elected to a seat on the Board to fill the vacancy caused by the death of Mr. Clement Sneyd.

Sandgate.—It is understood that the Council have entered into an agreement with the British Electric Traction Company and also with the Folkestone Electric Company with regard to the supply of electric light.

Devonport.—The Royal Exchange Assurance Company have arranged with the British Tariff Offices for the insurance of the electricity works in the sum of £20,000 for the minimum rate of 3s. 6d. per cent.

Shoreham Telephones.—The Council have accepted a draft agreement with Brighton Corporation containing a clause by which the latter undertake to establish and maintain a call office for exchange at Shoreham.

Grays.—The electric light and dust destructor works were formally opened on the 27th ult. by Mr. Herbert Brooks, chairman of the Urban Council. The works, designed for public and private lighting, have cost £16,000.

Paris Telephones.—Steps are being taken to extend telephonic communication between France and England, which has hitherto been limited to Paris and London, to all subscribers in the department of Seine-et-Oise.

Lancaster.—The Corporation have exhausted all their borrowing powers with reference to electric lighting, and a sub-committee has been appointed to consider and report as to what further borrowing powers are required.

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West Bromwich.—The electrical engineer is preparing plans and specifications for the extensions of the plant at the electricity works required for the supply of power for running the trams, and Mr. R. C. Quin, the consulting engineer, is advising on the matter.

Cheltenham.—The electrical engineer's last report states that the number of customers then connected was 538, and the equivalent number of 8-c.p. lamps was 33,900; these numbers being nearly 18 and 26 per cent. greater than at the corresponding period last year.

Eccles Telephones.—A resolution is to be proposed at the next meeting empowering the Town Council to join other local authorities in the Manchester telephone area in the promotion of a Bill for a license authorising them to provide a system of telephonic communication.

New American Cable.—The cable steamer "Faraday" on Saturday finished laying a cable between the Azores Islands and Ireland for the Commercial Cable Company. This completes the fourth cable of that company between the United States and England.

Stoke-on-Trent.—The Board of Trade having enquired which system the Corporation proposed to adopt for the supply of energy under their electric lighting order, the Council have decided to reply that at present the matter is under consideration, but that they were in favour of the low-pressure continuous system.

Grantham.—The Sanitary Committee have had the question of the provision of a destructor under consideration for some time, and intend shortly to visit various towns where destructors were in use. An enquiry will be held shortly into the proposal to borrow £2,000 to establish a municipal telephone system in the town.

Edinburgh.—The City Council have voted £65 to provide a small air compressor, to be used for cleaning the armatures of the dynamos. An application is to be made to the Secretary for Scotland for consent to the borrowing of £90,000 for the execution of capital works under the Edinburgh electric lighting provisional order of 1891.

Share Market.—City's, British Columbian ordinary, and Westinghouse preference improved during the week. London United Tramway preference shares were ⅞-1 premium for special settlement and the debentures 2-2½ premium. Tractions were rather in demand. Charing Cross, Notting Hill, and Westminster Electric shares were dull.

Walsall Telephones.—At the last meeting of the Chamber of Commerce a resolution urging the establishment of a municipal telephone exchange for the town was proposed. After discussion, it was agreed that the resolution should merely express approval of the Town Council making enquiries and expressing the hope that some good might result.

Halifax.—The Corporation Tramways and Electricity Committee have appointed Mr. W. M. Rogerson, chief assistant electrical engineer in the Nottingham Corporation electricity department, electrical engineer for the borough. Mr. Rogerson has held his present position in Nottingham for seven years. The salary is £400 a year. There were 36 applicants.

St. Andrews.—The negotiations which have been proceeding for some time between the promoters of the provisional order (Messrs. Crompton and Co.) and the St. Andrews Electric Lighting Committee, have resulted in an amended draft agreement, it is said, considerably modified in favour of the town. The proposed agreement is to be submitted to an expert.

Whitehead.—At a public meeting of the ratepayers last week a resolution was passed to the effect that electric light be adopted for lighting Whitehead under the clauses of the Local Government Act. A discussion took place regarding the proposed lighted area which would be chargeable to the rates, and a committee was appointed to take charge of the matter.

North Walsham.—The Urban District Council have acceded to a request by the National Electric Wiring Company, Limited, who are considering the lighting of the town of North Walsham with electricity, to grant them an option of six weeks, if necessary, to prepare a scheme of lighting, during which no time no other firm but themselves is to be negotiated with.

Electric Lighting and Traction Company of Australia.—A cable from Australia states that a supply of electricity has been commenced from this Company's Adelaide station. The Company's stations at Melbourne, Geelong, Adelaide, and Port Adelaide are now all in operation, and the supply is being rapidly taken advantage of for lighting and power purposes.

Eccles.—The Council have decided to forward to the Local Government Board plans prepared by the borough electrical engineer (Mr. Angus) for the extension of the electricity generating station in Cawdor-street, Patricroft, on the lines of his report and the recommendations of Mr. Wordingham, and additional land is to be acquired for the carrying out of these extensions.

Kingstown.—At a recent special meeting of the Urban District Council it was proposed that the resolution of the Council of Aug. 20, 1900, adopting the report of the Electric Lighting Committee, dated July 19, 1900, and such other resolutions, if any, as commits the Council to a scheme of electric lighting be rescinded. Finally it was resolved to postpone the question until the first meeting in February.

Morecambe.—Mr. H. P. Boulnois held an enquiry on Tuesday into the application of the Urban District Council for leave to borrow £5,000 for electric lighting purposes and £1,035 of excess expenditure on the refuse destructor. A portion of the money is to be expended in connection with the pumping station of the new sewage works, it being intended to use electrical current in raising sewage for treatment in the septic tanks.

Stock Exchange.—The Stock Exchange Committee have appointed Dec. 18 special settling day for Maxim (Sir Hiram) Electrical and Engineering Company's 134,500 shares of £1 each, fully paid, Nos. 20,001 to 154,500. Applications have been made to the Exchange Committee to appoint a special settling day in and to grant a quotation to Perth Electric Tramways £150,000 5 per cent. first mortgage debenture stock.

Ipswich.—The East Suffolk County Council at their last meeting considered an application of Messrs. Barber and Croft for leave to erect poles and wires along the main road in Oulton and Carlton Colville for electric lighting purposes. It was decided to instruct the committee appointed to inspect the road to see that no sanction be given without it being previously ascertained that there would be no infringement of the rights of adjoining landowners.

Hammersmith.—Since the last Council meeting 11 additional consumers have been connected, representing a maximum of 554 8-c.p. lamps. These added to the number previously reported show a total of 1,014 consumers taking current from the mains. The following estimates have been approved: accumulator charge station, £200; extension of mains from Boundary-road to Phœnix Brewery and Latimer-road Station, £958; and electric crane, £755.

Copper.—Copper has dropped as much as £8. 10s. per ton during the week, in spite of the limited supplies and the boasted American control of the market situation. Last Friday cash copper fell £5 per ton, and the three months' quotation £4 per ton. This depression is said to be due solely to operations in the share market, as a certain clique is said to be busily engaged in depressing copper with a view to causing a slump in the prices of copper shares. The market still continues weak.

Paisley.—The dispute in progress between the Town Council and Messrs. Ferranti, Limited, with regard to the plant recently delivered by the latter is, we understand, being settled upon the basis that the 350-kw. steam dynamos are to be accepted as 300-kw. machines, and therefore received accordingly, provided that they pass successfully the tests for full load and overload at that output; governors are also to be tested to the satisfaction of the Corporation's electrical engineer and Prof. Barr.

Loughborough (Leicestershire).—The Town Council at their meeting on Monday decided to establish an electrical undertaking for the borough. A report was presented from Mr. T. L. Miller, consulting engineer, of Liverpool, showing the probable cost of erecting a generating station, with all necessary dynamos, batteries, plant, machinery, and works, and distributing mains. The Council have appointed Mr. C. H. Gadsby, consulting engineer, as engineer for carrying out the works.

Bath.—At Tuesday's meeting of the Town Council a deputation was received complaining of the inconvenience and loss caused by the recent failures of the electric light in the town. Afterwards, when the Selection Committee proposed the re-election of the Electric Light Committee, an amendment was carried to the effect that they should not be reappointed, and that the whole Council should act as the Electric Light Committee. The Chairman of the Electric Light Committee seconded the amendment.

Farnham.—Sir W. Preece and Major Cardew's report has been considered at a special meeting of the Urban District Council. The report states that the proposals made by Messrs. Edmundsons appear to afford a basis for a satisfactory arrangement. The engineers have discussed the matter with Messrs. Edmundsons, and have ascertained that they are prepared, should an agreement be concluded, to put down a plant suitable in character and capacity to the requirements of the district. It was decided to defer further action until Mr. Preece's visit.

Pontypool.—The committee appointed by the Urban District Council to consider the question of acquiring the electric light company's works, powers, etc., have ascertained that the directors, although not prepared to name a price, would allow an expert to go over the works to assess their value. The Urban District Council propose to find out the cost to the Council of moving in this direction. The South Wales Electrical Power Distribution Company expect to have their generating station at Pontypool completed by next September.

Manchester.—At the meeting of the City Council on Wednesday objection was raised to a recommendation that the Council should give a contract to the value of £113,000 for electrical plant to the Electrical Company, Limited, Germany. A statement was made to the effect that the contract would have been given to an English firm if there had been a difference of only a few thousands, but the lowest English tender was £36,000 higher than the one recommended. It was also said that the British Westinghouse Company's tender was only £16,000 more than the German tender, but if that were accepted part of the work would go to America, and the remainder would be done here. The chairman pointed out that the British Westinghouse Company's place in Manchester would not be ready till next July, and the work would have been done in America.

Buxton.—Mr. Leeming, the assistant engineer, has taken over the control pending the appointment of a successor to Mr. Calvert. We understand that the appointment has been offered to him. Mr. Calvert has presented to the Council a report embodying a brief *résumé* of the work carried out during his term of office, from we note that the station commenced supply in May, 1900, with a total number of applications for light—4,500 8-c.p. lamps, and on Nov. 30, 1900, these had reached 6,486. There are now 11,063 lamps on the books, including street lamps and generating station lighting. The present plant, when complete, will be capable of supplying 12,000 lamps alight at one time, or say 18,000 lamps connected to the mains. The output of the station during the last week was 2,431 units. Total units generated from beginning of financial year, 121,000; corresponding period last year, 48,000. The committee have expressed high appreciation of Mr. Calvert's services, and it has been resolved that a testimonial be prepared by the chairman of the committee for approval next meeting.

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Accrington.—The electrical engineer's last report states that the units delivered to mains for week ending Nov. 16 were 3,551, as compared with 2,160 units delivered in the biggest week last winter Jan. 12, 1901). The total for year 1901 to above date was 67,958 units. The question of terms for hiring out motors has been referred to a sub-committee for further consideration.

Epsom.—The Urban District Council have adopted a report by Mr. Ledger containing a schedule of additional works extensions, the variations for which a further loan would be required, subdivided under the heads of public lighting, private lighting, buildings, and works equipment, and additional plant. The application for sanction to borrow £3,000 includes the cost of fencing, roadmaking, lighting, watering, drainage, etc., and it is proposed that the amounts be apportioned to the undertakings which will be benefited by the expenditure.

Wireless Telegraphy.—Satisfied with the utility and success of the Marconi wireless telegraphy installation to the cross-Channel steamer "Clementine" on the Dover-Calais service, the Belgian States Government have now determined to extend the system to all their passenger boats without delay. The mail packet "Rapide" is to be fitted with Marconi instruments, so that the vessels will soon be independent of shore installations. It is reported that a serious fire broke out in the Marconi glassworks at Pisa on Saturday. Three workmen lost their lives and two others were seriously injured.

Blackburn.—At a meeting of the General Purposes Committee of the Town Council on Monday the town clerk presented a report on the subject of municipal telephones. He advises that an expert should be consulted with regard to reliable estimates of the cost of erecting and working a telephone exchange suitable to the requirements of the Blackburn area. The report, which was referred to a sub-committee, incidentally stated that within the borough of Blackburn there were about 1,244 subscribers, and in the whole of the Blackburn area 2,510 subscribers connected with the National Telephone Company.

Wimbledon.—The draft agreement between the Council and the Croydon Rural District Council as to the supply of electrical energy within the parish of Merton has been approved. Application will be made during the session of 1903 for a provisional order extending the Council's area of supply so as to include the parish of Merton. The Council will also apply forthwith to the Board of Trade for a license under the Electric Lighting Acts to enable them to supply electrical energy within the parish of Merton, pending the application for a provisional order. The lamps now connected are 30,309, the street lamps 4,560, and the number of consumers 592.

Penarth.—On Tuesday evening the power station at Lower Penarth, for the supply of electrical energy to the town, was formally opened, and the chairman of the Urban District Council (Mr. D. Morgan) switched on the permanent supply of current. Mr. G. L. Leech, the engineer of the Electrical Power Distribution Company at Weston and Penarth, explained the equipment of the station. They supplied continuous current by two 50-kw. machines, which were capable of supplying 3,000 8-c.p. lamps, whilst their accumulators would act as a stand-by. Subsequently Mr. Offor, on behalf of the company, entertained the members of the Council to dinner at the Esplanade Hotel.

New Issue.—The National Telephone Company, Limited, are issuing 200,000 6 per cent. preferred shares of £5 each. At the same time the existing 590,000 ordinary shares will be converted into £983,333 preferred stock and £1,966,666 deferred stock. The shares now issued will, when fully paid, be converted into preferred stock, ranking *pari passu*, and entitled in the event of winding up to a bonus of 5 per cent. in priority to the deferred stock. The new capital is intended to be applied for the purpose of connecting new subscribers, of carrying out agreements already made with large towns for the improvement and extension of the company's telephonic systems, and for the general development of the business.

Heathman's Ladders.—The patent telescopic ladders made by this firm in various patterns and sizes have proved of great service to electrical engineers, but Mr. Heathman has found by experience that a few details demanded improvement, and he has taken a new patent so as to safeguard his latest improvements, which consist in a new system of coupling two ends of a rope, a new system of attaching the rope to the ladder so as to be quickly detachable, and a new ladder lock of automatic action, which will not damage the ladder rungs and is both easy and reliable in its action. We are informed that Heathman's new factory at Parsons Green is fully occupied to meet the increasing demand for this firm's ladders, steps, trestles, and tower wagons.

Sunderland.—When the electric lighting undertaking was commenced seven years ago, said the newly re-elected chairman of the Electric Lighting Committee (Mr. Alderman Bruce) last week, they supplied 7,724 8-c.p. lamps to 95 consumers, with a maximum load of 170 e.h.p., whereas they were now supplying 110,185 8-c.p. lamps to 688 consumers, with a maximum load of 1,850 e.h.p. In the first year 96,140 units were sold, and they expected that the output for the current year would be about 2,500,000. The first year resulted in a loss of £415; but for the year ended March 31 there was a net profit of £1,257. The average price received from consumers was, during the past year, 3·63d., the actual cost to the Corporation being 3d.

West Hartlepool. — The Borough Electrical Engineer (Mr. Friederichs) reported on Tuesday that, owing to the number of customers already being supplied, and the large number of new applicants, it would be necessary to provide additional plant and to extend the boiler-house. He estimated the cost at £6,000 to £7,000. During the five weeks ended Nov. 26, 45,951 units had been generated, 34,797 units being sold to customers, and 6,770 used for street-lighting. The number of 8-c.p. lamps, or equivalent, connected up to the end of November was 19,257. The Lighting Committee reported that the borough engineer had been instructed to have the following lights erected as a test: Welsbach incandescent, Scott-Snell incandescent, electric incandescent, and the Kitson light.

Surbiton.—At a public meeting of ratepayers on the 28th ult. the following resolutions were passed: (1) "That this meeting of ratepayers disapproves of the Urban District Council entering into an arrangement with Callenders, Limited, for supplying electric light in Surbiton as set out at the public enquiry held on July 9 last, or any modification thereof." (2) "That this meeting is of opinion that no scheme for supplying electric light to Surbiton should be entered into without first taking a poll of the ratepayers, except some firm or company is willing to take a transfer of our provisional order in the usual form as approved by the Local Government Board, and to carry out these works at their own expense without in any way pledging the rates as security." It was decided to forward to the Local Government Board and the Urban District Council copies of the resolutions.

Derby.—The Electric Lighting Committee have received a report of the borough accountant as to the payments to the sinking fund on electric lighting account, which states that for the year ended March 31, 1901, the electric light undertaking has involved a charge upon the district rates of £2,218. 15s. 10d. For the year ended March 31, 1901, the gross profit was £4,190. 6s. 8d., which is equal to a dividend of £3. 6s. 8d. per cent. on the capital expenditure up to that date. For the year ended March 31, 1900, the gross profit was £5,062. 16s. 8d., which is equal to a dividend of £4. 14s. 1d. per cent. on the capital expenditure up to that date. This difference in the gross profit between the two years is more than accounted for by the increase in the price of coal. Last year the coal cost £4,570, while in the previous year it cost £2,343, an increase of £2,227. The committee will recommend the Council to apply for sanction to a loan of £3,000 for the purchase of electric lighting motors.

Hull.—The Works Sub-Committee have sanctioned the laying of additional mains, which will cost £5,000. The electrical engineer's report upon the applications for current was adopted at the last meeting of the Electric Lighting Committee. In his letter, Mr. C. H. Wellesley Wilson, asking the committee to quote the lowest possible price for the supply of electric current for driving the shop machinery and lighting of Earle's works, stated that about 900,000 units per annum would be required. Messrs. Amos and Smith anticipated that the power they would require would not be less than 158 i.h.p., which would rise to 200 i.h.p. and perhaps more. They said that they were closely connected with Messrs. Earle's, and whatever decision was arrived at it would affect both firms. The electrical engineer suggested the following charges for the supply of electricity to large works, where the consumption was fairly evenly distributed for at least eight hours per day: for any quantity exceeding 100,000 units, and not exceeding 250,000 units, 1½d. per unit net; exceeding 250,000 units, and not exceeding 500,000 units, 1¼d. per unit; all over 500,000 units, 1d. per unit. It was resolved to reply to these applicants and Messrs. Rose, Downs, and Thompson that the Corporation were prepared to supply the current on the terms contained in the report.

Stepney.—Electric lighting is making rapid progress in this district. A report was adopted at the last meeting of the Borough Council, in which the Electric Lighting Committee recommended that £1,440 be expended for lamps as follows: Short-street and Goulston-street, five lamps; Brick-lane and Osborne-street, 10 lamps; Vallance-road and New-road, 10 lamps. The cost of maintenance (electricity and attendance) will only be £180 per annum in excess of the present cost of lighting these streets by gas, notwithstanding a tenfold better illumination will be obtained. A recommendation to light about 50 thoroughfares, mostly in Whitechapel, necessitating the extension of mains at a cost of £1,270. 10s. was also adopted. The committee further reported that they had had under consideration a petition signed by 68 residents of Three Colt-street, Limehouse, praying that that thoroughfare should be included in the list of streets to be lighted by electricity. The consulting electrical engineer has visited the street, and has reported upon the matter, and the committee are of opinion that when the Council's mains reach that neighbourhood it would be advisable to comply with the request of the petitioners. The committee will report at a later date upon the laying of mains along Commercial-road and Burdett-road, and when this work is carried out the petitioners' request will receive immediate consideration.

Gloucester.—The Town Council recently advised the promoters of the Gloucester Power Bill that they would feel bound to oppose any Bill for obtaining powers over any area including or affecting the city of Gloucester or its immediate neighbourhood, and suggesting that the promoters should limit the area to be applied for so as not to include or otherwise affect the city of Gloucester, as the promoters would then only have to deal with those interested in the Forest of Dean and the Stroud Valley district, for whose benefit the scheme was presumably being formulated. The letter also stated that if experience should show that the promoters would be able to supply electricity in bulk to the Corporations of Gloucester and Cheltenham at a lower price or otherwise on more advantageous terms than those Corporations could provide it themselves, the Corporations might at any time reconsider the matter, and, if deemed advisable, assent to or concur in an application for extending the area over which powers were given in the first instance, and intimated that the Corporation of Cheltenham adopted the views expressed in the letter. The promoters have consequently agreed not to include the areas of the Corporations of either Gloucester or Cheltenham or the rural districts of Gloucester or Cheltenham within the limits of the area of supply. Mr. Bache has been trying experiments with one or two Nernst lamps, and has now been authorised to obtain one dozen of the lamps for experimental purposes, and also to have some of them tried in the public streets in positions to be approved by the chairman and the Mayor.

Edinburgh.—The report of the resident electrical engineer, comparing the 27 weeks from May 15 to Nov. 21, 1900, with the corresponding period in 1901, shows that the equivalent in 8-c.p. lamps in 1900 was 47,695, and in 1901, 52,436, the total now connected being 431,016 8-c.p. lamps. The total horse-power for motors is 8,443, of which 361 have been connected since May 15. For the year 1900-

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1901 a loss was made each week until Oct. 4, the total estimated loss being £9,443. This year a profit was made during the week ending Sept. 26—that is a week earlier—and the total estimated loss was £8,515. From Oct. 5 to Nov. 22, 1900, a profit of £1,875 was made, but from Sept. 26 to Nov. 21 of this year the profit was £3,821—an increase of £1,946. The estimated loss to the end of the twenty-seventh week of 1900 was £7,568, as against £4,694 for the same period this year. There was thus a smaller loss this year, by £2,874, than last year, while the weekly profit was considerably larger. A statement as to the estimated income, cost, and profit for the twenty-seventh week in 1900 and 1901 shows for 1900 an estimated income of £2,480, against £2,708 in 1901; cost, 1900, £1,877; 1901, £1,737; profit, 1900, £603; 1901, £921. The largest output during the 27 weeks of 1900 was 4,595 kw., equivalent to 143,560 8-c.p. lamps alight at the same time; for this year it was 5,546 kw., or 173,310 8-c.p. lamps. The comparison of cost for the 27 weeks for 1900 shows: works cost per unit sold, ·868d.; for 1901, ·561d. Total cost per unit sold—1900, 2·158d.; 1901. 1·866d. The report also states that the erection of the new 1,200-h.p. steam dynamo at M'Donald-road station will be completed very shortly, and that there will be ample machinery at the two stations to supply the demand for the winter.

Royal Aquarium.—The dates fixed for the Twentieth Century Electrical Exhibition are Dec. 16 to Jan. 25, 1902, inclusive. The exhibition will be devoted to showing (in the largest centrally-situated place of amusement in London, with an area space of nearly three acres) all the latest inventions regarding electric lighting, power, locomotion, motors, telegraphy, heating, accessories to the foregoing, and electro-chemistry. A minor hall, specially adapted, will be available for showing machinery in actual work, and for firms desiring power in connection with their stands in the main hall; where possible, machinery in working will also be allowed in the latter. It is proposed to make the showing of the different kinds of machinery and apparatus in actual work the leading feature of the exhibition. The Westminster Electric Supply Corporation is in connection with the building. If the present excellent programme of amusements holds out, there is no doubt that the exhibition will be visited by many who would not otherwise be attracted by reason of its technical nature. Amongst the latest novelties we noticed a kind of musical lathe, introduced by Carle and Carmanelli; a balancing act, where the De Vans practically stake their lives upon their faith of the physical laws of balance; and a peculiar experiment by Georges Papuss, who has undertaken to lay for eight days without food or drink in a specially-constructed box, which is placed in a tank filled with water. Air is supplied through a tube by means of an electric fan. As the tank is lighted up by electricity, and there are several electric lights in the glass box, visitors can see Papuss lying quietly under water, and when he happens to be awake they will be able to talk to him through a speaking tube. An open table tennis tournament for the championship of London and valuable prizes will be held in the north-west gallery, commencing Dec. 11.

Broadstairs and St. Peters.—The Urban District Council have resolved that an agreement be entered into with the Isle of Thanet Electric Tramways and Lighting Company, Limited, embodying the following terms and conditions—viz.: (1) that the lamps for lighting any street or open place belonging to or under the control of the Council be of the following description only, and be supplied at the following prices and on the terms stated; (2) "every-night" lamps—12-ampere arc lamps in any number of sets of five, burning 3,000 hours per annum, £13. 6s. 8d. per lamp; (3) summer lamps, 12-ampere arc lamps in any number of sets of five, if used only between May 1 and Nov. 1, burning the same hours as "every-night" lamps, £12 per annum; (4) any extended use of the lamps beyond the said 3,000 hours to be paid for at the rate of 1d. per hour per lamp; (5) the cost of altering the position of any lamps to be paid for by the Council; (6) any arc lamps fixed by the company to be continued to be fixed and maintained by them for a period of 10 years; (7) the company at their cost to provide, erect, and maintain such lamps and all works and conveniences connected therewith, and keep same in decorative repair in accordance with the agreement entered into between the Council and the company on March 28, 1899. It was further resolved (the Chairman of the Council and Councillors Brown and Young not voting) that 10 12-ampere arc lamps be erected in the main thoroughfare between Sowell-street and the sea-front, and also that a further 10 lamps of a similar description be erected on the sea-front between Bath House and the Grand Hotel, such lamps to burn 3,000 hours per annum, at a cost of £13. 16s. 8d. per lamp. It was further resolved (1) that the agreement come into operation on March 31 next; (2) that the company be requested to submit a design for the electric lamp-posts proposed to be adopted for the Council's approval; (3) that the Council should be empowered, at the commencement of any year, to determine whether the lamps on the sea-front should be used for either 6 or 12 months; (4) that a committee, to be called the Electric and Street-Lighting Committee, be formed, consisting of the whole Council, that Councillor H. S. D. Byron act as chairman, and that the question of defining the positions of the 20 arc lamps in the foregoing resolution be referred to such committee to consider and report.

Gravesend.—The Council have received a letter from the Local Government Board, stating that the scheme for the supply of electric energy and the provision of a dust destructor is generally satisfactory, but before coming to a final decision on the application for sanction to borrow, the Board desire to be informed how the proposed cesspit, to which the drainage of the buildings will be carried, is to be built and rendered watertight. On consideration of the subject of the length of notice necessary to be given by the Corporation in order to determine the agreement with the tramway company for the supply of energy at the end of seven or fourteen years, it has been resolved that there was no objection to a notice of 18 months being required. If the company will agree, a charge of 6d. is to be made for every mile which may not be run, in consequence of any failure or defect in the supply of electrical energy, subject to the following proviso. Then the town clerk and the electrical engineer can proceed to confer with the company upon the technical difficulty, which the company state that they are satisfied can be removed. The proviso in question was that the number of car miles specified by the company—namely, 1,200 a day—must be considered as a maximum, and the charge must be at 6d. per mile, calculated at the rate of 1,200 miles for the 24 hours; and further, that no failure or defect which does not continue for a quarter of an hour shall be regarded. Mr. Stigant, one of the local solicitors of the proposed Kent Electricity Company, has been in communication with the Town Council on the subject of a scheme which will be submitted to Parliament in the ensuing session for the supply of electricity to the whole of the county, generally speaking wholesale. It appeared that the company proposed to charge (in addition to a small standing charge for service) 3d. per unit for any quantity under 5,000 units, but if over 200,000 units are consumed in any quarter then only ½d. per unit. The town clerk was of opinion that in view of the Power Acts which had already been granted in various counties, the new company, if their scheme were properly conceived, technically in order, and duly proceeded with, would, generally speaking, acquire a statutory right to supply current in Kent, unless the municipal and other local authorities amalgamate in opposing the Bill and in promoting a similar undertaking whereby the local authorities would become the wholesale producers and dispensers of electrical powers in place of a private company.

London County Council.—The Council have agreed to lend the Poplar Borough Council £3,100 for street-lighting. Notices under Electric Lighting Acts and orders have been agreed to as follows: from the Brompton and Kensington Electricity Supply Company, under the House-to-House Order, 1889, of intention to lay mains of high and low tension along a portion of Kensington High-street; the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, 1892, to lay low-tension mains along both sides of Rodenhurst-road; the Kensington and Knightsbridge Electric Lighting Company, under the company's order and the Kensington and Knightsbridge Electric Lighting Act, 1893, to lay mains (*a*) along and across Beauchamp-place, and (*b*) along Brompton-road, Kensington High-street, Kensington-road, and Hyde Park-gate; from the Metropolitan Electric Supply Company, under the Mid-London Order, 1889, to lay low-tension mains along portions of Charing Cross-road, Shaftesbury-avenue, Greek-street, Soho-square (two sides), Carlisle-street, Dean-street, Titchfield-street, Great Chapel-street, and Oxford-street, and to lay low-tension mains from Lincoln's-inn-fields, along Gate-street and New Turnstile, and across and along High Holborn to Southampton-row; the County of London and Brush Provincial Electric Lighting Company, under the County of London (North) Order, 1892, to lay power and high-tension mains along Woodbridge-street, Aylesbury-street, and Jerusalem-passage to St. John's-square, and to construct a transformer box in St. John's-square; the County of London and Brush Provincial Electric Lighting Company, under the County of London (Northern Extensions) Order, 1897, of intention to lay power and low-tension mains along a portion of Warner-street; the Woolwich District Electric Lighting Company, under the Woolwich Order, 1891, to lay mains along Nelson-street and Rodney-street; the St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, to lay mains (*a*) along Bromley-place and Savernake-road, (*b*) along a portion of Harrington-square, (*c*) along Great College-street and St. Paul's-road, and (*d*) along portions of Kentish Town-road and Grafton-street. Notices under orders granted to local authorities have also been received as follows: from the Hammersmith Borough Council, under the Hammersmith Order, 1893, of intention to lay mains across Boundary-road and along Latimer-road; the Poplar Borough Council, under the Poplar District Order, 1893, to lay mains along King-street Garford-street, Bridge-street, Preston-road, New-road, Manchester-road, Dacre-road, Stour-road, Bream-road, and Seyssell-street; and the Islington Borough Council, under the Islington Order, 1893, to lay mains along Tollington-park.

PROVISIONAL PATENTS, 1901.

Nov. 25.

23867. Mechanical point shifter for electric trams and the like. John William Jemmison and Lawrence Lupton, 16, Wood-street, Hampton, near Burnley.

23868. Improvements in electric tramway rail cleaning brush. Samuel Sudworth, 24, Ivy-lane, Brockley, London.

23895. Improvements in apparatus for electrically producing radiant heat. Herbert John Dowsing, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

23915. A new or improved method and means for securing incandescent lamp holders to service wires. Walter Reginald Lambert, 165, Queen Victoria-street, London. (Complete specification.)

23917. Improvements in high-tension insulating materials. Caspar Baur, 322, High Holborn, London.

23934. Improvements in and relating to automatic electric switches, indicating and recording devices, and like apparatus. George Charlton and Walter Edward Barton, 46, Lincoln's-inn-fields, London.

Nov. 26.

23979. Apparatus for simultaneous electric signalling by means of one wire or continuous conductor connecting two or more places. C. G. Fernie, West Wratting Park, near Cambridge.

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23996. Improvements in poles for electric railways, electric lights, and telephone and telegraph lines. George Van Amringe Conger, 33, Chancery-lane, London. (Complete specification.)

24011. Improvements in electrical apparatus, including telephone and like apparatus. Philip Middleton Justice, 55, Chancery-lane, London. (Charles Casimir Barton, United States.)

24012. Improvements in or relating to compound insulating material for electrical purposes. Reginald William James, 1, Queen Victoria-street, London. (The Mica Insulator Company, United States.)

24013. Improvements in and relating to the control of the E.M.F. in electric circuits. Henry Wilock Ravenshaw, 1, Queen Victoria-street, London.

24052. Improvements in globes or shades for incandescent electric lights. John Cronin Fleming, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24054. Improvements in resistances for arc lamps and other electrical apparatus. John Llewellyn Davies, 40, Chancery-lane, London.

Nov. 27.

24086. Improvements in electrical resistances. Wallace Fairweather, 62, St. Vincent-street, Glasgow. (Wallace Cranston Fairweather, Germany.)

24095. Improvements in house service terminal boxes. Sydney William Baynes, 25, St. George's-square, Regent's Park, London.

24096. A method of readily attaching or fixing the containing cases of electrical or other apparatus to telegraph, telephone, and tramway poles, or the like supports. Max Byng and Francis George Bell, 71, Queen Victoria-street, London.

24131. Improvements in electrically-illuminated night clocks. James John Stockall, junr., 10, Clerkenwell-road, London.

24134. Improvements relating to electrical connections. James George Accles and Frederick Henry de Veulle, 45, Southampton-buildings, Chancery-lane, London.

24137. Improvements in gas and electric light pendants, brackets, and stands. Philip Thomas and Charles John Shaw, 128, Colmore-row, Birmingham.

24148. Improvements in electrodes for arc lamps. Abraham Denby Raine, Norfolk House, Norfolk-street, Strand, London. (Hector Alan Macdonald, France.)

24149. Improvements in cams for quick return movements especially applicable to electric igniters for explosion engines. Mervyn Joseph Pius O'Gorman, 24, Southampton-buildings, Chancery-lane, London.

Nov. 28.

24163. Improvements in life-saving fenders for electric tramway cars and the like. Thomas Edward Corney Wilson, 62, Market-street, Manchester.

24169. Improvements in and connected with the supporting standard and trolley arm used in overhead electric traction schemes. Robert Lighton Ross, Carrignata, Portrush, co. Antrim.

24175. Improvements in conduits for laying electric cables. Henry Norman Brooke, Market-place, Huddersfield.

24186. Arrangement for decreasing and increasing the candle-power of an electric lamp. Henoch Frohmann, 3, Berny-buildings, Grove-street, Commercial-road, London.

24192. Protective mechanism for high-tension systems of electrical distribution. Ernest De Pass, 78, Fleet-street, London. (Robert Victor Cheatham and Joseph Adger Stewart, United States.) (Complete specification.)

24193. Improvements in trolley wheels for overhead electric cars, applicable to sheave and other grooved pulleys. Hugh William Pinkerton, 77, Colmore-row, Birmingham.

24206. Improvements relating to the ventilation of underground or "tube" railways. James Russell Chapman and the Metropolitan District Electric Traction Company, Limited, 45, Southampton-buildings, Chancery-lane, London.

24212. Improvements in or in connection with the handles of brakes, controllers, and the like of electric and other motorcars and vehicles. Joseph Tranton, 6, Lord-street, Liverpool.

24215. Improvements in electric transformers. Charles Russo, 23, Southampton-buildings, Chancery-lane, London.

24227. Improvements in speed-regulating means for electric motors. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 30, 1901, being date of application in United States.)

24228. Improvements in windings for electrical machines. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 30, 1901, being date of application in United States.)

Nov. 29.

24239. Improvements in cases or holders for Nernst lamps. Bernard Mervyn Drake, Eustace Graham Sheppard, Gilbert Scott Ram, and the Nernst Electric Light Limited, 18, Southampton-buildings, Chancery-lane, London.

24249. Improvements in or appertaining to wooden or other like casing for electric wires. Arthur Hammond Marriner, 2, Market-street, Bradford.

24254. Improvements in and connected with telephone and telegraph communications. William Foxton, 87, Victoria-road, Scarborough.

24276. Improvements in or relating to electric arc lamps. The Jandus Arc Lamp and Electric Company, Limited, and Adrian Denman Jones, Hartham Works, Hartham-road, Holloway, London.

24277. Improvements in and relating to plates for electric storage batteries. Charles Solomon Kaufmann, Fife House, Kingston-on-Thames.

24308. Electrical distribution. Joseph Lester Woodbridge, 31, Cannon-street, London. (Date applied for under Patents, etc., Act 1883, Sec. 103, March 12, 1901, being date of application in United States.)

24316. Apparatus for purifying water by electricity. James Slough Zerbe, 31, Cannon-street, London.

24327. Improvements in electric arc lamps. Frank Proctor, 40, Chancery-lane, London.

24336, Improvements in or relating to trolley heads and lines for tramways and the like. David Blythe Foster, 6, Lord-street, Liverpool.

Nov. 30.

24360. Improvements in and connected with the distance transmission of pictures and messages. Sherard Cowper-Coles and Co., Limited, and Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

24361. Improvements in and relating to aluminium welding. Sherard Cowper-Coles and Co., Limited, and Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

24364. Improvements in and relating to electric maximum demand or load indicators and recorders. David John Steele and Charles Kratt, 96, Buchanan-street, Glasgow.

24397. Improvements in multiplex telegraphy using undulatory or alternating currents. William Phillips Thompson, 6, Lord-street, Liverpool. (La Société des Télégraphes Multiplex (Système E. Mercadier), France.) (Complete specification.)

24422. Improvements in or connected with telephone systems. Isaac Hardy Parsons, of the firm of Gent and Co., Thomas Sloper, and Harry Snowdon, 4, South-street, Finsbury, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 21.

1900.

21447. Electric railways on the sectional conductor system. British Thomson-Houston Company, Limited. (Woods.)

21566. Accumulators or secondary batteries. Von Welsbach.

21578. Enclosed switch and cut-out combined. Fryer.

21812. Electric arc lamps. Emerick.

22019. Storage batteries. Meygret.

22411. Electric return for electric tramways or street railways. Sayers.

23323. Controller and switch for motors for electric lifts. John Bush and Matthew Thomas Medway.

1901.

234. Suspensory devices for carrying incandescence electric lamps by flexible conductors. Hurst and Ide.

998. Electric brakes for railway and tramway vehicles. Newell.

1468. Electromotors. Hodgetts.

1742. Dynamo-electric generators. Lamme. (Date applied for under International Convention, June 28, 1900.)

1872. Current collectors and ploughs for electric tramway conduits. Mills.

1890. Electric storage batteries or accumulators. Niblett.

1981. Electric storage batteries or accumulators. Niblett.

2553. Electric arc lamps. Eckstein and Angold.

10559. Telephone receiver holder. Meyer. (Date applied for under International Convention, Dec. 8, 1900.)

12773. Electric energy meters. Batlle and Bueno.

14807. Contact ploughs and conduits for electrically-propelled cars. Connett.

17249. Magneto-electric machines. Sims and Bosch.

17480. Electrolytic polarisation cells having an aluminium electrode. Siemens Bros. and Co., Limited. (Siemens und Halske Actien-Gesellschaft.)

18505. Central-station apparatus of telephonic installations with parallel branched subscribers' jacks. Abel. (Siemens und Halske Actien-Gesellschaft.)

18682. Electromagnetic motor. Perret.

18787. Electrical hauling apparatus, applicable also to other purposes. Greensmith, Wild, and Kidd.

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19938. Automatic device for controlling the power of motors of vehicles propelled electrically. Evans. (Allgemeine Electricitäts-Gesellschaft.)

20072. Electrical accumulators. Edison.

20093. Automatic synchroniser for coupling alternating-current electric machines. Pearson and Williamson.

20661. Electrically-driven apparatus for raising and lowering loads, especially applicable to the lifting tables of rolling mills. Schwarze.

21744. Apparatus for the wireless transmission of electric oscillations. Collins.

21767. Windings for electromagnetic spools or coils. Heany.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	—	—	—	—	—	—
Birmingham Tramways	—	—	—	—	—	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	Nov. 29	459	390	+ 69	24,182	21,448*b*
Blackpool Corporation	,, 28	234	185	+ 49	36,428	27,372
Blackpool-Fleetwood Tramways	,, 30	171	137	+ 34	20,356	19,713*b*
Bolton Corporation	Dec. 1	1,321	1,205	+ 116	69,529	57,276*b*
Bradford Corporation	,, 1	1,035	687	+ 348	43,735	22,525
Bristol Tramways Company	Nov. 29	3,681	2,988	+ 693	—	—
Carlisle Tramways Company	,, 30	107	118	- 11	4,002*b*	3,975
Central London Railway	,, 30	6,862	5,766	+ 1,096	134,295	—
City and South London Railway	Dec. 1	3,262	1,904	+ 1,358	45,936	35,86C
Cork E. T. and L. Company	Nov. 28	363	327	+ 36	22,112	19,647*b*
Darwen Corporation	,, 29	179	154	+ 25	9,050	7,449
Dover Corporation	,, 30	170	157	+ 13	10,456	9,920*b*
Dublin & Lucan Electric Railway	Dec. 1	75	67	+ 8	2,594	2,236
Dublin U. T., electric cars	Nov 29	3,218	3,265	- 47	—	—
Dublin S. District, Electric	,, 29	696	651	+ 45	—	—
Dundee Tramways Company	,, 27	623	479	+ 144	—	—
Glasgow Corporation	,, 30	10,794	8,999	+ 1,795	—	—
Halifax Corporation*	—	-	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 30	1,570	1,332	+ 238	38,179	31,310
Liverpool Corporation	,, 23	8,668	7,936	+ 732	422,589	373,531*b*
Liverpool Overhead Railway	Dec. 1	1,436	1,569	- 133	34,986	36,643
Portsmouth Corporation	Nov. 30	720	564	+ 156	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	Dec. 1	3,519	—	—	—	—
Southampton Corporation	Nov. 25	691	639	+ 52	—	—

* Fortnightly. *b* From Jan. 1.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £1,304 decrease.

Barcelona Ensanche y Gracia, £12 decrease. Barcelona, £241 increase.

Brisbane, £502 increase (month of Oct., £943 increase).

Buenos Ayres and Belgrano Electric, £100 decrease (month of Nov., £572 increase).

Calcutta, £20 decrease.

Cape Town (month of Oct.), receipts, £14,063; expenditure, £6,817.

La Capital Traction and Electric, Buenos Ayres (month of Oct.), £1,350 increase.

Mexico Electric (month of Oct.), receipts, £17,400; expenditure, £10,100.

Perth Electric, £255 increase.

Port Elizabeth (month of Oct.), receipts, £3,240; expenditure, £1,960.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅝-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¾-½
—— Ordinary, 1-125,000	1 ..	9/16-11/16
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-5¾
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5-5¼
Brush Electrical Engineering, Ordinary	2 ..	1⅞-1⅞
—— Non. Cum., 6 per cent. Pref.	2 ..	1⅞-2⅛
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	112-116
—— Ordinary	5 ..	14½-15½
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3½
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	⅛-¼
—— 5 per cent. Debentures	5 ..	1½-2½
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1⅞-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10½
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16-17
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	23-24
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6½
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	103-105 xd
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-102
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9½-10¼
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	8¼-8¾
—— 7 per cent. Preference	5 ..	8¼-8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7⅞-8⅛
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10½ xd
Charing Cross and Strand	5 ..	8¼-9½
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5¼-5¾
—— 40,501-50,936	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	11½-12½
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	8¼-9½
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5½-6
—— 6 per cent. Cum. Pref.	5 ..	5¾-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4¾
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	3¼-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	113-116
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1⅛-1⅜ xd
—— £5 Shares	5 ..	7⅛-8 xd
—— £4½ Shares, New	4½ ..	7-7½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15½-16½
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11½-12½
Electric Railways.—		
Central London, Ordinary	100 ..	107-110
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	107-110
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-119
City and South London, Consolidated Ordinary	100 ..	63-65
—— Ordinary	10 ..	6-6½
—— 4 per cent. Debenture Stock	100 ..	112-116
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	3⅛-4⅛
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-128
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¾-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	5⅞-6¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	8¾-9¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14-14¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11¾-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅞-2⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¼-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-6
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
—— Prov. Cert., all paid	100 ..	100-103
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅞-2⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11½-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22¼
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	104-106
New General Traction, Ordinary	5 ..	2⅛-3½
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	98-102
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¾-10¼
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8s. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Telephones.—		
National Telephone, Ordinary	5 ..	3¼-4⅛
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5
—— 4 per cent. Deb. Stock, Red.	100 ..	96-98
—— 3½ per cent. Deb. Stock, Red.	100 ..	99-102
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

Proposed Electro-Therapeutical Society.—We are asked to state that it is intended to form an electrical society for duly qualified medical practitioners who are interested in the application of all forms of electricity to disease. Any practitioners willing to give their support to such a society are requested to send their names to Mr. Chisholm Williams, at 20, Bedford-square, W.C.

Electrolytic Separation of Mercury from Copper. In reply to the statement of Mr. Emil Goecke that the separation of mercury from copper cannot be satisfactorily effected by electrical means, Messrs. C. Rosere Spare and Edgar F. Smith have published the results of a number of estimations to prove the accuracy of the method. Contrary to Mr. Goecke's conclusion, they find that the deposit of mercury is free from copper. They also obtained satisfactory results in the presence of copper, cadmium, and zinc.

Licensed Electricians.—The Municipality of Chicago is proposing to institute a city examining Board for electricians, which would examine and, where thought fit, grant licenses to electrical construction workers; and no man would be allowed to do any electrical construction work without such a license. The license fee for electrical contractors would be £2, and for wiremen and linesmen 4s. a year. We understand that severe objections are being raised to the city's proposal by the union labour men.

Proposed Exhibition in Vienna.—Another international exhibition of inventions and novelties is proposed to be held on the Continent, to take place in Vienna some time in 1903. The general scheme of the exhibition has been endorsed by a committee composed of leading manufacturers, members of the Vienna Chamber of Commerce, and representatives of prominent corporations. It is proposed that the programme of the exhibition shall embrace all varieties of technical inventions, and in particular those already practically introduced in the manufactures. The financial support of the undertaking is said to be assured.

Treatment of Cancer by Electricity.—We note that Dr. Horace Manders claims to be quite successful in the application of the electric current in the curative treatment of cancer by means of the X-rays. The patient is subjected to the electrical treatment daily. The first few days produce little effect that can be seen, but in a week there is an evident change for the better. As the treatment is continued its good effects become more and more apparent, and the wound itself takes the form of a healthy one from the outward appearance. At last, according to Dr. Manders's claim, the wound is covered, the cancerous growth has disappeared, and the patient is cured.

Electrical Progress in Siam.—We understand from our contemporary *Indian Engineering* that the city of Bangkok enjoys the advantages of an excellent electric light system and of an electric tramway some six miles long. This latter undertaking is now being extended by the laying of a second line of equal length. The service of the two plants already in operation is good, and with the introduction of the new tramway, they mark a decided advance in the development of electricity in that country. Both undertakings are in the hands of private companies. The telephone system of Bangkok, however, is said to be decidedly bad and leave room for vast improvement. It is owned by the Government and forms part of the postal telegraph department.

Niagara Graphite.—As an instance of the many uses to which the electrical energy obtained from the Niagara Falls is being put we may quote the manufacture of graphite. The International Acheson Graphite Company use a large amount of electrical energy from Niagara, and are evidently getting successful results with their plant. We have received from them a graphite pencil, which leaves nothing to be desired, especially as the question of its cost price does not enter into our consideration. It would be interesting to know how far this artificial graphite will compare in cost with the natural product. In quality there is nothing to choose.

Institute of Chemistry.—Mr. Hanbury, M.P., speaking at the annual dinner of the Fellows and associates of the Institute of Chemistry of Great Britain and Ireland last week, made some interesting remarks on the chemical industry. He considered that if we were to hold our own in the world, we should have to become more scientific than we were. Alluding to the fact that the discovery of aniline dyes was largely due to the chemists of this country, the speaker pointed out that the trade had practically gone to Germany, because this country had not made sufficient use of its chemists. He further expressed his view that scientific and technical experts did not receive that remuneration which they could get in other countries. Chemists rendered great services to several departments of the Government, but if he might judge from the report of the recent Committee on Preservatives, they were sometimes a little inclined to act as poachers as well as keepers. It was for agriculture that chemists did, perhaps, their most important work, and as President of the Board of Agriculture he desired to encourage their services.

Rhythmical Traction.—Dr. Laborde has made an interesting communication to the Paris Academy of Medicine with reference to two cases in which what is known as "rhythmical traction" to the tongue has been employed with signal success for restoring consciousness. The doctor, it is said, has specially devised an electric motor for ensuring mechanical traction for hours, and this was brought into use on the occasion in question. The first was the case of a child which was restored to consciousness, although apparently dead, by the application of this method of rhythmical traction for about an hour or so. The second was also the case of a newly-born infant, who was livid, and to all appearances lifeless. Dr. Laborde's treatment was again eminently successful in establishing respiratory movement in the patient. The invention has also been successfully applied to numerous cases of suicide by hanging, drowning, and asphyxiation. Respiration, however, has not always been so quickly attained as in the two cases in point, and sometimes it requires quite three or four hours' exertion before life is restored. The improved motor which Dr. Laborde has constructed is especially to facilitate the continuance of the periodic pulling of the tongue.

Electric Heating.—The question of warming and ventilating buildings is one on which a large amount of work has been done, and yet the problem can by no means be considered as definitely solved. It is now, however, usually the practice to use electrically-driven fans in connection with all ventilating systems. When heat is required, a steam-coil is frequently interposed in the path of the air from the fans, so that it may be heated before delivery into the room where it is required. We notice a device described in one of our American contemporaries, in which it is proposed to replace this steam-coil by an electric heating device. The same inventor, who hails from Boston, also proposes to put the resistance material, which

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is heated, on the blades of the fan. In one instance he goes so far as to make these blades of carbon blocks, which act as the heating agent. It seems to us that although this course has advantages, it is liable to the great disadvantage that the mechanical strength of the carbon blocks is by no means what it should be in order to resist the centrifugal force. The advantage, of course, is that by reason of the motion the resistance can be worked at a much higher current density than is possible under normal conditions. This means low first cost, which is always to be desired.

New South Wales Tramways.—The quarterly report of the New South Wales Railway Commissioners for the quarter ended Sept. 30 last, has just reached this country. As compared with the corresponding period last year, it is somewhat disappointing to find that the results for the quarter under review are not quite so satisfactory. True, it is that, due to the fact that the number of miles of tramways open has increased from 76¾ miles to 80 miles, the revenue has gone up from £116,000 to £136,049, but the earnings per car mile for the quarter ended Sept. 30 this year have fallen off from 1s. 6¼d. to 1s. 3¼d. Also the expenditure per car mile still remains very high—*i.e.*, 1s. 1d., although this figure shows a decrease of 2¼d. as compared with the corresponding quarter last year. While the total expenditure has gone up from £97,125 to £117,168, the percentage of expenditure to earnings is 86·12 as compared with 83·58 in 1900. The number of passengers carried has increased by about 3½ millions, but this is small in comparison with the car miles run, which on Sept. 30 last stood at 2,154,600, as compared with 1,525,673 the corresponding quarter last year. Taking it as a whole, therefore, the report does not present such an encouraging state of affairs as might be desired.

Mixed System of Electric Traction.—We note that it is proposed to use a mixed system of trolleys and accumulators on the Florentine electric tramways, which are at present being worked solely on the overhead trolley system. By the new method it is hoped to get rid of the whole of the overhead equipment in the busy streets of the city of Florence, and to run the cars by accumulators until the outskirts of the city be reached, when current would be obtained in the old way from the overhead conductors. Apart from the practical side of the scheme, the financial question is one which would probably present many difficulties. It is estimated, for instance, that the adoption of accumulators on the cars would increase the first cost per car by at least £240 beyond the expense of equipping it with the trolley. This additional cost would make a difference of 1·6d. per mile for each car; adding 5 per cent. for maintenance and renewal of accumulators, the annual expenses beyond those incurred on the present system would be £2,400 for 625,000 car miles. It is, therefore, to be feared that from a financial point of view the use of both accumulators and trolleys on the cars would not prove a success. The Florentine tramways are worked by the Belgian Tramway Company, of Brussels, and extend to a length of 78 miles, of which 21 miles are in the commune of Florence.

The Copper Ring.—From the financial papers this week it would seem that the copper ring in America is falling to pieces. This combination, which has for several years forced up the price of copper, has done much to retard the progress of electrical engineering. While fortunes have been made by the members of this ring, it seems likely that these fortunes are now to be lost. The following figures as to the price of Chile bars show that there has been a gradual fall in the prices of raw copper throughout the year, but the sudden decline during the past week indicates that the ring have lost control of the market. Thus in January last £72 per ton was the market price of raw copper. By the end of March this had fallen to about £68 or £69, and at the beginning of September perhaps £66 was the average. Even as late as Nov. 27 this price was maintained, but during the last week Chile bars have been quoted for successive days at £60, £58. 10s., £56, £57. 10s., and £55. 10s., and on Wednesday last the price had dropped to £55. 2s. 6d. While the falling off in the world's trading may partly account for this, the fact remains that with a slight decrease in the demand for copper the financiers in America, who have tried to control the countries' demand, have failed. Their failure, which was prophesised by us in the first instance, is good news to electrical engineers as a whole.

Bath Electric Lighting.—The history of the public supply of electric light in Bath has not been a particularly happy one. For this the Corporation of the town are not by any means wholly to blame, as Bath was one of the first places to have electric light supplied by a company. As is necessarily the case with all pioneering undertakings, experience had to be bought dearly, and the time arrived when the plant first installed had to be consigned to the scrap heap. Eventually the Corporation took over the assets and liabilities of the company, and proceeded to reorganise the same. During the process of reconstruction there have frequently been stormy debates in the Council, which have not augured well for the undertaking. We see now that after numerous failures in the light the whole Council have constituted themselves into an electric lighting committee, owing to the want of confidence which the towns people had in the Electric Lighting Committee. This seems to us to be rather an absurd solution of the difficulty, as up to the present the more people who have been concerned with the electric lighting undertaking, the more trouble there has been. We think the Council would have done well to elect a small strong committee to have looked into the matter. In any case, we are pleased to note that the present electrical engineer is not held to be responsible for the breakdowns in cables and switchboards that have occurred.

Alloys of Copper and Tin.—Mr. Wm. Campbell, B.Sc., of Columbia College, New York, will read a paper before the Institution of Mechanical Engineers on the 20th inst., giving useful information relating to the microscopical examination of the alloys of copper and tin. The paper, it seems, will embody a portion of the work of the Alloys Research Committee, and should prove of great interest. From a syllabus of the paper we have seen, the author will first give a further explanation of the freezing-point curve of the copper-tin alloys as referred to in the fourth report of the committee in 1897, describing at the same time certain definite compounds crystallising out as SnCu, $SnCu_3$, $SnCu_4$. He will also offer a probable explanation of the eutectic lines, and show that copper when in excess crystallises as yellow dendrites and skeleton crystals. Having given an analyses of crystals, Mr. Campbell will explain various changes in the character of the alloy from 1 per cent. to 100 per cent. copper. An explanation of the branches of the cooling curve will follow, and reference be made to the change in structure due to casting; also to quenching and annealing. The preparation of the alloys for microscopical examination—slowly cooled, cast, and furnace-cooled—will next be described, and the paper will conclude with a reference to the processes of cutting, grinding, and polishing, etc. The author has illustrated the paper with 120 photo-micrograph sections and figures, each of which will be described.

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The X-Rays in War.—Under the title of "Bullets and their Billets" Mr. J. Hall Edwards gave an interesting account of his experiences as surgeon-radiographer to the Imperial Yeomanry Hospital in South Africa before the members of the Röntgen Society last week. Having described the varying nature of the wounds given by different classes of bullets, the lecturer contrasted the old method of "probe" exploration with the vastly-improved system of locating bullets in the human body by the use of the X-rays. Before going out to South Africa, Mr. Hall Edwards was inclined to believe that the coils might be used with advantage in the field; but actual experience had convinced him that they could be much more profitably employed in the field hospitals. The method of localising bullets was founded on mathematical calculations; but the foreign body was sometimes difficult to reach even when localised. This was due to the fact that the incision might diverge a little from the perpendicular, and the deeper it went the greater would be the divergence. Excellent results had followed the use of the X-rays in South Africa, though the officers at some hospitals had not availed themselves of this method of diagnosis as fully as they might have done. The lecturer then gave details of a large number of cases which had been successfully treated with the X-rays, and which were illustrated by the radiographs aken by him. The paper was well received.

Duty on Electrical Plant.—The various cities of New Zealand which are going in for electric light and power and electric tramway systems have found themselves faced with a very grave difficulty. It is not possible at present to manufacture the necessary plant for these purposes in the colony, as there are no works suitable, and it is therefore forced upon them to obtain the plant and materials required to carry out such schemes from abroad. In this state of affairs a very important question arises as to how far the financial success of these undertakings, for which the plant and machinery have been so obtained, is assured, having regard to the fact that the Government are placing an import duty of 10 per cent. on all electrical and tramway plant obtained from out of the colony. The Auckland City Council is the first municipal body to break a lance in its own cause and that of its brother councils who are proposing to set up an electric light supply and to provide electric tramway communication for the populace. The Government is being petitioned to remit the duty at present imposed, and the petitioners ask that all electrical and tramway plant required for the colony shall be admitted on the same terms as mining machinery, which are presumably much lower than 10 per cent. It seems to us that a great effort should be made to meet the wishes of the municipalities in this matter, especially having regard to the very large expenditures which are contemplated in the colony in carrying out electric lighting, power, and tramway schemes.

Andrew Carnegie Research Scholarship.—We are informed that a research scholarship or scholarships (of such value as may appear expedient to the council of the Iron and Steel Institute from time to time) founded by Mr. Andrew Carnegie (vice-president) who has presented to the institute 64 1,000dol. Pittsburg, Bessemer, and Lake Erie Railroad Company 5 per cent. debenture bonds for the purpose, will be awarded annually, irrespective of sex or nationality, on the recommendation of the council of the institute. Candidates, who must be under 35 years of age, must apply, on a special form, before the end of March to the secretary of the institute. The object of this scheme of scholarships is not to facilitate ordinary collegiate studies, but to enable students who have passed through a college curriculum or have been trained in industrial establishments to conduct researches in the metallurgy of iron and steel and allied subjects, with the view of aiding its advance or its application to industry. There is no restriction as to the place of research which may be selected, whether university, technical school, or works, provided it be properly equipped for the prosecution of metallurgical investigations. The appointment to a scholarship will be for one year, but the council may at their discretion renew the scholarship for a further period instead of proceeding to a new election. The results of the research will be communicated to the Iron and Steel Institute in the form of a paper, and if the council consider the paper to be of sufficient merit, the Andrew Carnegie gold medal will be awarded to its author.

Locating Cable Faults.—Mr. A. C. Stott, in the November issue of the *Transactions* of the American Institute, has a paper on a method of localising faults in underground distribution systems. He first shows that when one wire in a long run is earthed through a fault, the resistance methods become somewhat difficult to use in practice. In fact, he concludes that resistance methods are of no practical value for lighting and power mains. The three other methods he classifies as follows: (*a*) the cut-and-try method; (*b*) the smoke method; and (*c*) the compass method. The cut-and-try method is stigmatised by the author as too bad to merit description, in view of the great time and cost of cutting up the cables into lengths in order to localise the faults. This criticism is rather severe if disconnecting links have been provided in the junction boxes in the manholes. The second or smoke method consists of putting a large current on the cables, and then watching at the manholes to see where the heat is given off. This is a dangerous one, and is liable to damage good cables in the process of localisation. The third or compass method, advised by the author, consists of putting a small current of, say, 10 amperes on to the cable through the earth and reversing it at regular intervals of, say, 10 seconds. A needle held over the cable then is deflected at every reversal of the current. By trying at the various manholes along the route, it is easy to find the point at which the deflections of the needle cease, and then the fault can be localised as lying between two manholes. The author states, in conclusion, that he has been using the method for over four years, and has found it exceedingly successful. He illustrates in his paper a small motor-driven commutator for providing the intermittent currents.

Royal Institution.—The following are the lecture arrangements at the Royal Institution before Easter: Prof. J. A. Fleming, six lectures (adapted to young people) on "Waves and Ripples in Water, Air, and Æther"; Dr. A. Macfadyen, six lectures on "The Cell: Its Means of Offence and Defence. Immunity"; Mr. W. N. Shaw, two lectures on "The Temperature of the Atmosphere: Its Changes and their Causes"; Prof. E. P. Poulton, two lectures on "Recent Researches on Protective Resemblances, Warning Colours, and Mimicry in Insects"; Dr. A. S. Murray, three lectures on "Recent Excavations at Delphi and in the Greek Islands"; the Rev. John Watson (Ian Maclaren), three lectures on "The Scot of the Eighteenth Century: (1) At Home, (2) In Kirk, (3) With His Books" Sir Henry Craik, two lectures on "Scotland's Contribution to the Empire"; two lectures on "Caricature in and out of Parliament," by Mr. E. T. Reed; four lectures on "The Landmarks in the History of Opera: Gluck, Mozart, Weber, Wagner," by Mr. W. H. Hadow; six lectures on "Some Electrical Developments," by Lord Rayleigh. The Friday evening meetings will commence on Jan. 19, when Lord

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Rayleigh will deliver a discourse on "The Interference of Sound." His Grace the President will after the discourse unveil and present to the institution, on behalf of the subscribers, a bust by Mr. Onslow Ford, R.A., of Sir Frederick Bramwell, Bart., honorary secretary of the Royal Institution from 1885 to 1900. Succeeding Friday evening discourses will be delivered by Mr. H. G. Wells on "The Discovery of the Future"; Prof. A. Crum Brown, "The Ions of Electrolysis"; Prof. Arthur Gamgee, "Physico-Chemical Researches on the Blood-Colouring Matter"; Major P. A. MacMahon, "Magic Squares and other Problems on a Chessboard"; Mr. W. Duddell, "Musical and Talking Electric Arcs"; Prof. Henry A. Miers, "Gold Mining in Klondyke"; Prof. H. Becquerel, "Radio-Active Bodies"; Prof. E. Ray Lankester, "The New Mammal from Central Africa and other Giraffe-like Animals"; and Geheimrath Prof. Otto N. Witt on "Recent Developments in Colouring Matters."

Electric Traction in Melbourne.—The application of electric traction to the present steam railways forming the suburban system of Melbourne has recently formed the subject of enquiry by a Select Committee of the Legislative Council, specially appointed to deal with the question. The committee's report has not yet been published, but we are enabled to give some of the details of the scheme from an account of the proceedings before the Select Committee which appears in the *New South Wales Railway Budget*. It seems to have been generally agreed among the engineers that there is no necessity now to make experiments in electric traction, and the whole enquiry appears to have turned on the question whether or not it would pay. The average speed on the suburban steam lines now is 15 miles an hour, but with electric traction this would be increased to 20 miles an hour. In all there are over 100 miles of double lines within the suburban radius, and in the event of electric traction being adopted, it is intended to apply it to the whole system. An estimate of cost has been prepared by Mr. Rennick, the engineer-in-chief, who is of opinion that the whole of the existing steam lines could be converted to electric traction for about 2½ millions sterling, allowing for a set off of nearly half a million on account of the selling value of the present engines, cars, etc. Of this total he estimates that about 1¼ millions would be absorbed by the power station, which would have a capacity of 64,000 h.p. Sub-stations would cost £200,000; cars, £640,000; line equipment, including conductors and cables, at £4,000 per mile, £400,000; and extra cost of motorcar sheds, etc., £50,000. With this large capital expenditure Mr. Rennick estimates that the additional revenue eventually deriving from immediate and natural increase of traffic would, after deducting working expenses, come to £52,000 per annum. The present revenue from the steam lines is £500,000. During the investigation of the committee, it was generally admitted that for electric railways, as distinct from electric tramways, the third-rail system should be adopted, but it was thought that 12 months might very profitably be spent in the consideration of the subject before the conversion of the lines was finally agreed upon.

Northampton Institute.—On Friday evening last the Marquis of Northampton distributed the prizes and certificates to the successful students in the large hall of the Northampton Institute, St. John-street-road, Clerkenwell. The building was crowded with the relatives and friends of the members of the institute, and his lordship's remarks were listened to with the deepest interest. Earlier in the proceedings Dr. Walmsley, the principal, gave a short address, testifying to the steady progress which had been made both on the educational and on the social and recreative side during the past year. The electrical engineering laboratories, he said, had been so crowded that the question of increased accommodation had to be solved. This had now been provided by the building of a new mechanical laboratory and workshops in the courtyard, and the utilising of the space so obtained for the electrical engineering laboratory, which even in its extended form was none too large for the classes which were using it this winter. The Marquis of Northampton, previous to distributing the prizes and certificates, expressed his high appreciation of the progress made in the past year, and reminded his hearers that every prize received was an additional feather in the cap of Dr. Walmsley and the staff which surrounded him. He fully believed that if we in this country were to successfully compete with foreign countries we must have greater possibilities of a higher education, and he was pleased to see that we were going ahead in this matter. In closing his remarks, his lordship asked the students in the next session to make still greater progress and confer still higher honours on the Northampton Institute. A conversazione was given afterwards, at which the Marquis himself attended and inspected some of the workshops, the laboratories, etc. Exhibits of electrical instruments were given by some of the leading firms, including the General Electric Company, Messrs. Veritys, and Messrs. A. G. Thornton. In the course of the evening the institute military band, very ably conducted by Mr. E. Cawley, rendered some highly acceptable selections of music, while for those whose tastes lay in other directions there were gymnastic and swimming displays and interesting demonstrations in the wiring workshop, the electrical engineering and other laboratories.

Electrical Properties of Chromium.—The current number of the *Journal* of the Chemical Society abstracts a paper by Mr. Eberhard Brauer, giving the results of a study of the electrical properties of chromium during dissolution in acids. It seems that the dissolution of "active" chromium is attended by a remarkable periodicity in the rate of evolution of hydrogen, whilst active chromium also exhibits changes in its electric potential as the current produced by a cell of active chromium and platinum immersed in acid periodically varies. The author describes apparatus by which both these variations can be simultaneously studied; a cell of active and inactive chromium in hydrochloric acid was employed, and the variations of hydrogen evolution and of current strength produced oscillations of two reflecting mirrors, whereby two permanent records on photographic paper were obtained in juxtaposition. It was found that the two variations were intimately connected, perfectly analogous curves being obtained for both, although evidence of variations in the electrical properties was obtained when the evolution of hydrogen was apparently constant. The influence of temperature was studied; no periodicity was observed at 6deg., it was very marked at 20deg., and an increase to 31deg. caused a great increase in the frequency. The effect of variation of concentration of the acid was also investigated the frequency was found to increase with concentration, but to be no longer apparent when the acid was too strong. A cell was also employed in which a current of the acid was maintained, so that variations of composition at the electrodes were avoided; in some cases a sufficiently rapid flow of acid caused a cessation of the periodicity. It was found that a piece of pure chromium was inactive, but that activity was induced by rubbing with a piece of cadmium. Slight activity was also occasioned by the addition of sulphides or arsenic to the acid, this addition having further very great influence on the periodicity of active chromium. The author considers that the explanation of these

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phenomena is to be looked for in the variations of E.M.F. associated with the different oxidation stages of chromium.

Electrical Distribution in Large Towns.—We have received from the American Institute of Electrical Engineers their *Transactions* for November, 1901. In it we find a number of advance copies of papers which were read on Nov. 22. This prior publication of the papers is good in a collected form, although, perhaps, we prefer the method of our own Institution in issuing an advance copy of each individual paper to any member who desires to have the same so as to read it before the discussion. The first contribution to the *Transactions* now before us is one by Mr. Louis A. Ferguson on the distribution of electrical energy in large cities. This paper discusses the difficulties which American engineers are having owing to the large number of electric lighting and power distribution franchises which have been granted in the past. The author says, for instance, that nearly every city has granted franchises to many companies having varied degrees of financial and engineering ability. The result is that those engineers who have finally to combine the number of separate supplies into one harmonious whole find it difficult to avoid the condemning of a large amount of apparatus. The author proceeds to describe what has been done in the case of Chicago. We find that here a number of the old station plants were left complete, but they are only used at times of a peak load in the winter months as auxiliaries. In this way large extra expenditures are saved. In the case of Chicago the author shows that out of a total maximum output of 22,500 kw., 23·4 per cent. is now effected by means of alternating current at 60 frequency. The area supplied is about 58 square miles. The remaining 76·5 per cent. of the maximum output is distributed by direct currents over an area of only 10 square miles. In remodelling the supplies in question, 25-frequency alternating currents have been used as the means of transmitting energy from one centre to another. The next point taken up by the author is an investigation of the relative amounts of energy required for electric lighting and motors. This shows at present about 70 per cent. for lighting and 30 per cent. for power. But this 30 per cent. only includes the motors used on elevators and for working machines, and does not allow anything for electric traction. The author concludes that a direct current is much the better for use in thickly-populated portions of the city, because the direct-current motor is much superior to the alternating-current motor, and the disturbing effects on the line pressure are less. He also complains that the cost of three-phase motors is at present excessive in America, and is much more than that of a direct-current motor. Again, 12½ per cent. of the whole output of the company in Chicago is used for working elevators, or, as we should call them, lifts, and Mr. Ferguson states that up to the present he does not know of a really satis factory three-phase motor equipment for driving lifts. Another advantage of the direct-current system of supply is its use for accumulators, and on this great stress is laid. Mention is made of occasions where the bursting of a boiler tube would have resulted in the discontinuance of the supply but for the fact that the accumulators could keep things going until repairs had been made. We must admit, however, that on this side of the Atlantic there is little indication that accumulators are relied upon as a stand-by in the way suggested. English engineers seem to regard with more favour the breaking-up of the steam plant into sections completely isolated from each other, and to minimise the risks in that way. Exceedingly useful figures are given further on in the paper as to the sizes of units adopted, and the means of regulating the transmissions from large central stations to sub-stations in outlying districts. We notice that 9,000 volts are used on the main transmissions, and that induction regulators are employed to keep the voltage constant in certain cases. The last part of this paper gives a brief *résumé* of some Continental practices.

Cable-Laying in the Philippines.—Practically the first matter to which the United States Government paid serious attention in the Philippines after the fall of Manila was the laying of land telegraph wires and cables to connect the principal towns of the group of islands. Mr. Frederick Moore, in the *Scientific American*, gives an interesting account of the difficulties which had to be overcome in carrying out the work, due in part to the presence of the enemy and in part to the natural conditions of the country. Most trouble was experienced with the land wires from the fact that the Filipinos knew their value, and it became useless to stretch land wires unless the army surrounded them or they were guarded by a line of troops. Also, the system abandoned by the Eastern Extension Company fell into the enemy's hands, who developed and extended it with considerable ability, utilising barbed fence wire at times. It was soon discovered that cable was much the easier to maintain, as the Filipinos had no picking-up gear or grappling and cutting utensils. The first attempt of the United States War Department to establish a complete cable system between the islands seems to have met with misfortune. In the first place the problem of securing a satisfactory staff was by no means an easy one, for the business of cable-laying was new to the United States. A force, however, was at last got together, which sailed on board the "Hooker" with all the paraphernalia required for carrying out the work. On arriving at Manila the "Hooker" was sent to Hong-Kong to coal, but never returned, as she struck an outlying reef on Corregidor Island, and went to the bottom, together with the whole of the cable and equipment. Some delay occurred before another vessel, the "Romulus," could be chartered and the cable and equipment recovered from the sea, but eventually the work of laying the cables was begun in real earnest. For operating in the rivers and lagoons barges were equipped and towed by shallow-draught gunboats. The gunboats could repel disturbers, and the same exposure was not required in reeling out cable as was necessary in stretching land wires. Every five miles stops would be made to test the cable. The small military force which accompanied these expeditions when in hostile country would be deployed while the electricians landed to make the tests. For the actual work of establishing the lines natives were employed. It takes three natives to do the work of one American, but the native only asks a salary of £1 a month, and his accustomed fare of rice, dried fish, etc. The first work was done by the army, but subsequently contracts were let for laying the cable as well as furnishing it. At the present time all the principal cities and all the large islands of the Philippines are joined, and more than 2,500 miles of cable laid. In conclusion, the writer mentions "a curious protest" which was offered when the first military cable was laid. The Eastern Exten sion Company had acquired a new franchise from Spain before the war, with the sole right of cables in the Philippines. The franchise lasts until 1940, and a clause in the contract provides a payment of £5,000 for each year before that date that other cables shall be used. The company made a claim upon the United States for the amount, but the claim, according to the writer, will be ignored for reasons connected with the disposition of the cable at the beginning of the war.

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A NOVEL METHOD OF MOTOR TRACTION.

In a recent issue of the *Elektrotechnische Zeitschrift*, Herr Max Shiemann describes a system of electric motor traction which may be new to many of our readers, although shown on a practical scale in connection with the Paris Exhibition. The essential novelty of the system consists in supplying energy to the motorcars from two overhead trolley wires, notwithstanding that no special tracks are provided for the running wheels of the cars. The system is recommended as a pioneer to permanent tramways for the carriage of passengers and goods from and to outlying villages. So far as initial cost is concerned, this is claimed to be far less than in the case of permanent tramways—in fact, from £1,600 to £2,000 for the former, as against £6,400 to £8,000 per mile for the latter, exclusive of power-house. A service of motorcars on the system under notice has been inaugurated between the railway station at Eberswalde and the town of the same name in Germany, and another in the Biela Valley between Königstein and Königsbrunn. The latter serves both for passenger traffic and the conveyance of goods between the Elbe and the goods station at Königstein, on the one hand, and the manufacturing district of Hütten, on the other. A seven-mile extension of this system is proposed. The accompanying illustrations (for the originals of which we are indebted to Messrs. Siemens and Halske, the makers of the cars shown) will render any very detailed description superfluous. The arrangement of the double-pole contact wires is clearly seen.

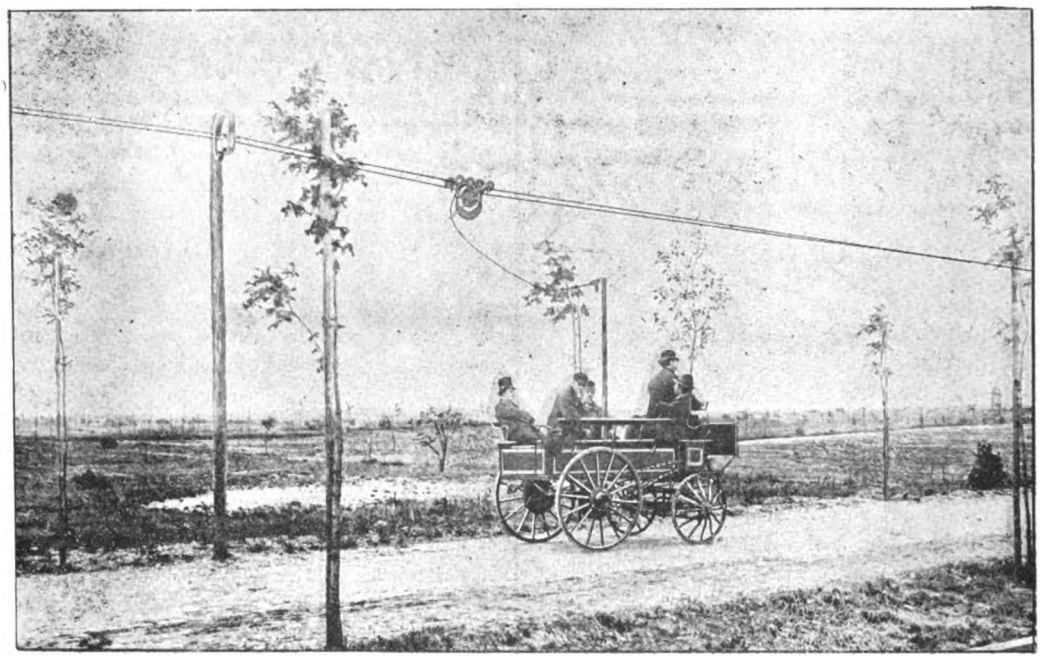

FIG. 1.

As far as possible, the conditions prevailing for electric tramways have been adhered to in order to facilitate subsequent conversion should this be considered desirable. Connection to the contact wires is made through rubbing contacts somewhat similar in design to the well-known Dickinson trolley. By this method the flexibility obtained is not so great as in the case of the French system of connection through a flexible cable (shown in Fig. 1), but as the roads over which the cars have to run are generally

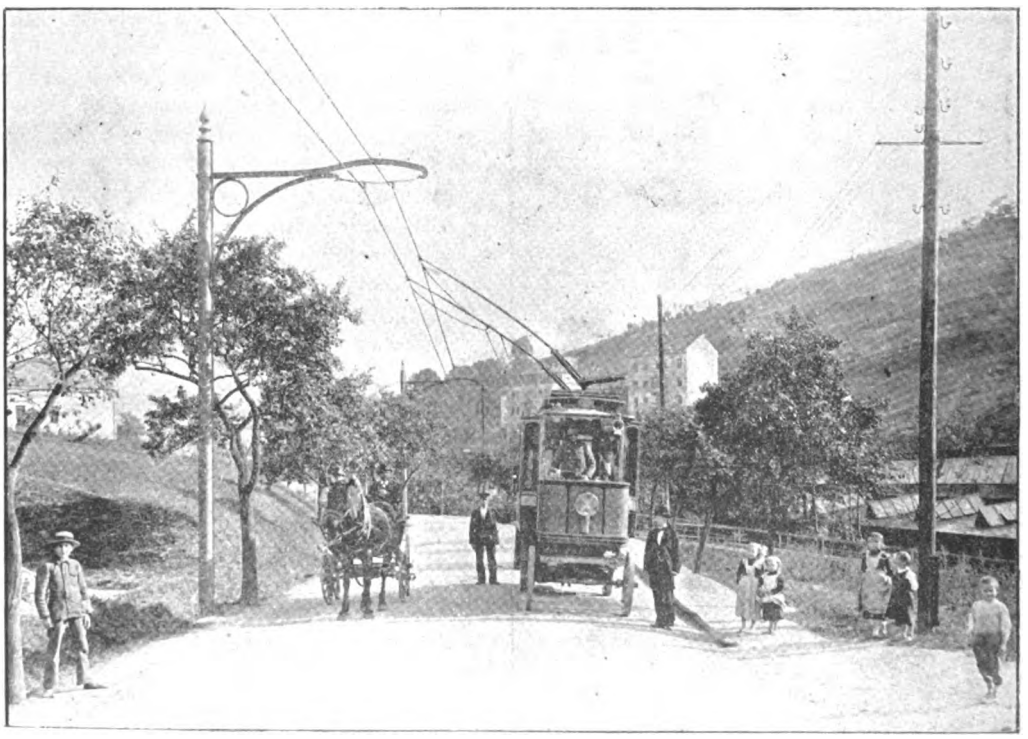

FIG. 2.

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from 20ft. to 26ft. wide only, it suffices to allow a play of 10ft. to either side of the contact wires, which are suspended above the centre of the roadway. It is shown in Figs. 2 and 3 to what extent the contact arms allow

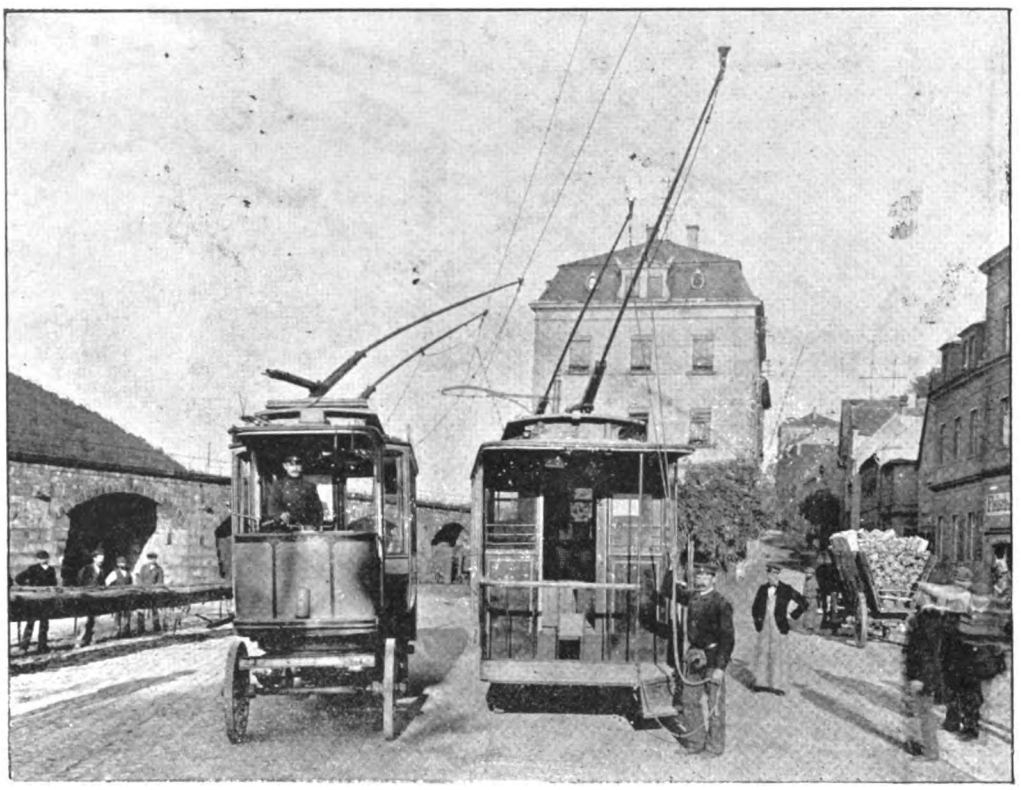

FIG. 3.

the cars to turn out. Experience has proved that the allowance made is amply sufficient to enable the cars to pass each other, or, in fact, any road vehicles. The absence of a fixed track, coupled with the flexibility of the cars, enables the rules applying for ordinary traffic to be preserved. Fig. 4 is a front view of a passenger

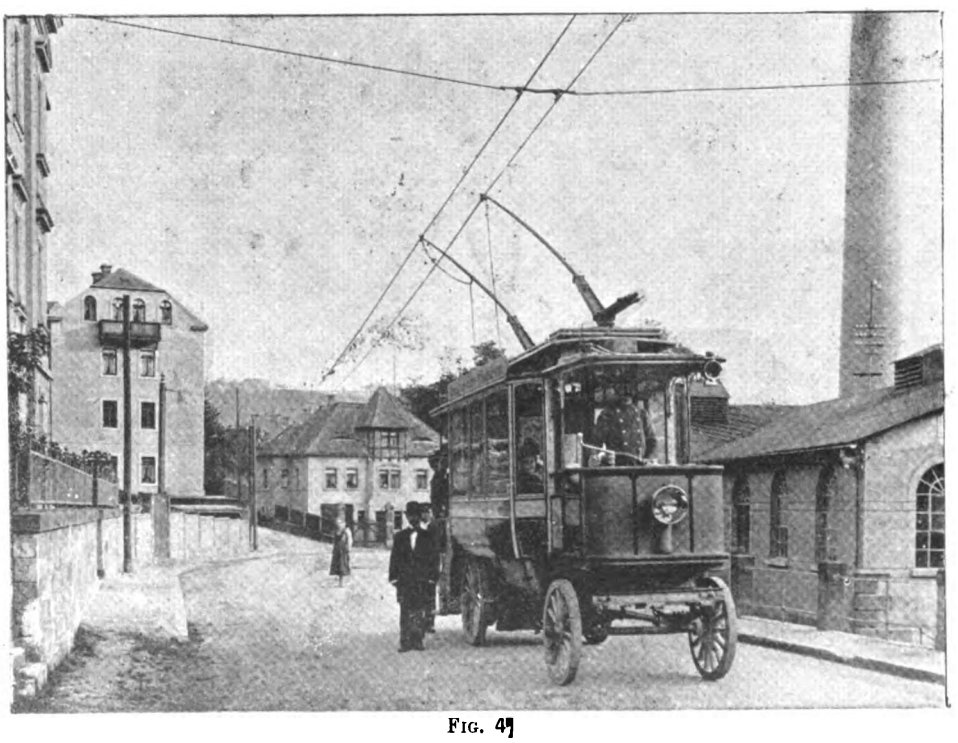

FIG. 4.

car, while Fig. 5 is a side view of the car, with a small goods trailer attached.

It is claimed that the system adapts itself very readily for the carriage of goods, since sidings to factories present no difficulties, all that is necessary to establish the same being a double-pole contact wire branched from the nearest supporting mast. The speed maintained on the Biela Valley route averages 7½ miles per hour for the passenger service and from 5 to 6¼ miles for the goods traffic. When two cars travelling in opposite directions meet, the contact arms of one are swung away from the contact wires to allow the other car to pass (as shown in Fig. 3). The turning of a car at the end of its journey is shown in Fig. 6. In designing the system first attention had to be given to the provision of a suitable contact. Eventually, a modification of the Dickinson type of trolley was adopted, having a rubbing shoe made to turn about a horizontal and vertical axis. The long contact shoe is lined with a soft metal, so as to prevent undue wear of the contact wire, provision being also made for lubricating the contact. A new type of car, similar in general design to a tramcar, is proposed, whereby the necessity of turning round at the end of each journey will be avoided. Great care seems to have been bestowed by Messrs.

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Siemens and Halske on the design of the cars. The controlling apparatus is placed in front, the different speeds being obtained by placing the motors in series or parallel as the case may be. A combination of coach and spiral springs between the car body and running axles was found to be the best suited to the conditions of the service.

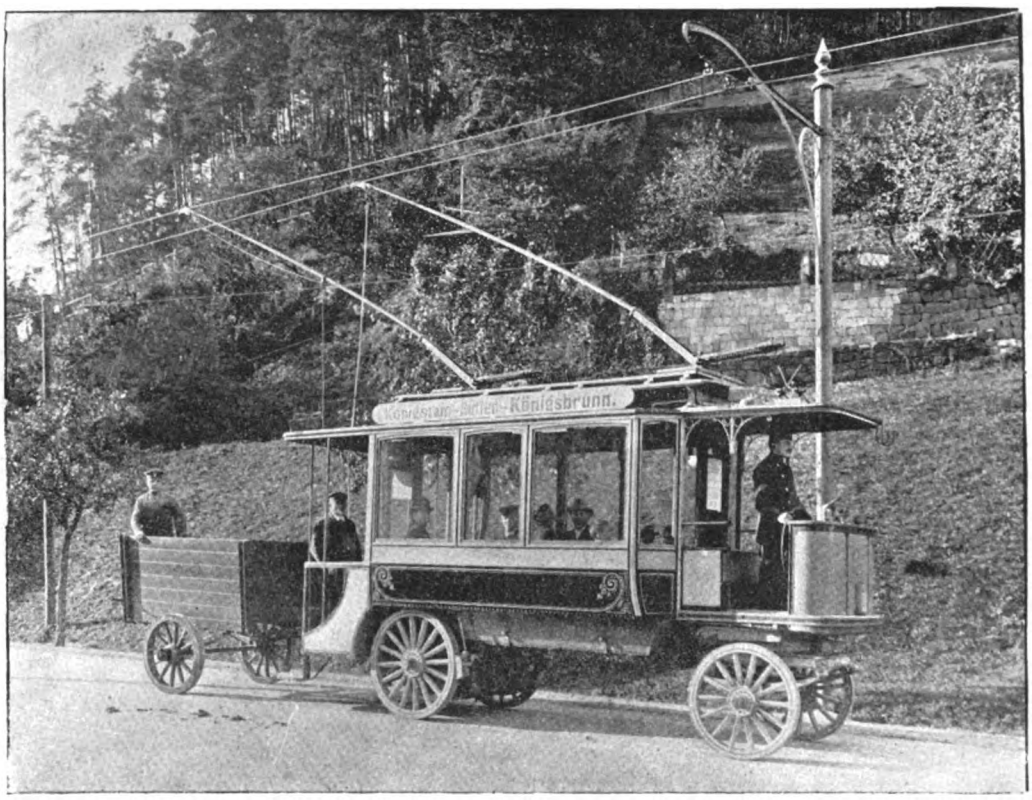

FIG. 5.

The Biela Valley route has an average ascent of 25 in 1,000. It has also many curves, but, on the other hand, the road surface is excellent. The additional tractive force required to overcome the ascent amounts to 55lb. per ton, while the internal resistance of the car, including the resistance of the track, has been found to vary between 55lb. and 66lb. per ton, according to the state of the road, so that scarcely any power is required for the down journey. A tramway would require for the ascent on the straight an average tractive force of 26·5lb. + 55lb. = 81·5lb., while here 55lb. + 55lb. = 110lb. is necessary. For the down journey, however, the first would require a brake power on the straight of 55lb. – 26·5lb. = 28·5lb., whereas the road motor-car requires no braking. The specific consumption of current, based on three months' working, amounts on the Biela Valley route to an average which is only double that for a railway. It is claimed that the cost of the extra energy required represents in this case but the tenth part of the interest on the sum which would have to be expended in making a permanent way. The argument in favour of the new system only holds when the traffic is light. For heavy traffic the railway would naturally be more serviceable. The writer further maintains that the installation of the system described would in many cases provide an additional day load for conveniently situated electricity supply stations, which it would pay these stations to have even if the supply had to be given through stationary batteries of accumulators.

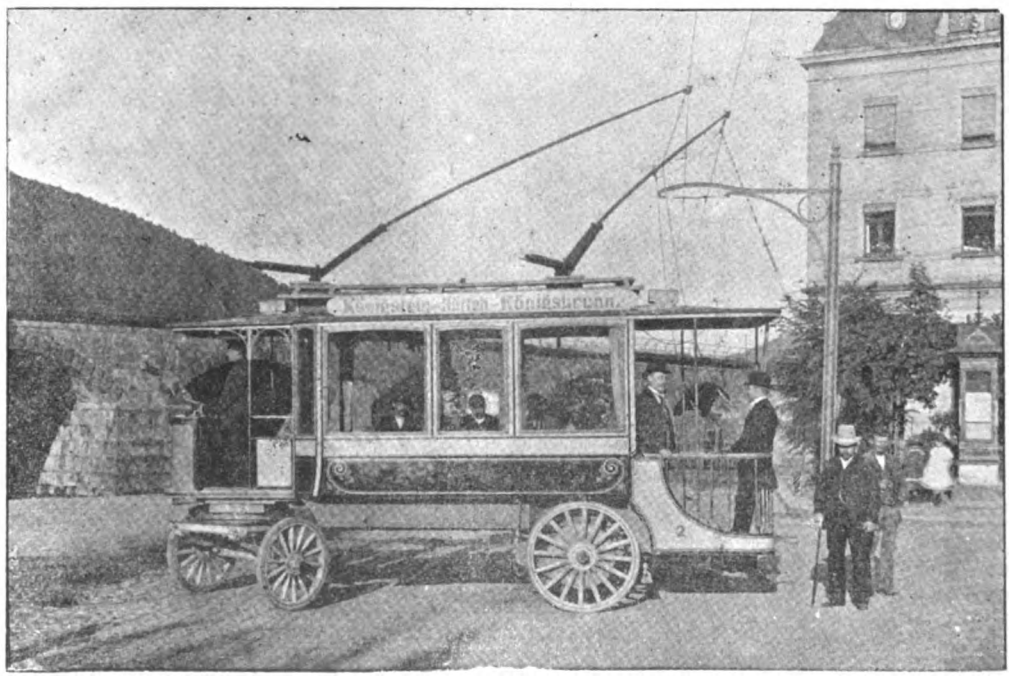

FIG. 6.

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SHALLOW UNDERGROUND TRAMWAYS.

The following is a brief abstract of the valuable joint report by the tramway manager and the electrical engineer of the London County Council on the construction and working of the Boston subway and on the rapid transit subway now under construction in New York. We also give abstracts from the addendum to this report by Mr. J. Allen Baker, the vice-chairman of the Highways Committee. The first two gentlemen went to America in August last with Mr. Baker in consequence of a minute of the Council passed on July 23 authorising them to obtain the fullest information possible with regard to the system of shallow underground tramways, and also as to the latest developments in the application of electrical and other forms of mechanical power for tramway traction.

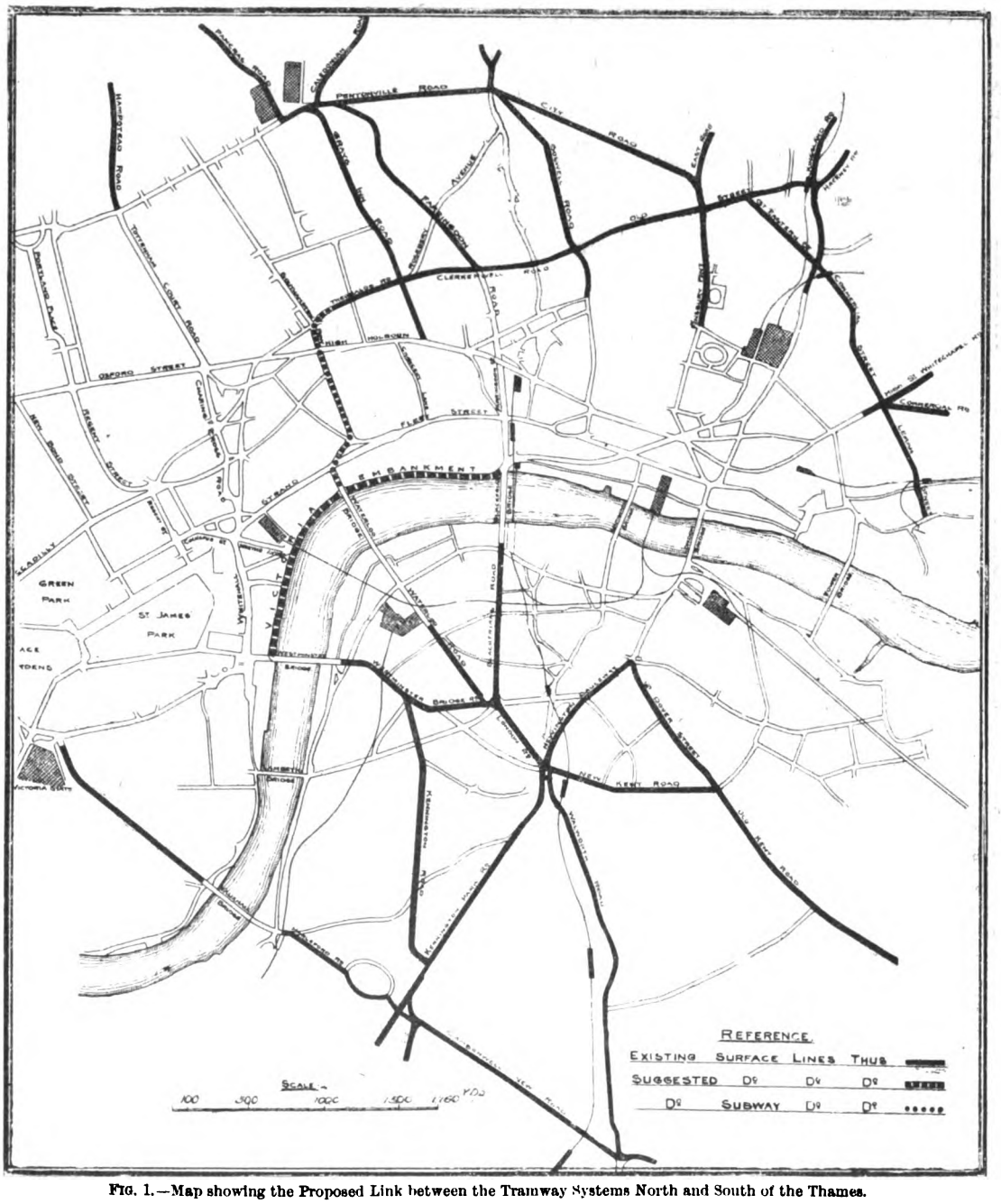

FIG. 1.—Map showing the Proposed Link between the Tramway Systems North and South of the Thames.

In the report before us, the first subject—*i.e.*, of shallow underground tramways—alone is dealt with. From it we gather that the Boston subways are the outcome of the considerations of the Transportation Commissioners appointed in 1891 to consider the best way to relieve the congested state of certain streets. Thus Tremont-street was at certain periods of the day filled with tramcars moving in almost unbroken procession with a slowness which was vexatious. The rate of progression was often not more than two miles per hour. Before deciding on a shallow tunnel the Commissioners came to Europe and inspected, amongst other systems, that of the City and South London Railway Company. The final conclusions of the Commissioners, however, were in favour of shallow tunnels, which communicate at points with elevated and street railways. These tunnels have now been constructed, and have an equivalent length of five miles of single tracks. The number of tracks actually contained in the subways is in most cases two, and in some cases four. The actual cost of the work was £850,000, and it took 3 years and 4½ months to complete. During its construction the streets under which it passed were always open for traffic from 8 a.m. to 6 p.m. Excepting small portions, where tunnelling was resorted to, all the excavation in the city streets was done by "cut and cover" methods. The details of the methods employed varied in different parts of the work, but throughout were such that the car tracks were not disturbed, and the surface of the street was left free for its normal traffic during the daytime. The work of construction was carried out both by day and night, and also generally on Sundays. The nature of the excavated soil varied considerably in different parts of the work. Near the surface "filling" was generally encountered, while lower down gravel and sand were met with at some points and clay at others. The methods adopted for building the subway were of three distinct types. In the first, the side walls and the arch are of masonry,

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a single wide arch covering the whole subway. In the second, there are two distinct tunnels side by side, each built of masonry. In the third, upright steel columns for the side walls and transverse steel girders for the roof are used, with masonry and concrete around and between them. The two former methods are practically identical with an ordinary railway tunnel. The latter method is being adopted almost entirely in the New York subway. The open inclines leading to the surface roads have granite walls, and are protected by railings. The one at the Public Gardens is particularly neat and unobtrusive. The standard height of the roof is 14ft. clear above the surface of the rails, and the roof is generally about 3ft. below the street surface. In some places, however, the subway is considerably lower than this. The authors then allude to the ease with which the public can get to the trams in this subway, as they have only to pass down a well-lighted staircase having from 25 to 30 steps. Island platforms are provided at the stations. As both the ordinary trolley cars and the cars of the elevated railway have to pass through the subway, a third-rail conductor, as well as a wire overhead, are provided. Owing to the limited height, only single-deck cars can get through.

being constantly changed. There was no sense of stuffiness, and although the day was hot the temperature inside the subway was pleasantly cool. At the same time, the difference in the temperature was not so great as to be likely to cause chill or discomfort by the sudden change.

In one of the reports of the Commission above referred to the following statistics as to people carried are given, which shows that the number of passengers using the Park-street Station of this subway are just about as many as use our Broad-street Station in London:

Station.	Passengers per annum.
Grand Central, New York	14,000,000
South Union, Boston	21,000,000
North Union, Boston	23,108,000
Broad-street, London	27,000,000
Park-street, Boston Subway	27,400,000
Waterloo, London	28,659,000
St. Lazare, Paris	43,062,000
Liverpool-street, London	44,377,000

The report of the London County Council experts goes on to say that the number of cars running in each direction in the Boston subways is about 250 per hour, or about 4,000 in each direction per day of 16 hours. On the Central London Railway there are only 350 trains per day

FIG. 2.—View of the Surface Work for the New York Rapid-Transit Subway, taken near the City Hall.

This subway was built at the expense of the Boston ratepayers, but the Boston Railway Company, which owns both the tramway and elevated railway lines, lease the subways from the city. The lease is for 20 years, and the company have to pay 2½d. for every car going through, or a minimum yearly sum equal to 4⅞ per cent. on the cost of construction. The railway company laid the tracks in the subway, and has to bear the cost of all repairs except those made necessary by act of God, mob riots, or the falling and settling of buildings. There is no provision for pipes to be carried in the subway. The report adds that the subway is well lighted by incandescent lamps, besides which a considerable amount of natural light is obtained. This was especially noticeable at the stations. The authors were also impressed by the comparative quietness of the subway, both as regards the traffic inside and the noise which might have been expected from vehicles passing overhead. When in the streets, also, no noise whatever was apparent from the subway, although cars were continually passing close under one's feet. The authors were particularly struck with the brightness and airiness of the subway. The air was extremely good and fresh, and gave the impression of

in each direction. These, of course, are trains consisting of about five carriages, but even allowing for this, the traffic in the Boston subway is considerably greater than in the "twopenny tube." They express the opinion that single cars at frequent intervals give less trouble from crowding at the stations than trains.

In New York the system of subways is actually in course of construction, and we are able to produce at the end of this article some interesting photographs of the construction work. The authors of the report point out that, owing to the geographical position of this city, it can only extend in two directions, which makes the transportation problems considerably more simple as far as interconnections are concerned. It means, however, much more density of traffic in those directions. The Rapid Transit Commission of New York also favoured the construction of shallow subways rather than deep tunnels. The arrangement under which these are being constructed is that the city pays the contractor the amount of his bid for construction, while he in turn is to pay as rental the interest on the bonds issued by the city to provide the required funds, and in addition 1 per cent. as sinking fund. The contractor provides equipment, power-

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houses, and generating machinery, which the city is to purchase at the conclusion of the lease at a valuation to be determined then by arbitration. Under this arrangement the city obtains the benefit of immediate construction of a rapid transit railway, and without burden on the rate-payers, because the contractor is to pay the interest on the investment. A map is given of New York showing the position of these subways. No less than four tracks are provided on the most busy parts of the line, and two of these will be reserved for express cars. On the express service the stations will be 1½ miles apart, and the average speed 30 miles an hour, and on the outer track a speed of 14 miles per hour is expected, with four stops per mile. This will necessitate two types of stations, one with platforms on the outside of the outer tracks, at which the local trains only will stop, the express trains running through the centre tracks, and the other with outer platforms for the local trains only, and island platforms for either express or local trains. At these latter stations the subway is depressed sufficiently to allow of a bridge under the roadway over the four tracks, with stairways leading to the various platforms.

FIG. 3.—Excavation showing how the Conduit Tramways are Supported while the Subway is being Constructed.

Instead of the arched roof and massive masonry side walls, a rectangular iron construction, such as is shown in Fig. 6, is used. The contract price for the construction of this New York subway is £7,000,000. Its entire length is 21 miles, which makes it cost £333,000 per mile. These figures do not include the cost of the rolling-stock, or of the power-houses. This report by Mr. Alfred Baker (the tramway manager) and Mr. John F. Rider (the electrical engineer) terminates with the following conclusions:

"Having explained, necessarily very roughly, the general lines of the Boston subway and the one under construction in New York, the committee will naturally wish to have an expression of opinion as to the practicability of such subways being constructed in London, and, if constructed, of the advantages likely to accrue, and how far these structures would assist in solving the great problem of rapid transit.

"From the foregoing it will be seen that the subway in Boston answers the purpose solely of relieving the street traffic in a congested area by taking the surface cars underground where traffic is great, the cars coming to the surface again where the traffic is less dense. The subway in New York is to be entirely self-contained, quite apart from the surface cars, in the same way as the Central London Rai way, with the important difference that it provides for express as well as local traffic.

"It appears to us that the problem in London will never be satisfactorily solved until the tramways north and south of the River Thames are linked together. London has suffered much from want of intercommunication on account of its tramway system being completely divided by the river. Attempts have been made from time to time to induce Parliament to allow tramways to cross the river by means of Westminster Bridge, but without success. This, however, may be accounted for by reason of most of the proposals being for horse traction. The City Corporation, as well as the West-end authorities, have also steadily resisted any attempt to introduce tramways within their areas. The physical difficulties of making adequate connection between the north and south tramways by means of surface lines are almost insuperable, involving street widenings through some of the most valuable business property in the world.

"It appears to us that by the construction of shallow underground subways in London, two important objects would be gained—viz.: (1) a method of linking up existing tramways by taking surface cars underground through congested and, what might be termed, prohibited areas; (2) a provision for pipes, cables, wires, etc., which would obviate the continual breaking up of the streets.

"With regard to (1), the Council, after much anxious thought and attention, is about to commence the reconstruction for electric traction of the whole of the existing lines in South London, and the Highways Committee is considering the possibility of the electrification of the northern lines. When this work is carried out, enormous advantage will accrue to London. Still, the difficulty will remain of the want of intercommunication between north and south. We think the solution of this question would be largely assisted by the construction of subways in congested districts and through prohibited areas, as has been successfully done in Boston.

"With regard to (2), the committee is so well acquainted with the great inconvenience and annoyance that has been caused for years by the constant breaking-up of the streets by gas, water, electric lighting, and other companies for the purpose of laying mains, etc., that there is no need for us to dwell upon the matter. Many proposals have from time to time been made with a view of obviating the nuisance. In some cases where the Council has constructed new streets

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subways for the purpose of accommodating pipes, etc., have already been made. This, however, only touches the fringe of the problem, and any suggestion to make subways under existing principal thoroughfares solely for this purpose would doubtless be vetoed on account of the cost. By constructing subways which could be used for passenger transit purposes, as well as for taking pipes, etc., a considerable revenue would be earned, sufficient, in our opinion, to warrant the heavy outlay.

"Apart from these purposes, we believe that shallow subways, such as we saw in Boston and in New York, are, in many respects, preferable to deep-level railways. The absence of elevators, and the ready access from the street to the stations and *vice versâ*, by means of short stairways, render them particularly useful to those who wish only to ride short distances. The deep-level railways are not so well adapted for this kind of travel; indeed, it is hardly to be conceived that anyone wishing to save time would take the trouble to go down in an elevator 60ft. or 70ft. below the street, ride, say, 300 or 400 yards, then take another elevator in order to reach the street again.

"Then there is the question of vibration. We made very careful enquiries regarding this matter, but could not find there had been a single complaint of vibration. Our own observations certainly supported this.

"The ideal form of transit, in our opinion, is the one proposed in New York—viz., a subway, easy of access from the street, catering for express and local traffic. Of course, New York, where the avenues are wide and perfectly straight, is peculiarly adapted for a scheme of this kind, as it will be quite possible throughout a considerable length of the route to construct the four tracks without even tunnelling under the side walks. In London the difficulties would be infinitely greater on account of the narrowness of the streets. The fact that vaults and cellars in some cases extend right under the carriageways would necessarily add considerably to the cost, as many of them are used for business purposes.

"However, if it be not possible to reach the ideal, we believe that the condition of things can be vastly improved by a system of subways, which would have regard to the needs of London as a whole rather than by the construction of a subway to meet the requirements of any particular district. In our opinion the true solution of the question does not lie in the building of deep-level railways, or, for that matter, subways, as separate schemes entirely disconnected from each other, but rather in a complete system which should be carefully conceived, and carried out from the first with a view of intercommunication between all parts of the Metropolis. Unfortunately, however, the deep-level railways already authorised, as separate schemes, render it extremely difficult, if not impossible, to devise a complete system such as London needs.

"We have already presented to the committee a map showing a number of routes which are, in our opinion, suitable for shallow subways, both for the purpose of linking up the Council's existing tramways and also for providing communication in other districts. The time at our disposal, however, rendered it impossible to make full enquiry into the engineering features of what we should consider to be a fairly comprehensive and adequate scheme, and we, therefore, do not think it advisable to mention the routes in this report. There is, however, one definite proposal which we venture to submit as being quite practicable, and, at the same time, highly desirable.

FIG. 4.—View of Narrow Cutting on one side of Park Row, out of which all the Spoil from the Subway is Removed by Buckets travelling on the Rope seen above.

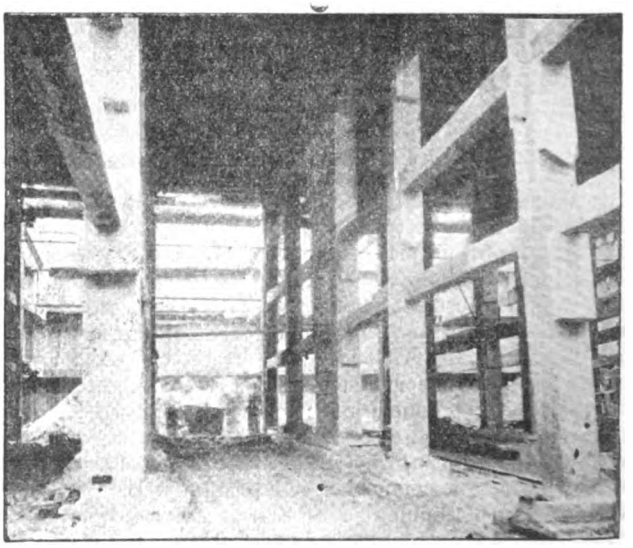

FIG. 5.—View of Timbering under Road Surface.

It is that a subway should be constructed from the level of the Victoria-embankment, at a point close to Waterloo Bridge, under Wellington-street, across the Strand, and under the new street now being made by the Council from the Strand to Holborn. Passing under Holborn to Southampton-row, it would connect by an incline to the surface lines in Theobald's-road. The Council has already decided to apply to Parliament for powers to construct a surface

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tramway along the Victoria-embankment, and if the application be successful a connection between the tramway and the subway could be effected at Waterloo Bridge, where the physical formation of the ground would enable it to be made without any gradient.

"If this proposal were carried into effect, communication would be obtained from both Westminster and Blackfriars Bridges to the greater portion of the northern tramway system. Short connecting lines over the two bridges would only then be required to link up the southern system. The accompanying map (Fig. 1) of a portion of the London tramways shows plainly the proposal indicated above.

"Probably the most important factor to be considered in deciding upon any system of subways is that of cost. We have taken a great deal of trouble to arrive at a satisfactory basis on which to estimate, and while the cost of subway construction in London is not necessarily the same as in America, still we think that the figures obtained in Boston and New York will be a valuable guide. Both in Boston and in New York the subways are constructed partly for four tracks and partly for two tracks. The cost of a four-track subway is, of course, not nearly double the cost of a two-track, although the amount of actual excavation may be very nearly twice as much. We have assumed that a four-track subway will cost about one-third more than a two-track subway, and on this basis the Boston subway works out at about £425,000 per mile for a two-track subway. In New York the matter is rather more complicated, since about five miles of the extreme ends of the lines will be an elevated structure, and not a subway, as was mentioned earlier in this report. After making due allowance for this, the cost in New York works out at about £350,000 per mile for a two-track subway.

"We think this latter figure may be taken as a rough guide for a large proportion of the proposed subway work in London. While in London the difficulties with cellars and pipes will doubtless be much greater than in New York, yet labour there is much more expensive than in this country, and the great quantity of rock which had to be removed must have added considerably to the cost. We also had it on the best authority that the contractor for the New York subway had had offers of sub-letting at a figure considerably under the contract price, thus showing that the real cost was under rather than over the figure we have given.

"Taking the New York figures, therefore, as a basis, and assuming that the type of construction adopted in London would be similar to that in New York, which we should strongly recommend, the cost of the scheme we have suggested works out at about £282,000. This figure, however, does not include any sum for the purchase of vaults, cellars, or any other vested interests, or for the addition of pipe galleries to the subway or for the transfer of pipes to them."

The addendum to this report by Mr. J. Allen Baker briefly gives the history of the proposals for the construction of such subways in London. In the following list Mr. Baker gives the tabulated advantages he sees in favour of the shallow tramway, as compared with the deep tube construction. These are:

"1. The shallow construction may be used as a subway for water, gas, electric, etc., mains, as well as a tramway, thus affording a double advantage and yielding a double revenue.

"2. When the pipe services have been removed into their subways, the great annoyance and disadvantage now experience by the tearing-up of the streets by the companies would be over, as no work would require to be done on such streets, except repaving or repairing of the pavement.

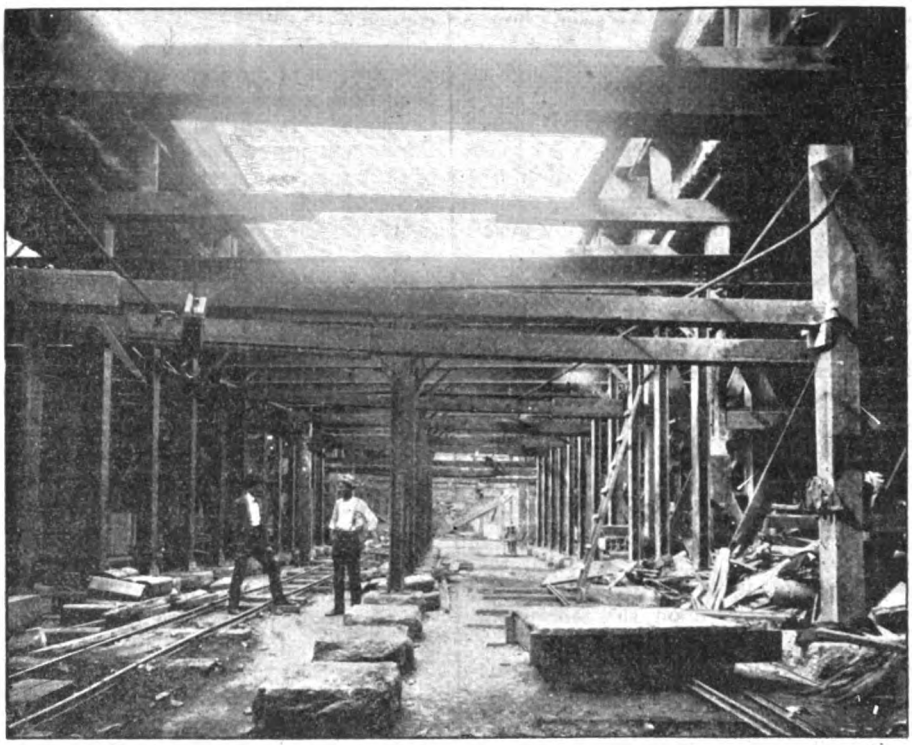

FIG. 6.—View of the Standard Steelwork for the New York Subways.

"3. This double service would not only enable the municipal authorities to deal with the pipes and mains without loss to the ratepayers (which would be impossible otherwise), but should prove to be financially profitable.

"4. The shallow tramway should be less costly for construction than the deep tube, and as it would run so near the surface, and be provided with more frequent stations, is not only better ventilated and better lighted, but being more accessible to the public would receive greater patronage, especially by short distance riders.

"5. The shallow tramway following the routes of the streets would avoid running under any private property, thus preventing the possibility of objection being raised on account of vibration (and which would also be entirely prevented by its special construction).

"6. The service would be much more frequent than in the deep tube, thus avoiding any waiting for trains, and as the shallow tramway would be approached by steps from the street (which would be 12ft. or 14ft. above the tramway platforms), the time taken to descend by the elevators to the deep tube would be saved, and also the expense of operating the elevators, which is an important item of working cost.

"7. As these underground tramways have proved to be a great financial success and a public benefit in reducing

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congested street traffic in such cities as Boston, Paris, and Budapest, it may be safely assumed that a like result would be experienced in London, where the population and the need are so much greater.

"8. The provision of these subways in connection with the Council's surface lines would greatly enhance the value and increase the earning power of the Council's tramway system in London, and the providing of a complete system of intercommunication would be of the greatest value in solving the housing problem."

The only advantage which Mr. Baker sees in the tube system is that the streets are not so much disturbed during its construction. In order to cope not only with the present congestion, it is suggested that the additional powers should be obtained from Parliament to construct such subways and to charge rent to users of the same for pipes, etc. In view of the many schemes for deep tube railways to be brought before Parliament next session, Mr. Baker suggests that the necessary powers should be sought during the session in question.

This concludes our abstract of report and addendum, which we should like to have given in full. There only remains to say a few words respecting the illustrations given herewith of the constructional work on the New York tramways. Thus, Fig. 2 is a view of the loop near the city hall, in which open cuttings can be seen. Fig. 3 is another view from below of a cutting, which shows how the conduit tramways are still kept running, although all the soil beneath them has been removed. In Figs. 4 and 5 we illustrate the method adopted when the street cannot be closed to traffic. In these a fairly wide trench is opened down the one side of the street, down to the depth of the bottom of the subway. The engineers then proceed to excavate under the street, supporting the same by means of wooden trestles, as shown in Fig. 5. All the spoil is removed from the open trench by means of buckets worked from a longitudinal wire. In Fig. 6 we show the standard steelwork used in these subways.

CONTRACTS BETWEEN LOCAL AUTHORITIES AND THEIR MEMBERS.

A question has been put to us as to the position of a member of a district council who takes a contract with the council. We are asked whether such conduct is legal, and whether the contract is binding upon the parties, and our querist makes further observations upon the morality of the proceedings.

The points here raised are of very general and widespread interest. To persons who are concerned in contracts it is all important to know within what limits they may avail themselves of the good offices of members of any local authority, and it is equally important for councillors to be fully aware of their position, so that they may not subject themselves to penalties by improper conduct while they are members of the council. The recent disclosures at Manchester and the enquiry at Leeds have served to resuscitate the old bogey of municipal corruption, and many of the provincial papers have taken up the line of attack upon the purity of councillors.

No doubt there are cases of dishonesty which occur in every walk of life, but any person who has had the smallest practical experience of public life knows perfectly well that the standard of public life in this country is higher than in any other country, and the integrity of our councillors, whether they belong to urban districts or rural districts, whether they are members of borough councils or boards of guardians or county councils, is free from all suspicion. Men who give up a great deal of their private time, which could be profitably employed in their own business, all for the sake of the public good, and who devote the best of their energies, for no pay whatever and no thanks, to the public service deserve far more recognition than they usually receive. For those cases where the public position of a councillor and his private interest may conflict, the law has made ample provision in the Local Government Act, 1894, Section 46, which runs as follows: "A person shall be disqualified for being elected or being a member or chairman of a council of a parish or of a district (other than a borough) or of a board of guardians if he holds any paid office under the parish council, or district council, or board of guardians, as the case may be; or is concerned in any bargain or contract entered into with the council or board, or participates in the profit of any such bargain or contract, or of any work done under the authority of the council or board; provided that a person shall not be disqualified for being elected or being a member or chairman of any such council or board by reason of being interested in the sale or lease of any lands or in any loan of money to the council or board, or in any contract with the council for the supply from land, of which he is the owner or occupier, of stone, gravel, or other materials for making or repairing highways or bridges, or in the transport of materials for the repair of roads or bridges in his own immediate neighbourhood; or in any newspaper in which any advertisement relating to the affairs of the council or board is inserted; or in any contract with the council or board as a shareholder in any joint-stock company; but he shall not vote at any meeting of the council or board on any question in which such company are interested, except in the case of a water company or other company established for the carrying on of works of a like public nature. This prohibition may be dispensed with by the county council."

The foregoing provisions deal, it will be observed, with the position of an urban district councillor, a rural district councillor, a member of a board of guardians, and a parish councillor. It will be seen that the terms of the Act of Parliament are very wide, and nearly every possible case of contract must come within the meaning of the section, and cause a disqualification.

With reference to county councillors, they are under the same disqualification as members of a borough council. All members of municipal corporations are governed by a different law to the newly-created district councils. In order to ascertain what are the disqualifications attaching to a county councillor or a borough councillor, reference must be made to the Municipal Corporations' Act, 1882, Section 12, which is in the following terms: "A person shall be disqualified for being elected and for being a councillor if and while he is an elective auditor or a revising assessor; or holds any office or place of profit, other than that of mayor or sheriff, in the gift or disposal of the council; or has directly or indirectly, by himself or his partner, any share or interest in any contract or employment with, by, or on behalf of the council.

"But a person shall not be disqualified, or be deemed to have any share or interest in such contract or employment, by reason only of his having any share or interest in any lease, sale, or purchase of land, or any agreement for the same; or any agreement for the loan of money, or any security for the payment of money only; or any newspaper in which any advertisement relating to the affairs of the borough or council is inserted; or any company which contracts with the council for lighting or supplying with water or insuring against fire any part of the borough; or any railway company, or any company incorporated by Act of Parliament or Royal charter, or under the Companies' Act, 1862."

A careful comparison of these two different statutory enactments will show the reader that there is a considerable difference between them, so that the position of a district councillor is by no means the same as that of a borough councillor. It will be interesting to first point out the disqualifications which are common to councillors of all kinds, and then to deal with the peculiarities affecting particular councillors.

It is obvious that an officer of any council or board of guardians is not entitled to be a member of the authority which employs him. This will extend to the case of a doctor who takes fees for visiting patients in hospital, such fees being paid out of the funds of the local authority; he must either resign his position as hospital doctor or his seat on the council. It is clear, therefore, that anybody who directly makes any profit out of the council is, during the time for which he makes such profit, disqualified from being a member of the council.

Passing on to deal with a more general question of

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contracts, it must be specially observed that, although the member of the local authority is disqualified, the contract remains valid. In other words, the disqualification attaches to the individual, and not to the contract or bargain, so there is nothing to prevent a councillor voting upon the making of any contract in which he may be interested; but directly the contract is made, then he loses his seat on the council. This distinction must be carefully noted—namely, that a councillor may vote upon any matter relating to the making of a contract before the contract is actually made, because no disqualification arises until there is in effect a binding contract, so that even upon the resolution of the council which adopts the contract in question the councillor is entitled to vote, and his vote is a good and legal one, but immediately afterwards he becomes disqualified and cannot, subject to certain exceptions to be hereafter noticed, take any further part in the proceedings of the council without incurring severe penalties. If he does take any further part, his votes are null and void.

Let us now state the general exceptions to the rule which disqualifies a councillor from continuing as a councillor while he is interested in a contract.

First, a councillor may be interested in any sale or lease of lands, therefore he might let stables to his council or other property for their purposes. Further, if he is a member of any district council (urban or rural) or any parish council or board of guardians, he may contract for the transporting of any materials for the repair of highways or bridges in his own neighbourhood. This is a kind of work known under the Highway Acts as "team labour," and this exception was no doubt introduced to protect the rights which always existed under the law for the members of a parish to do "team labour," and to be paid for it out of the highway rate. This exception does not avail a county councillor or a member of a borough council.

Then any councillor or guardian, with the solitary exception of a member of a borough council, is entitled to contract for the supply of stone, gravel, and other materials for making and repairing highways or bridges, from any land of which he is the owner or occupier, but with the limited exception in the case of a county councillor (under the Highway and Bridges Act, 1891, Section 5) that his share or interest in the contract must not exceed £50 in any one year.

Agreements for a contract for a loan of money are also exempt from the rule of disqualification.

All advertisements in newspapers which are inserted by the local authority have no effect to disqualify any member of the authority who may be interested in the profits of the particular newspaper. It is well known that some newspapers have existed for a brief time it may be, but certainly in great measure solely from the contributions they received from the advertisements from local authorities, whose favours were entirely due to the interest certain members of the local authority had in these newspapers.

Then we come to a very important exception. Any water company, or lighting company, or insurance company, or any incorporated company under the Companies' Acts, may contract with the council, and although a member of the council is a shareholder in such company, he is not thereby disqualified. A county councillor or a member of a borough council may not only be a shareholder, but may have any interest either pecuniary or otherwise in the company which contracts with the council. He may even be a director drawing large fees from the profits which the company makes out of the particular contract, or he may be a secretary of any such company.

With regard, however, to a member of any other council or a board of guardians the rule is much more strict in dealing with companies; the only exemption in favour of the councillor is when he is a shareholder. If he derives any benefit beyond the ordinary benefits of a shareholder, whether as a secretary or as a director who makes fees out of profits, then he certainly is disqualified. It is open to argument whether a director who merely gets paid a fixed salary which has no relation to the profits of the company would not be entitled to continue as a councillor, and would not be thereby disqualified.

It is of the highest importance to remember this exception with reference to companies, because the one-man company business is a recognised form of trade, and there is nothing to prevent a commercial man turning himself into a company in which his wife and children and near relatives and friends have a nominal interest, then as a shareholder only in such company he makes contracts with the local authority of which he is a member. There does not appear to be anything in the law to prevent such a thing happening.

There is, of course, this proviso, that once a contract is made such councillor is not entitled to vote on any question in which the company is interested, and this is a continuous disqualification. In certain cases this disqualification may be removed by the county council—namely, in the case of a shareholder in any water company or other company which exists for similar public purposes, such shareholder being a member of a rural or urban district council, or a parish council, or a board of guardians.

These are, then, the leading exceptions to the general rule which prevents a person remaining a member of a local authority when he is interested in any contract made by that local authority.

With regard to borough councils and county councils, a member must not have any share or interest, directly or indirectly, either by himself or his partner in any contract with the council. When the interest ends, so does this disqualification. On the other hand, if the contract has been performed before the interested person has been nominated as a councillor, although the money will be paid afterwards, yet there is no disqualification, because the interest is merely a debt due in respect of something done and finished with. In another case, a contract by a council to make up a new street for the benefit of a member of the council will disqualify such member, but, on the other hand, the mere fact that a councillor claims compensation from his council for property which they have taken under their statutory powers does not disqualify him. He is an individual who has a statutory right given him to be compensated for any property which may be taken from him by any local authority, and although this may be done by his own local authority of which he is a member, he is not thereby disqualified.

The restriction against being in partnership with any person who even indirectly has any share or interest in any such contract must be carefully noted. It will be observed that this restriction does not apply to a member of a district council, urban or rural, or a member of a parish council or of a board of guardians. The rule with regard to these councillors is this: they are not entitled to participate in any profit from any contract or bargain, and, further, they may *not be concerned in any bargain or contract with the council.*

Therefore, an auctioneer might continue a member of a council although his partner was appointed a surveyor to value property on behalf of the council, providing that the payment or salary for such surveying is kept separate from the partnership receipts, and will always be received by such surveyor alone.

On the other hand, it is clear that the words "concerned in any bargain or contract" are of very wide import. These words do not presume profit to exist; they indicate any interest, however small, to be sufficient to disqualify a councillor. It may, therefore, be that a contract with the wife of such a councillor, or even with his daughter, would disqualify him from his seat. Suppose that the daughter of a councillor was appointed to collect rents, and was paid for her work by a percentage on the amount collected, she living with her father, then it would appear that he is disqualified from his office. These words are not found among the disqualifications of a borough councillor or a county councillor.

It is clear that any interest where it is real is sufficient to disqualify, so if the council makes a contract with A, and A sub-contracts for portions of the work, and one of the sub-contractors employs a member of the council to do part of his work for him, then such councillor becomes disqualified. The contract continues to be legal, and the disqualified councillor can legally continue to perform it, and he is entitled to be paid by the council for doing it.

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But he loses his office, and he is not legally entitled to be re-elected until his interest has ceased.

The interest must be a real one, so if a councillor is a trustee of a schoolroom where the parish council happens to meet, and they pay the trustee for the use of the room, since as trustee he makes no profit whatever out of the business, he is not thereby disqualified from being a member of the parish council. His interest as a trustee is not in any way personal—in fact, the law expressly forbids him as a trustee from making any profits or benefit whatever out of his trusteeship.

Under this general clause which prohibits a councillor from "being concerned" in any bargain or contract, it appears that any interest, other than that of a shareholder in a company, would be sufficient to disqualify a councillor. This naturally means any secretary or director, or other official of a company who gets any remuneration, whether a fixed annual sum or a salary varying with the rate of profits; such an interest is something more that of a mere shareholder, and is clearly "being concerned" in a contract with the council. The fact that a member of the council is an officer of some other body to whose funds the council may contribute, whether directly or indirectly, does not make him concerned in any contract or bargain with his own council; for instance, a collector of poor rates who is employed by a board of guardians may sit as a councillor on an urban district council, although the council pay an annual contribution to the board of guardians, because the councillor is not appointed as collector by his council, nor is he their officer in any way, nor is he concerned in any bargain made by his council, and the payment made by his council is a statutory liability and not a liability arising out of a mere contract.

We have now as shortly as possible gone over the leading points of disqualification which affect all members of local authorities who may be desirous of contracting with their own council.

It is obvious from a mere perusal of these provisions made by Parliament that the net is spread much wider than one would think; indeed, it would scarcely be stating the matter in too wide language if we were to sum up all that we have written on the subject by saying that with the main exception of a shareholder in a company, any interest in any contract with his council disqualifies a councillor, remembering always that the contract remains legal, and can be enforced by both sides.

Such a state of things rigorously administered would no doubt prevent much good work being done. Everyone can call to mind cases in rural districts, and it may be in other districts, where all the best men are on the council, and in any important class of work which the council may want done the only possible man to do the job has already been elected one of the council. In other words, to go outside the council would mean debarring the council from employing the only man who could do the work properly, and forcing them to hand over the business to some fourth-rate man of no experience and of no ability. This practical objection is very much more prevalent than the dwellers in cities may think. An enormous amount of sanitary work in rural districts can only be done by local men if it is to be done at all, if only from motives of economy, to say nothing of many other reasons. It may be pertinently observed that a member of a council has got more than a monetary interest in making a good job of any matter he has undertaken to do for his council. His personal reputation is at stake, the good appreciation and the good fellowship of his brother councillors is in jeopardy if he scamps the work he has undertaken to do for them. No doubt this argument would not prevail in large centres, where it is comparatively easy to procure good workmen, and where there is no personal interest taken in the proper application of the rates.

It seems to us, then, that the law at present existing is far too wide in generalisation to be of any real and effective value; it makes no distinction between the local interests of a parish of 400 or 500 people and a city of over a quarter of a million inhabitants. Obviously, such sweeping provisions cannot result in good all round. There must be, and there undoubtedly is, danger in their application. It remains with the public spirit and commonsense which is characteristic of most Englishmen only to enforce them at the right time. In the purity of municipal life and the integrity of our public men we have every confidence, but we are bound to deprecate the attitude of distrust which many persons appear of late to be evincing.

There must be give and take, live and let live, in all municipal and public life. It is idle to suppose that a man when he gets into a councillor's chair can get rid of all his personal feelings of friendship, and divest all prejudices, all sympathies, and antipathies when he takes off his coat and hat to go into the council-room. The idea is ridiculous. We do not want angels, but men of business to conduct our affairs, and so long as they are conducted in a businesslike way, and the work is well done, we see no reason why the interests of contractor and of councillor are not perfectly compatible with the public welfare.—*Contract Journal.*

THE INSTITUTION DINNER.

The annual dinner of the Institution of Electrical Engineers was held on Monday last at the Hotel Cecil, Mr. W. E. Langdon, the president, taking the chair. A large and distinguished number of guests and members attended, who included Sir F. Mowatt, Major-General C. E. Webber, Sir C. P. Ilbert, Sir J. D. Pender, Sir J. Crichton-Browne, General Sir R. Harrison, Admiral Sir W. J. L. Wharton, Sir D. Tennant, Mr. C. E. Spagnoletti, Sir P. Magnus, Colonel R. E. Crompton, Major-General W. Salmond, Prof. Silvanus P. Thompson, Mr. C. Hawkesley, Archdeacon Sinclair, Mr. Balfour-Browne, K.C., Mr. C. J. Owens, Mr. E. G. Mawbey, Major R. S. Erskine, Dr. C. Chree, Prof. J. Perry, Mr. J. Swinburne, Mr. J. W. Swan, Prof. J. M. Thomson, Mr. J. Gavey, Dr. R. T. Glazebrook, Mr. R. Kaye Gray, Mr. J. Staats Forbes, Dr. T. F. Thorpe, Mr. A. Siemens, Mr. S. Z. de Ferranti, Mr. C. P. Spinks, Colonel Holden, Mr. H. Hirst, Mr. R. Hammond, Mr. Mark Robinson, Dr. J. Larmor, etc.

After the usual loyal toast, Sir J. CRICHTON-BROWNE proposed "The Imperial Forces." In the course of a most able speech, he said that electricity should really be included amongst the Imperial forces in view of the great assistance it was to the British Empire. Again, speaking of the reorganisation of the army, he contended that only reorganisation of methods was required, as the material from which our army was composed had again proved its worth in South Africa.

Admiral Sir W. WHARTON, responding for "The Navy," referred to the importance at the present time of maintaining the paramountcy of our navy, and to the largely extended use to which electricity was put on all new vessels for the English fleets.

General Sir RICHARD HARRISON, replying for "The Army," referred, amongst other things, to the coast defences, which came under his charge. In these works, which the navy were supposed to render unnecessary, electrical engineers played a great part. No fewer than 150 lights had been established round the coast for harbour defences, and the Electrical Engineer Volunteers would in time of war assist in the working of these.

Colonel R. E. CROMPTON, replying for "The Auxiliary Forces," said that the Corps of Electrical Engineer Volunteers, which he had the honour to command, were now represented by 170 men in South Africa. They had also 100 more men ready to go out, which, with the detachment last dispatched, would bring the total number to about 300. He was pleased to say that they were the healthiest corps at the front, having lost the fewest number of men, which was due to the intelligence of the men forming the corps, and to the care of their officers. He claimed that these volunteers could show that the Institution of Electrical Engineers had been the means of raising a powerful weapon for the good of their country.

Prof. SILVANUS P. THOMPSON then proposed the toast of "Engineering and Science." He said that it was forgotten in the present rush after new schemes of electrical communications that to an Englishman, the late Mr. Greathead, we owed much as the pioneer of such undertakings. It was

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10 years since this pioneering expert constructed the first deep-level line in London.

Mr. C. HAWKESLEY, the president of the Institution of Civil Engineers, and Dr. R. T. GLAZEBROOK, the director of the National Physical Laboratory, responded. The latter speaker referred to the importance which pure science was to a nation.

Sir DAVID TENNANT, in giving the toast of the evening, "The Institution of Electrical Engineers," said the society had now been in existence 30 years, and had 4,000 members on its roll. The Institution had done wonders in its day and generation, and it was still capable of doing a great deal more. There was no science which so absorbed public attention as did theirs, and they looked forward with eagerness to the time when they would have problems solved which were trying the wisest of men.

The CHAIRMAN, acknowledging the toast, said that during the existence of the Institution he could claim for it that it had been closely associated by its members or by its work with all those great advances which had been made in electrical science during that period. The objects of the Institution were to promote the general advancement of electrical science and its applications, and those objects had never been lost sight of by those responsible for carrying out the work of the Institution. Within the last two years local sections of the Institution had been established at Glasgow, Newcastle, Manchester, Birmingham, and Dublin. With a view to the further extension of the influence of the Institution, similar sections had been established in Calcutta and the Cape of Good Hope. All these sub-sections were based upon lines similar to those of the London Institution, and were subscribers to it. The Institution was also represented in almost every country of the world by its local hon. secretaries. Among the 4,000 names on the roll of the Institution were those of 600 students. He expressed the hope that some day the Institution might find a home of its own.

The toast of "Our Guests" concluded the list.

INSTITUTION OF JUNIOR ENGINEERS.

There was a crowded attendance at the meeting of this institution on Dec. 6 held at the Westminster Palace Hotel, the chairman (Mr. Percival Marshall) presiding, the paper read being on "Street Railway Construction for Electric Traction," by Mr. F. S. Pilling (member), of Devonport.

In introducing the subject, the author pointed out how necessary it was in laying-out a tramway scheme to keep well in mind the object of such an undertaking—viz., to attract the largest possible number of passengers. Unless the engineer were familiar with the *working* of the system from the traffic manager's point of view, there would ultimately be failure somewhere, preventing the lines from being worked at their full earning capacity. Reference was made to the arrangement of termini as affecting the car mileage, and to the mistake often committed of constructing double junctions between main and branch lines with no provision on the main line at the junction for transferring a car from one line to the other, with the result that when the cars were being distributed in the morning and returning in the evening, they frequently have a profitless run of perhaps 300 or 400 yards to the nearest cross-over in order to be transferred to the right line outwards or inwards.

The objections to constant radius curves were dwelt upon, and the writer showed that the application of railway practice to permanent-way construction for tramways on a public highways was a mistake. In considering the construction of the track, the difficulty was to make and maintain it in an absolutely rigid condition. The weakness arose in the jointing of the rails, the most satisfactory type of which at present, to meet British requirements, was the girder with a weight of not less than 90lb. per yard. Considerations affecting the design of rail section for electric traction purposes were then entered into, and the chemical composition touched upon.

In treating the question of rail joints and to show the necessity of perfect rigidity in them, the author theoretically investigated the problem of a loaded car meeting with obstruction through an imperfect joint, proving that the defacing force of the blow upon the joint would be equal to that given by a steam hammer, the head of which weighed 4,000lb., falling at a velocity of practically 3ft. per second at the moment of impact. Sole-plates were not to be commended. The adoption of a deeper rail section with a very much wider sole than is usually employed, together with the use of deep-ribbed fishplates secured by means of six pairs of bolts, would probably be found advantageous, the bonds taking the form of copper rivets of large area compressed into holes drilled through both plates and the web of the rail. Reference was made to the Falk system of cast weld solid jointing, it being stated that the joint produced was an expensive one, and liable to fracture, though the percentage of failures was claimed to be extremely low.

The processes in connection with rail-laying were then dealt with, and the very great importance of good bonding was emphasised. Points and crossings having been considered, questions relating to the preparation of the concrete forming the bedding were treated; and, in conclusion, the best materials to employ in the laying of the paving were considered, the use of all kinds of wood-block paving being regarded as unsuitable.

In the discussion which followed Messrs. A. F. Gatrill, A. H. Stanley, H. Stevens, A. H. Tyler, V. H. Chabot, W. J. Tennant, T. C. Morewood, K. Gray, L. H. Rugg, C. J. McNaught, T. E. Moorhouse, and the chairman took part, and the proceedings closed with the announcement of the visit on Saturday afternoon, Dec. 14, to the Croydon Corporation combined electric light and traction works.

FORTHCOMING EVENTS.

FRIDAY, DEC. 13.

Physical Society.—At 5 p.m., ordinary meeting. Papers: "On Circular Filaments and Circular Magnetic Shells equivalent to Circular Coils, and on the Equivalent Radius of a Coil," by Prof. Thomas R. Lyle; and "A New Hygrometric Method," by Mr. E. B. H. Wade, etc.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 (in Sunderland), second general meeting.

Electro-Harmonic Society.—At 8 p.m., at St. James's Restaurant (Banqueting Hall), smoking concert.

South-Western Polytechnic.—At 8 p.m., distribution of prizes and certificates by Prof. Rücker, D.Sc.

SATURDAY, DEC. 14.

Institution of Junior Engineers.—At 3.15 p.m., visit to the Croydon combined electric light and traction works.

Manchester Association of Engineers.—Annual general meeting.

MONDAY, DEC. 16.

Institution of Electrical Engineers (Newcastle Section).—Ordinary meeting. Paper: "Electric Car Equipments and their Maintenance," by Mr. Arthur Wigram.

TUESDAY, DEC. 17.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., ordinary meeting. Paper: "The Breaking of Shafts in Direct-Coupled Units Caused by Oscillations Set Up at Critical Speeds," by Messrs. Julius Frith and E. H Lamb.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper: "Motive Power from Blast-Furnace Gases," by Mr. Bryan Donkin.

WEDNESDAY, DEC. 18.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "Range Finders," by Prof. George Forbes, F.R.S.

Royal Meterological Society.—At 7.30 p.m., ordinary meeting. Papers: "Further Observations and Conclusions in Relation to Atmospheric Transparency," by Mr. F. A. Rollo Russell"; "Remarkable Phosphorescent Phenomenon Observed in the Persian Gulf," April 4 and 9, 1901," by Mr. W. S. Hoseason; "On the Mechanical Principle of Atmospheric Circulation," by Captain R. A. Edwin, R.N.

THURSDAY, DEC. 19.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Adjourned discussion on "Some Principles Underlying the Profitable Sale of Electricity," by Mr. Arthur Wright. Dublin Section.—At 7.30 p.m., ordinary meeting. The address will be given by the chairman, Prof. W. F. Barrett, F.R.S.

FRIDAY, DEC. 20.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper: "Transmission Dynamometers," by Mr. A. M. Morgan.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Paper: "The Microscopical Examination of the Alloys of Copper and Tin," by Mr. Wm. Campbell.

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THE
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TO CORRESPONDENTS.

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SHALLOW UNDERGROUND TRAMWAYS.

The report of the tramway experts of the London County Council on the broad subject of shallow underground tramways deserves most careful consideration. This consideration is due not only from engineers electrical and civil, but also from the business men of London. This is so because in order to justly consider the financial problems arising out of the proposed construction of these shallow underground tramways and of the pipe and cable conduits adjoining the same, one has to place a cash value on the delay experienced by all classes of conveyances in consequence of the present congested state of the streets. The next consideration is whether the diversion of a certain class of the street traffic into a specially-constructed subway will sufficiently relieve the present streets as to reduce by a large amount the time and money wasted in traffic delay. This waste would be prevented to a very large extent by the subsidiary conduits containing all the pipes and conductors for the numerous public services, as these would prevent the frequent breaking up of the street surfaces. The first note of encouragement to be drawn from the report before us is that in Boston, while these subways have been constructed with public funds, the Boston Railway Company, which owns the elevated railways and the tramways in Boston, was found willing to enter into a lease for twenty years for the use of the same. Under this lease the company undertakes to pay at least the interest and sinking fund charges ($4\frac{7}{8}$ per cent.) on the cost of construction. In other words, the benefit derived by this company in the way of quickened service, etc., by the use of the subways is valued sufficiently highly to warrant their construction. Now, these Boston subways were constructed to relieve the congestion in certain streets arising from the vast number of tramcars which are run on the surface roads. The congestion was so bad as to bring the speed down in certain sections to about two miles per hour. While Boston has not the cab and private carriage traffic to the extent that we have in London, there is no doubt but that this relief in the congested streets is highly appreciated by other classes of vehicular traffic, and this improvement has been effected without a charge on the rates. The report on the Boston subway shows that the company is prepared to pay capital and interest charges, but it would seem to us that they do so, not because the line, *per se*, is so valuable, but because it affords a quick means of connecting up their lines at the busy parts of the system. In the case of the New York system, which is now in course of construction, the city again provides the money. The contractor, who also leases the subway when completed, undertakes to find interest on the money for a period of fifty years, and also 1 per cent. of sinking fund. Here, again, the sole return to the contractor will arise from the conveyance of passengers. In fact, in New York the subways will really contain an underground railway system. The main difficulty in applying these results, which show that shallow underground lines are commercially possible in Boston and New York, to the problem of communication in London, is that the local conditions are so different. Also the procedure under which such subways can be constructed is totally different. To quote one particular point: before any such public work can be carried out in London a Bill has to be obtained in Parliament, and in the course of the parliamentary procedure the opposition of all parties likely to be affected by the proposed work has to be met. In the case of such work in London, the opposition is largely prompted by considerations of possible profits to be made out of damage done. In America the opposite extreme is gone to. We

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believe we are right in saying that when the last scheme for supplying New York with water was carried out, the natural water supply of extensive areas was interfered with and often cut off, and that without a tithe of compensation being paid. We do not mean that this will not be paid at any time, but that the money provided by the city for the works has all been spent without this being done. Reverting, then, to the question before us, the construction of such shallow subways for traffic and for pipes. In the new street between Waterloo Bridge and Holborn it is without doubt the right thing to do. The subway can be constructed on cleared land owned by the Council, and can be supplemented by subways on either side to contain water-pipes, gas-pipes, hydraulic pipes, and the numerous cables required for electric light and telephone purposes. Whether the conduit is to be used for tramways only, or for ordinary traffic as well, is a matter for consideration, but if the London County Council get powers to construct the tramways across the bridges, as are shown in the map given elsewhere in this issue, then most decidedly a considerable traffic would be taken on tramways through the subway. So far we are with the Council, but we should like some evidence that the tramways over the two bridges in question will not cause more obstruction to traffic than is compensated for by the relief from the subway now proposed to be constructed. Before a useful opinion can be passed on the bolder scheme of making these shallow subways for both trams and pipes through main streets in London, due consideration has to be paid to the rights of present occupiers of houses on both sides and the present users of the ground under the street surface. The question of the interference with traffic is also a serious one, and in our opinion it is yet to be proved that the suggested schemes, other than the one mentioned above on a new road, can compare financially with the deep-level tubes made on the Greathead system.

THE BOARD OF TRADE DECISION.

According to the information which appears elsewhere in this issue, the dispute as to which system of electric traction is to be used on the Inner Circle has now been definitely settled by the Board of Trade. The result is in favour of the use of direct currents on the trains, and consequently against the Ganz system. In view of the evidence given before the arbitrator, it seems to us that the decision is the correct one. The Ganz system has many advantages, especially for long lines, and we trust that in future it will be proved commercially that these advantages, both in first cost in construction and economy of power afterwards, can be extended to suburban lines. While the Metropolitan District Railway Company, under the direction of Mr. Yerkes, has thus gained its way, we trust that the Metropolitan Railway Company will accept the decision in the right spirit. This decision while binding them to a particular system, does not bind them to equip electrically their portions of the line now or at any particular time. It is to be hoped, therefore, that no jealousies between the two companies will prevent this equipment being quickly ordered. It is probable that this will be the case, in view of the unsatisfactory financial position of the companies at the present time. It is only to electricity that they can look for new life.

BATH.—Mr. Manville, of Messrs. Kincaid, Waller, and Manville, Westminster, has been appointed to report to the Council on the present condition of the electricity works and the future of the undertaking.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE ARMSTRONG-ORLING SYSTEM OF WIRELESS TELEGRAPHY.

SIR,—Referring to the article in your last issue under the above title, would it not have been better to have confined your observations to the subject indicated, and to have refrained from giving expression to what I must characterise as a nonsensical statement of what "seemed to you to be the opinion of one of the gentlemen you saw at the company's office." The ascription of such an opinion to another is not complimentary, but its absurdity renders repudiation unnecessary.

The contention was that current could not exist without E.M.F. Your statement, it is true, is only a transposition of words, but it conveys a very different meaning. When a current is too weak to produce audible sound in a telephonic receiver, it is, of course, because the E.M.F. at its terminal is too low to overcome the resistance of the instrument. Is it not, therefore, manifest that telephonic as well as electro-capillary apparatus are dependent upon E.M.F.?

Perhaps the cause of your objection is the application of the phrase "sensitive to electric currents" to the Armstrong-Orling apparatus, but this, I believe, you are responsible for, for, according to your quotation from the paper referred to in your article, the inventors' words are: "That far weaker currents may be detected."

It would, however, be interesting to know the cause of your derision at the comparison made, for it really seems that it is the writer of the article who has strange views upon the subject of currents and E.M.F.—Yours, etc.,

Dec. 11, 1901. THE ONE REFERRED TO.

[N.B.—We are sorry there is a difference of opinion as to what "The One Referred To" said at our inspection of the instruments in question. The statement in question was the outcome of a cross-examination on our part as to whether the instrument was really affected by current or by voltage. The expert in question could not see the difference between the two, and apparently does not do so now. The fact remains that the chief use of electro-capillary electrometers, up to the present, has been to measure extremely small differences of electrostatic pressures. A current passing in such measurement would be objectionable, as it would alter the electrostatic pressure. Thus we contend that Armstrong, Orling, and Co.'s comparison of this instrument with a telephone which requires a minimum current to give audible sounds is absurd. The discussion is between electrostatics and electrodynamics—a subject too large to enter into here.—ED. *E. E.*]

LIGHTNING CONDUCTORS.

SIR,—My object in writing the letter appearing in your issue of Oct. 25 was, as stated in the concluding paragraph, to obtain the opinion of your readers—or, at any rate, of those gentlemen who had been awarded prizes for their answers to the question of bends in lightning conductors—as to the relative extent to which the damage caused to All Saints' Church, Nottingham, should be attributed to inductance or ohmic resistance.

Your editorial comment on the letter showed that the enquiry was perfectly legitimate, and I can only regret that neither of the four gentlemen referred to have thought it necessary to offer any opinion on the subject.

Your correspondent, Mr. Hands, to the anticipated surprise of your humble servant, states that neither inductance or bad earth need be taken into consideration, the fault being due to the proximity of the gas-pipe—basing his opinion upon what he evidently considers, judging from his reiterated statement, a unique practical experience and close study of the literature of the subject.

That other gentlemen are in touch with the said literature is proved by the remarkable coincidence in the first and second answers—see lines 1-2, and 71-2-3 on p. 560, Oct. 18.

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However, Mr. Dalby and "J.W. F." having replied to Mr. Hands, I will merely say that I admit being surprised, my surprise being of the same nature as that experienced by Sidney Smith when he saw the fly embedded in the amber. What surprised him was not the fact of the fly being there, but how the—"ahem," it got there.

That is my difficulty with All Saints' Church, because we are distinctly told by Anderson (see "Lightning Conductors," p. 195) that only the inner and outer *faces* of the tower were damaged, the middle portion of the 4ft. 6in. of masonry not being disturbed.—Yours, etc.,

W. H. WHITEHOUSE.

37, Waterloo-street, Birmingham, Dec. 9.

AN ERRATUM.

SIR,—In Mr. C. J. Leaper's little compilation of "Questions in Elementary Electrical Engineering," the following problem is given: "(48) Calculate the resistances of a $\frac{1}{10}$ and a $\frac{1}{20}$ shunt for use with a galvanometer of 5,000 ohms resistance."

To which the following answers are given:

"For the $\frac{1}{10}$ shunt we want $\left(\frac{5,000 \times 10}{11}\right)$ ohms. For the $\frac{1}{20}$ shunt we want $\left(\frac{5,000 \times 20}{21}\right)$ ohms."

If by the expression "a $\frac{1}{10}$ shunt" is meant a shunt taking nine-tenths of the current, or, in technical terms, a shunt having the multiplying power $n = 10$, the above answers are very far wrong. The ratios $\left(\frac{G}{S}\right)$ of the resistances should in the first example be 9, and in the second example 19—*i.e.*, the values for S should be $\left(S = \frac{G}{n-1}\right)$ 555·5 and 262·63, instead of 4,545·45 and 4,761·9.

The well-known expression for the multiplying power of a shunt is

$$n = \frac{G+S}{S} = \frac{G}{S} + 1;$$

whence $$n - 1 = \frac{G}{S},$$

and $$S = \frac{G}{n-1}.$$

—Yours, etc., D. G. F.-G.

ARTIFICIAL LOADING OF ALTERNATING-CURRENT MACHINERY.*

BY RUDOLF GOLDSCHMIDT.

An important point in the determination of the capacity of an electrical machine is the heating factor at full load and at overload. When the machines dealt with are not too large, it is generally possible to carry out a continuous full-load test without trouble in the ordinary works test-room.

One will naturally try to accomplish this with as little expenditure of power as possible, and can usually effect this by connecting the machine under test in circuit with the power mains. With alternate-current generators and transformers, loading with wattless currents is an additional and convenient method. Such methods, with their numerous variations, might well be more generally known. It is essential in these cases that a machine of sufficiently large capacity to take up the output of the machine under test shall be obtainable. On this account difficulties often arise in the testing of abnormally large machines.

For the ordinary characteristic tests (open circuit, short-circuit) from which the electrical performance of alternate-current machines can be sufficiently accurately determined, no machine to take up load is necessary, and even with the largest machines only relatively small amounts of power are required. If satisfied with the same degree of accuracy in the heating test, it is possible to obtain that also without a load machine, and with the least possible expenditure of energy. In order that the machine under test need not be loaded, even with wattless current, the E.M.F. induced in the working winding must have no part in the production of the current. The following method is based on this consideration: The iron must be worked under its normal conditions by running the machine at full voltage unloaded, and the copper must be heated by passing the normal current from some external source through the winding. As a heating current, continuous current deserves the first place. It is, of course, not possible to obtain the heating current by connecting a continuous-current machine or a battery direct to the terminals of a fully-excited alternator. One must, naturally, so arrange matters that

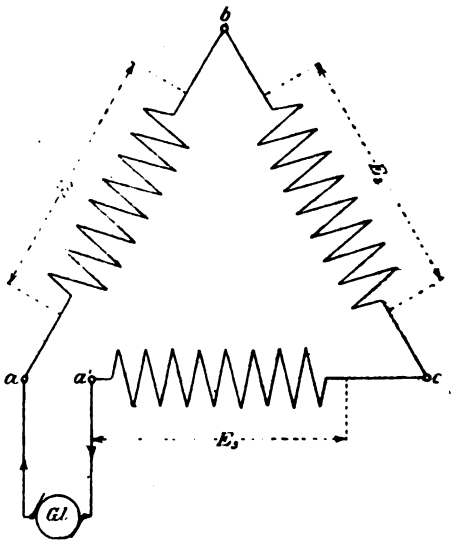

FIG. 1.

the continuous-current machine can pass current into the alternator windings without itself being able to take current from the latter. As a second condition, the continuous-current machine must not be able to cause any disturbance or damage to the alternator. With closed windings—as, for instance, three-phase ones with Δ coupling—the test can be carried out without further trouble. The winding must be broken at some point *a a'* (Fig. 1), and closed again through the continuous-current source. The three branch voltages, E_1 E_2 E_3, cancel one another. Of course, the third harmonic components of these voltages add up with regard to *a a*^{1}, so that a quite considerable difference of potential may exist between *a* and *a'*.* In spite of this, however, the currents set up in the closed circuit from this cause are practically nil, since the reactances of the three limbs coupled in series offer an extremely high resistance to such internal currents at three times the frequency. One should therefore connect the continuous-current supply before exciting the three-phase alternator, and there is then nothing to fear. When testing

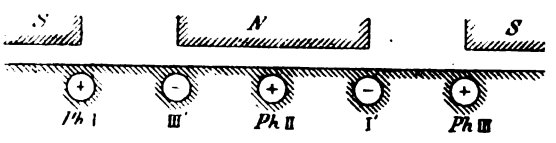

FIG. 2.

high-tension machines the goodness of whose insulation is questionable, one should connect one pole of the continuous-current machine to the frame in order to protect its winding. The continuous current in the three-phase armature does not produce any reaction on the field magnets, since the three phases traversed by currents in the same direction cancel one another. Only local magnetic fluxes can result. In fact, the armature winding forms poles three times as numerous as the field poles (Fig. 2). One might expect that these fields would induce powerful eddy currents in the pole-pieces. This is, in actual

* Translated from the *Elektrotechnische Zeitschrift*.

* With alternate-pole types this voltage is from 9 to 15 per cent. of the branch voltage, according to the slot and pole spacing, indicating a 3 to 5 per cent. third harmonic component.

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practice, not the case. The leakage of the local fluxes and the frequency of the eddy currents is too considerable, and the armature ampere-turns on modern machines are relatively too small to allow appreciable eddy currents to be induced in the pole-shoes.

The absence of armature reaction naturally has as a consequence that the field exciting current is too low, and that certain field distortions, principally due to the cross-magnetising action of the power current, do not appear. The exciting current in our case is practically the same as that required for non-inductive full load. The heating of the field winding on inductive load can be determined by proportion, since, within the limits under consideration, the temperature rise may be taken as proportional to the

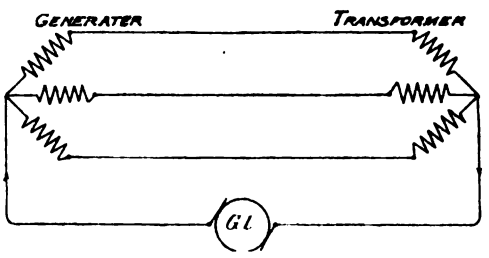

FIG. 3.

expenditure in watts. If one estimates the increase in hysteresis loss through field distortion, either by theoretical considerations or by the help of tests on similar smaller machines, one can allow for it in the heating test by a definite increase in the excitation. The field ampere-turns will be increased by the armature ampere-turns by a certain percentage which is almost entirely dependent on the pole spacing.

The continuous-current machine supplying the armature winding has only the copper losses to deal with, and therefore has to supply only about 1 or 2 per cent. of the three-phase output. The provision of the necessary low-voltage heavy-current continuous-current machine for the testing of low-voltage three-phase generators is a matter of some inconvenience. If a suitable machine is not forthcoming, it is possible to utilise the short-circuit current of a higher-voltage continuous-current machine. This can generally be increased to from $1\frac{1}{2}$ to 2 times the normal current, continuously. Very often the exciter is suitable for the supply of the armature current. The armature resistance of the three-phase generator increases with the increasing temperature, so that a constantly increasing continuous-current voltage is necessary in order to maintain the armature current constant. This voltage is at the same time a direct measure of the armature temperature rise.

If the armature of the three-phase machine is star coupled, it will be necessary to alter it into triangle coupling temporarily for the test, for, without special arrangements, the method only lends itself for the testing

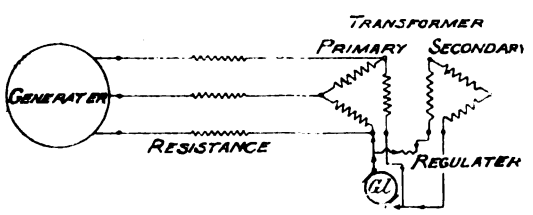

FIG. 4.

of closed windings. One can, however, retain the star coupling if a transformer of the same load and voltage as those of the three-phase machine is obtainable. The transformer should be connected to the generator terminals, and the continuous-current source should be coupled between the two neutral points (Fig. 3). In this way the transformer is also loaded, but a continuous current must at the same time be passed through the secondary winding, which must be triangle coupled. This current may either come from the same source as that supplying the primary winding, or, if the electrical conditions do not suit, from a separate source. Should one wish to employ this coupling for the general testing of transformers, it will be necessary to have a generator of equal power to the transformer. In order to make a smaller three-phase source do, however, it will be preferable to connect the primary also in triangle. In this case, however, it will be necessary to protect the three-phase generator from the continuous current by the insertion of resistances (Fig. 4). The drop of alternating voltage in these resistances is negligible on account of the small transformer no-load current. For the same reason one can, without danger, connect the continuous-current source into one of the primary branches. No want of symmetry in the voltages need be feared. If the transformer winding is subdivided into a number of separate coils, one can do away with the

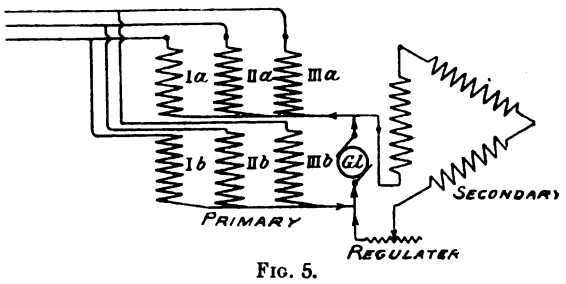

FIG. 5.

safety resistances by connecting the primary in two parallel groups with two separate neutral points, between which the continuous-current source is connected (Fig. 5).

The transformer must then be supplied at half voltage. For the loading of two or more similar transformers no safety resistances or recoupling are necessary. All the windings should be star connected, and the two transformers

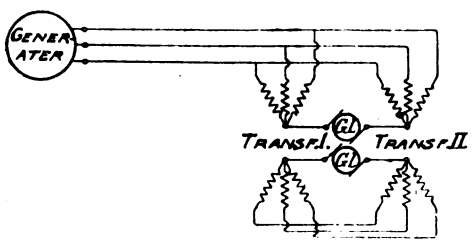

FIG. 6.

should be connected in parallel both on the primary and secondary sides. The continuous current can then be brought in at the two neutral points (Fig. 6).

It is often convenient, in order to employ only one source of continuous current, to connect the two secondary (low volt) windings in triangle and in series with one another (Fig. 7). The above method of loading transformers is, as far as heating is concerned, exactly equivalent to real loading, since the continuous current in the windings does not magnetise the iron.

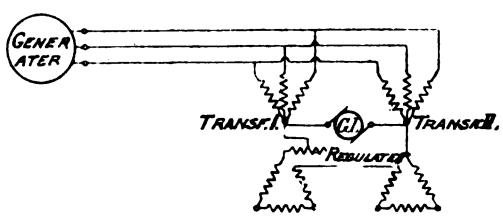

FIG. 7.

Induction motors do not lend themselves conveniently to this method of loading. In the case of these, it should only be necessary to supply the continuous current to either the rotor or the stator (the connections corresponding to Fig. 5). If, for instance, we pass a continuous current through the rotor by connecting the neutral point of the latter to the frame and coupling the continuous-current generator between the frame and the slip rings, a stationary field will be set up in the rotor having three times as many poles as the main field (see Fig. 2). If, now, the primary winding is triangle coupled, the continuous-current field of the rotor will induce an alternating current, circulating within the

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triangle only. Unfortunately, the primary current corresponding to normal rotor current is only equal to $\frac{1}{\sqrt{2}}$ times the power component of the full-load current + the open-circuit current (geometrically added). These results have been approximately confirmed by experiment.

It is only in quite special cases (coil windings which can readily be recoupled) that single-phase generator armatures can be heated from an external source. In order to allow of this, alternate coils must be coupled in opposition (Fig. 8), so that the terminal voltage is nil, and the continuous-current source can be connected to them without danger. With single-phase transformers it is only necessary to couple two parts of the winding in opposition, an alteration which is easily accomplished.

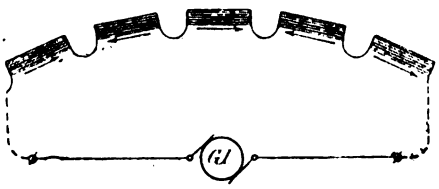

FIG. 8.

Loading by continuous currents can be combined with alternate-current loading—*e.g.*, in cases where the latter is insufficient to give full load, it can be helped out by continuous current. The method has repeatedly been found of great use in the testing department of the Elektricitätz Actien-Gesellschaft vorm. Kolben und Co.

ELECTRIC TRACTION ON THE UNDERGROUND.

Not altogether unexpectedly comes the announcement, formally made on Wednesday evening, that the Board of Trade have decided that the system with which the Inner Circle is to be electrically equipped shall be the direct current. The award, which, of course, is in accordance with the report of the tribunal over which the Hon. Alfred Lyttleton presided, and which only concluded its sittings a few weeks ago, is a distinct triumph for the District Company, and the three-phase system, so strongly urged as the best by Messrs. Ganz and Co., backed up by the Metropolitan Company, has been "shelved"—for the time at least. We believe that the decision of the Board of Trade will be warmly endorsed by the majority of electrical engineers in England and America, if not on the Continent: for, although on the question of cost the superiority of the direct-current system over the polyphase system is in some doubt, it was made abundantly clear by the expert evidence before the court of enquiry that it was the only perfected system for underground working in London. As we mentioned in this journal a couple of weeks ago, the contract for the equipment of the District Company's power-house has been placed with the Westinghouse Company, but, of course, this will not deter the Metropolitan Company from disposing of their portion of the work in whatever quarter they please. It is stated, indeed, and with some authority, that the Metropolitan Company intend to entrust the equipment of their own lines with Messrs. Ganz and Co., in consideration of the leading part that company have played in the enquiry. Now that the system to be used has been finally settled, it is to be hoped that the engineers to the scheme will be as good as their word, and have the Inner Circle working by electricity in two years' time. In the official language, the decision of the Board of Trade is as follows:

"Whereas pursuant to Section 9 of the Metropolitan District Railway Act 1901 the Board of Trade did by writing dated the 18th day of September 1901 appoint the special tribunal referred to in the said section to hear evidence and to report to the Board of Trade as to the system of electrical working which should be applied on the portions of the railways of the Metropolitan District Railway Company and the Metropolitan Railway Company forming part of the Inner Circle Railway and also on the City lines and extensions railways of the two companies.

"And whereas the said tribunal so appointed has duly made its report to the Board of Trade and the Board of Trade have considered the same.

"Now therefore the Board of Trade in further pursuance of Section 9 of the same Act do hereby determine that the system of electrical working which shall be applied on the portions of each of the said companies' railways forming part of the Inner Circle Railway and also on the City lines and extensions railways of the said two companies shall be the system described in a statement dated the 5th September 1901 signed by the secretary of the Metropolitan District Railway Company and declared and submitted by the said Metropolitan District Railway Company as the system of electrical working which it desired to adopt and which system may be shortly described or referred to as the continuous-current system of electrical traction."

LONDON TELEPHONES.

On Friday last a deputation from the London County Council was received at St. Martin's-le-Grand by Lord Londonderry (the Postmaster-General), who was supported by Mr. Austen Chamberlain, M.P. (Secretary to the Treasury), and Sir George Murray. The deputation was introduced by Mr. A. N. Torrance (the chairman of the London County Council). Mr. J. Williams-Benn was the spokesman of the party and explained what they considered to be the public objections to the agreement between the Postmaster-General and the National Telephone Company.

Lord LONDONDERRY, in reply, said he hoped to explain in the course of his speech that the real and effective competition recommended by the Select Committee had been obtained with reasonable rates. In the first instance, he admitted that they had not established that keen competition which frequently existed between two rival business houses. The reasons for this were twofold—first, that telephonic communication to be efficient really should be a monopoly, and, second, that it would be most inappropriate for the Post Office to carry on such an obstructive competition as that referred to above with a company licensed by the Post Office itself. His object had been not to make large profits out of the business, but to see that a thoroughly efficient system was set up in the Metropolis. If they had entered upon that competition urged by the Council, the Post Office would have been involved in a "war of rates" with the company, and then, he asked, what would have been the position of the users of the telephone? The National Telephone Company had between 30,000 and 40,000 subscribers in London, and he hoped that in due course the Post Office would have as many. But at the outset the Post Office would have had to attract customers without being able to offer them any very strong inducement, and in the meantime each subscriber to either system would have been entirely cut off from the other, or would have been compelled to subscribe to both. With great confidence he submitted then that, as matters stood, the London public would not have been well served without an arrangement for securing co-operation between the two systems. The company being as conscious of these considerations as the Post Office, approached him on the subject. He was, however, unable to entertain any scheme which included a proposal for the extension of the company's license beyond 1911. In the end an arrangement was arrived at which should be regarded as equally satisfactory to the British taxpayer as to the London public. While all the advantages of both systems were placed at the disposal of all subscribers to either, the arrangement offered the inducement, which competition alone could give, to provide and maintain efficient plant. This was substantially the kind of competition which the Select Committee of 1898 had in view. The Postmaster-General then went on to refer to the scale of charges, pointing out that one of the advantages of the arrangement between the Post Office and the company was that the latter had agreed to abolish forthwith the so-called terminal fees which they were previously entitled to charge on calls exchanged between subscribers to their system in the provinces and subscribers to the Post Office system in

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London, or *vice versâ*. He also stated that the Post Office had agreed to lease to the company, on terms which were sufficiently remunerative to themselves, such underground wires as the company might require for extension purposes This would enable the Post Office to get a return at once from certain portions of their plant, and it also enabled the Post Office to control in some measure the extension of the company's plant. On the question of purchase, he pointed out that the terms with the company were identical with those inserted in the municipal licenses, and also with those on which the London County Council had acquired the undertakings of the London tramway companies. The Post Office had agreed at the expiration of the company's license to purchase so much—and so much only—of the plant of the company as might be suitable to the Post Office requirements. Summing up his remarks so far, Lord Londonderry said he had endeavoured to show—first, that competition in the ordinary sense of the word was not calculated to provide an efficient system of telephonic communication; secondly, that the public of London, and in all probability the taxpayers of the country, would have suffered materially if any such competition had been established; thirdly, that the competition contemplated by the committee of 1898 and the Act of 1899 was competition of an essentially different character; and, lastly, that the competition which the Post Office proposed to establish, including as it did a large element of co-operation, was best adapted to attain the object which both the London County Council and the Post Office had in view. Dealing now with the rates to be charged, he emphasised the point that the rates agreed on with the company did not differ materially from those which the Post Office would have fixed independently if there had been no agreement with the company at all. Without going into details, he showed that the £17 rate entitled the subscriber to communicate, free of all other charge, with a very large body of subscribers, spread over an area of between 600 and 700 square miles, and representing a population of 6,000,000 persons. Referring to the comparisons which had been made with the rates charged elsewhere, he pointed out the difficulties in the way of such comparisons. One of the most important considerations was that the cost of establishing and working a telephone system not only increased with the number of the subscribers to be provided for, but increased very much more rapidly than the number. In the London area the Post Office would have from 15 to 20 exchanges, each of them with a capacity equal to the requirements of a good-sized provincial town. Then, again, the cost of all underground work in London was enormously increased both by the large proportion of wood and asphalt in our streets, and by the extreme complexity of the various systems of pipes and mains laid underneath them. Another important point was that the original estimates of the cost of construction had had to be increased by from 15 to 20 per cent. owing to a general inflation of prices at the time the contracts were placed. As regards the telephone rates in force in large cities like Paris and New York, he had seen it stated that the rate charged in Paris for unlimited user was £16 a year in an area of less than 30 square miles, and that in New York, with an even smaller area, the corresponding rate was £48. The Post Office were also now in a position to offer a subscription on the "toll" or "message rate" system, by which a subscriber might either have a line for his exclusive use, or he might share it with two or more other persons. In the first case a subscriber could make three calls a day throughout the year for a total payment of £9. 8s. 4d., or two calls a day for £8, while if he shared the line with one other person he could make two calls a day for £6 per annum. In New York the lowest subscription on the "message rate" system was £15, which covered no more than 600 calls a year. The Post Office charges for a similar number of calls in London was £7. 10s. With the introduction of this message-rate system, he observed that it became not only justifiable but necessary to fix the inclusive rate for unlimited user at a higher point than if it were the only rate available for a subscriber. He went on to mention that the rates which had been agreed on with the company were open to revision in 1905, but he stated, in conclusion, if he hesitated to encourage the public to look forward to such a reduction, it was only because he felt so strongly that the step the Post Office were now taking was more or less "a leap in the dark," especially in its financial aspects.

Answering Mr. Benn's enquiry as to whether the agreement would be ratified by Parliament, Lord LONDONDERRY said the agreement had been signed by him, and did not come before Parliament at all.

Mr. TORRANCE having thanked the Postmaster-General, the deputation withdrew.

The full text of the agreement above referred to has now been published. Most of the essentials of this have already been given in our columns. The new points which we notice in perusing the agreement are that the Postmaster-General has to supply all the wires for connecting the Post Office exchanges with the exchanges of the National Telephone Company, until such time as the Post Office subscribers exceed 10,000. After that, the National Telephone Company are to pay rent on half the junction wires. Another clause, which has not been referred to in the Press, is that the company are now bound, by agreement, to give telephonic connection to any person demanding the same without inserting in the agreement any conditions as to wayleaves. This is most important, as up till now the National Telephone Company in London have only connected subscribers who would enter into an agreement for poles to be erected on the roofs of their premises, if required. Again, while the Postmaster-General has agreed to provide and lease to the company any underground wires they may require, he has reserved under the agreement the right to consider each application separately, and to refuse to provide the wires if they are considered by him unnecessary, or are likely to be unsuitable for the requirements of the Post Office system at the expiration of the company's license. Still, this clause states that the Postmaster-General will practically assist the company to extend and develop the latter's London system with a view to promoting the general efficiency of the London telephone service as a whole. The rents to be paid for these wires are, for cables containing more than 50 pairs of wires, £2. 5s. per mile per annum for every pair of wires if the same are maintained by the Postmaster-General. But if the wires are maintained by the company this charge is reduced to £1. 5s. per mile per annum. The charges also obtain for cables containing less than 50 and more than 25 pairs of wires for short lengths, but if these smaller cables are required for more than 50 yards, the charges on the above basis are to be £3. 10s. and £2. 10s. per mile per annum for every pair of wires. The purchase clause at the expiration of the company's license only provides that the Postmaster-General shall buy such plant as at that date is suitable for the telephonic service of the Post Office within the London area. The usual clauses as to this plant such as have been inserted in all the municipal licenses are also included in the agreement. Another clause says that the Postmaster-General shall grant such postal, telegraphic, and telephonic facilities to the subscribers to the National Telephone Company's exchange as would be granted to the Post Office subscribers.

The following schedule as to the specification of the plant which the Postmaster-General may be called upon to purchase is worthy of reproduction in full. It reads as follows:

1. In this specification the term "exchange subscriber's circuit" means the wires and apparatus connecting a subscriber's office or offices with a telephone exchange, and the term "junction circuit" means the wires and apparatus which connect any two separate exchanges or an exchange and a prescribed post office.

2. All circuits, whether exchange subscribers' or junction circuits, shall be metallic. Any necessary earth connections shall either be made at the centre of balanced resistances of high inductance bridged across the circuit or by means of appropriate electrical devices so that speaking circuits when in use shall be free from inductive or other disturbances. All circuits shall be so arranged that exchange subscribers shall be unable to overhear what passes on any other than their own circuits or those to which they are joined through.

3. The use of iron conductors in any portion of a speaking circuit shall not be permitted.

4. With the undermentioned exceptions wires shall be laid under-

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ground, but the distribution wires from selected points to exchange subscribers' offices may be either overhead open wires or underground as may be considered desirable. Open wires other than distributing wires may, however, be erected overground (*a*) where power to execute underground work is unobtainable; (*b*) where the number of wires required is insufficient to justify the cost of underground work regard being had to the subsequent cost of maintenance. Where the company can obtain underground wayleaves the Postmaster-General will not consider open wires justifiable in cases where a line of poles carries or is intended to carry upwards of 25 circuits or 50 wires, and he will regard underground wires as being more suitable for acquisition by the Post Office than overhead wires. A line of poles extending less than a quarter of a mile from a distributing point will be considered as a distributing line. A line of poles in excess of this length will come under the limitations prescribed by the last paragraph. Where overground conductors consist of cables the copper to be used shall have a conductivity of not less than 98 per cent. according to Matthiessen's standard of pure annealed copper—that is to say, the resistance of 60deg. F. of a wire a square inch in cross-sectional area shall not exceed ·04318 of the standard ohm. The circuits in such cables shall have conductors of a minimum size of No. 20 S.W.G., weighing 20·7lb. per mile.

5. Where wires are placed underground (*a*) dry-core cables of low electrostatic capacity shall be used, and the conductors shall fulfil the following conditions: The copper to be used shall have a conductivity of not less than 98 per cent. according to Matthiessen's standard of pure annealed copper—that is to say, the resistance at 60deg. F. of a wire a square inch in cross-sectional area shall not exceed ·04318 of the standard ohm. For subscribers' circuits within half a mile of an exchange the conductors shall be not less than No. 22 S.W.G., weighing 12½lb. per mile. Exchange subscribers' circuits beyond the half-mile limit and junction circuits less than five miles in length shall have conductors of a minimum size of No. 20 S.W.G., weighing 20·7lb. per mile. Junction circuits of more than five miles in length shall have conductors not less than No. 18 S.W.G., weighing 36·8lb. to the mile. (*b*) All buried cables shall be efficiently protected by pipes or ducts of approved materials or by such other means as the Postmaster-General may have approved before the cables are laid. Cables in subways or tunnels shall be supported in such a manner as to prevent fracture of the lead covering.

6. Open wires erected overground shall comply with the following conditions: They shall be not less than No. 18 S.W.G., weighing 36·8lb. to the mile for subscribers' circuits and for junction circuits less than five miles in length. For junction circuits exceeding five miles in length the wire shall not weigh less than 100lb. per mile.

7. A thoroughly efficient method of calling the exchange and of signalling the close of a conversation shall in all cases be provided on every exchange subscriber's circuit, and the calling and clearing signals shall be effective in all conditions and upon the longest circuits used in an area when connected together.

8. Switchjacks on multiple panels of local subscribers' sections shall be connected on the branching system unless otherwise authorised by the Postmaster-General.

9. Junction circuits connecting exchanges with prescribed post offices shall be provided with automatic signalling arrangements of a character approved by the Postmaster-General and suitable for working in connection with his trunk circuits, and shall be worked in accordance with such regulations as he may from time to time prescribe.

10. The apparatus fitted at exchange subscribers' offices shall be efficient for trunk-circuit communication, and where separate batteries are provided at each exchange subscriber's office for speaking purposes the E.M.F. shall not at any time fall below two volts, and such apparatus shall be so fitted as to admit of a clearing signal being transmitted by the exchange subscriber to the Post Office trunk centre to indicate the close of a trunk conversation.

11. With a view to avoid difficulty under the last two preceding clauses the company shall at least six months before the opening of an exchange furnish the Postmaster-General with diagrams, illustrating both the exchange subscribers' circuit connections and the method by which it is proposed to actuate the signals on the junction lines at the Post Office trunk centre.

12. Where an overhead electric light or electric traction system co-exists with any portion of the company's London system, and where such last-mentioned system is partially or wholly overground, suitable safety devices, including fuses and heat coils, shall be provided in all circuits likely to be affected both at the exchange and at the exchange subscribers' offices.

13. Efficient lightning protectors shall be provided on all circuits.

14. Proposals for the modification of the foregoing specification will be considered by the Postmaster-General or the company (as the case may be).

This specification does not apply to the existing plant of the company nor to any plant of the company now in course of construction. Notwithstanding anything contained in this specification the existing plant of the company may be added to so as to utilise it to the extent of its capacity, but such plant may not be extended otherwise than in conformity with this specification.

TRADE NOTICES AND NOVELTIES.

Protected Rheostats and Measuring Instruments.

We have received from Messrs. Isenthal and Co. a copy of their new list of protected rheostats and measuring instruments, etc. In the "Electra" rheostats of this firm's make the resistance wires are embedded in a highly refractory insulating material, a protecting shell of metal being cast around the latter, whereby it is claimed that a thorough protection of the wires against oxidation is obtained. The contact slab is in a separate piece, and rests only in three places upon the hot shell in such a way as to ensure efficient cooling between the shell and slab. Several very compact types of motor-starting rheostats for continuous and rotary currents are shown, in which standard resistance elements are used. Dimmer switches for electric incandescent lamps of from 5 c.p. to 25 c.p. are also illustrated and described. These switches each contain a reducing rheostat, by means of which the light emitted by an incandescent lamp may be regulated. Multiple dimmer switches are made to control two lamps alternately from one point or one lamp from two different points.

Flexible Metal Tubes.

Patent seamless flexible metal tubes are the subject of a price-list just issued by Messrs. George Schultz and Co., 90, Cannon-street, London, E.C. The flexible tubes, for which Messrs. Schultz and Co. are the sole agents in the United Kingdom, are made from solid-drawn bronze tubes, being absolutely tight under working pressures of steam, air, water, gas, etc. The tubes are manufactured in lengths of 8ft., and can be joined or furnished with intermediate or end couplings as desired. Quotations are given for internal diameters of from ¼in. to 2½in. Amongst the uses to which this tubing may be put are the following: movable and temporary steam connections, as compensation tubes, for blowing out ashes in tubular boilers, for conducting lubricating fluids on machine tools, for pump connections, as tubes for oil and other fluids, engine and tender water connections, railway carriage gas, and pneumatic tubes.

Large "Buffoline" Pinion.

The accompanying illustration shows what may be done in the way of manufacturing noiseless gearing of large dimensions for heavy pump driving. This pinion has a diameter of 2ft. 6in. and a width of 5in.

It has 47 teeth, with a 2in. circular pitch, and is capable of transmitting 120 b.h.p. The pinion is a recent production of the Buffoline Noiseless Gear Company, of Levenshulme, near Manchester, who, we understand, have the sole rights of manufacture.

Measuring Instruments.

From the British Schuckert Electric Company, Limited, we have received an illustrated price list of measuring instruments. Ammeters for continuous currents to measure from 5 to 4,000 amperes are catalogued, whilst the continuous-current voltmeters listed have a range from 5 to 1,000 volts. As regards instruments for alternating currents, the ammeters described and priced have a range of from 0·25 to 4,000 amperes, and the voltmeters from 2 to 1,500 volts. For use on shipboard, voltmeters with swivel attachment are recommended.

Electrical Accessories.

We have received from the firm of S. N. Wolff and Co., Weveling-hoven, near Düsseldorf, Germany, their latest price-list of electrical accessories suitable for the English market. The articles quoted and illustrated include glass lamp shades of plain and fancy patterns, enamelled iron shades, ship globes, well-glasses, and enamelled shades for watertight fittings, arc lamp globes, opal candles, accumulator boxes, glass insulators, silvered glass lamp shades, Geissler tubes, Röntgen tubes, high and low tension electric incandescent lamps, wood switch blocks, bells and telephones, bell pushes and switches, alarm contacts, porcelain switch insulators, watertight lamp fittings, lampholders, wire lamp guards, and soldering irons, etc. The prices are in some cases quoted free to London, and in others to Hamburg only.

New Tyre Fastening.

From Messrs. J. E. Hopkinson and Co., Limited, West Drayton, Middlesex, we have received a price-list of rubber tyres fitted with Williams's patent detachable and adjustable band fastenings for all classes of carriages, cabs, and other vehicles. The fastening is claimed to avoid the possibility of creeping, or of the band working loose, while the danger of the rubber being cut through is at the same time minimised. It is not shown whether the method of attachment can be adapted to pneumatic tyres.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

437. What is the cause of flat places forming on dynamo commutators, and is there any way of preventing them? I have had the commutator of one of my dynamos turned several times to get rid of these flat places, but they always come again in a short time.—F. G. A.

438. Why do small toy series and shunt wound motors run equally well on direct and alternating current circuits?—J. C. R.

ANSWERS.

Question No. 431.—What *kind* of measuring instruments are used in ship-lighting to read correctly when the ship rolls?

Best Answer to No. 431 (*awarded* 10*s.*).—For ship-lighting work there are, practically speaking, many instruments which with slight modifications are applicable for this purpose. Whatever type of instrument be adopted, it should be specially constructed for the purpose, not necessarily of different design, but made more fit to suit the conditions of working.

The instruments most suitable for this work may be set down as follows: (1) suspended-coil instruments, such as the Weston type; (2) hot-wire instruments; (3) Perry's spring ammeters and voltmeters. The modifications that become necessary are generally in the form of greater accuracy in the balancing of the needle, so that in the case of the more modern hot-wire instrument for this work the needle requires so balancing that there will be no undue strain on the wire by the oscillations of the ship. In the case of the spring instrument of the Perry type there are very few special considerations necessary, for the spring which imparts motion to the pointer cannot be very much retarded by coming in contact with the inside of the coil, due to the rolling of the ship, and there should be only very slight inaccuracy when tilted 10deg., which would be a very great oscillation considering that the dynamo, together with the switchboard, is situated as near the centre of gravity of the vessel as possible, which is the usual practice. But if this is not the case, then the oscillations may be looked upon as a simple up-and-down motion to many of the instruments, and would, of course, affect the latter type of instrument very much. So that the successful working of many instruments will depend upon the position in which they are placed.

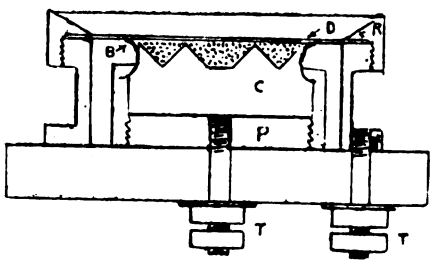
Without reference to the positions in which they are placed, the best instruments for all purposes on board ship are the Weston and Stanley types when finished specially for the purpose.—K.

Answer to No. 431 (*awarded* 5*s.*).—Electric measuring instruments for ship use should be of such a nature that the effect of gravity upon the instruments is neutralised (this effect of gravity is neutralised by using instruments with an adjustable spring control); also the instruments should not be constructed of such materials that are liable to deteriorate by the heat of the engine-room Dealing only with voltmeters and ammeters, these are of three types—viz. (1) the hot-wire: (2) the electrostatic: and (3) the electromagnetic. Of the wire type, Messrs. Cardew and Hartman and Braun are those chiefly employed. This type of instrument is being largely employed as an ammeter, as well as for a voltmeter. Of the electrostatic type, the well-known vertical multicellular voltmeter of Lord Kelvin's is exclusively employed. Of the electromagnetic type there are a great many makes. This type of instrument is chiefly used for ammeters. The cost of this instrument, both for voltmeters and ammeters, is low when compared with those of the hot-wire type. In the hot-wire type of instrument, however, the error due to the variations in temperature is more easily compensated than in the other types mentioned. As the whole of these instruments are so well known, it is unnecessary to give a detailed description of them here.—JUNO.

Answer to No. 431 (*awarded* 5*s.*).—The *kind* of measuring instruments used are those in which the reading is obtained by a "hot wire," as the Cardew voltmeter, for instance, or those in which the needle is returned to zero by means of a spiral spring. It will be at once apparent that gravity instruments are inadmissible. The Cardew voltmeter is a very favourite instrument for ship use; it is dead-beat, and the replacing of a new *wire* is not above the skill of an average mechanic. Many engineers prefer that form of ampere-meter and voltmeter of which the Weston is, perhaps, the best known—viz., that in which the field is made by a permanent magnet instead of by an electro magnet or solenoid. For rough testing a detector having a spring recoil will be found useful, but the more serious work is better done with an ampere-meter or voltmeter using the full E.M.F. of the plant for the purpose. Although it is urged against permanent-magnet instruments that the magnets weaken, so also the spring may weaken, and thus the one fault may tend to compensate the other.—M.

Question No. 432.—I am trying to make a micro-telephone to give the maximum loudness and distinctness of tone. What is the best form of microphone for the purpose, and what other means should I take to attain my object?

Best Answer to No. 432 (*awarded* 10*s.*).—Without doubt the best form of transmitter is the granular carbon type, with copper foil or carbon diaphragm. As shown in the illustration, C is a carbon block, with V grooves turned on



Section of Transmitter.

the upper surface, which are filled in with granular carbon, held in position with a soft cotton bag, B, frayed at the edges, which press lightly against the diaphragm, D. A round brass plate, P, with the edge screwed, is bound down to the base with a central screw, forming one terminal of the instrument. To this brass plate is bound the carbon block—making good contact—with a screwed ring, and at the same time fixing the cotton bag, which takes any strain caused through unevenness of the bottom surface or flange on the carbon. The diaphragm is securely fixed in a similar manner with the screwed ring, R, and flanged cylinder, F, one of the binding screws forming the other terminal of the instrument. The whole working of the transmitter depends on the different resistances between the two terminals caused by the sound vibrations impinging on the diaphragm, which in turn exerts a vibrating pressure on the granules. Dampness has a very deteriorating effect on the granular carbon transmitter, as it tends to cake the granules, more especially if the instrument is out of use for a long time. This, I think, is the strongest and most sensitive form of transmitter, and as it is practically damp proof, it can scarcely get out of order.

The receiver next claims our attention. There are so many different styles of receivers, each having advantages and disadvantages of their own, that it is really hard to decide which is the best. I think that perhaps "W. A. T." had better make one with an adjustable diaphragm, so that he could arrive at its maximum loudness experimentally. In the sketch, M is a horseshoe magnet of good hard steel, permanently magnetised by passing a strong current

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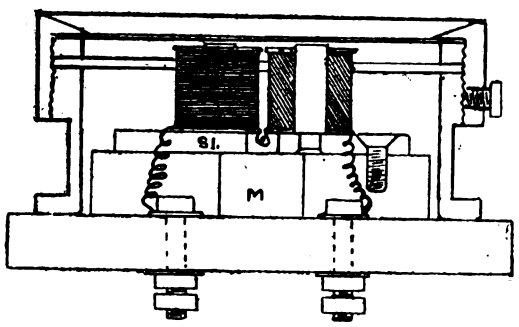
through a few turns of wire wound round one of the limbs and hammering during the operation. To the poles of the magnet are screwed two pieces of soft iron, S I, to which the cores of the coils are screwed or riveted, the distance between these two pieces being at least ¼in., so that the break causes the majority of the magnetic lines to pass through the cores and diaphragm. The coils which are under the centre of the diaphragm are wound so as to form a magnetic field similar in direction to the permanent magnet; this tends to keep up the strength of the permanent magnet, the ends of the wire being taken to two terminals on the base. The diaphragm may be made of 22 S.W.G. tinned sheet iron, and the coils wound with about 25 or 26 S.W.G. single silk-covered copper wire. The diaphragm, when fixed as shown, can be adjusted to a nicety and fixed in that position by the side screw.

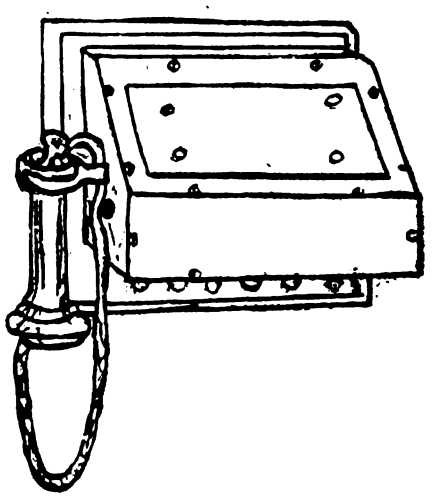


Section of the Receiver. In these Illustrations the Ear and Mouth Pieces have been omitted.

There are very widely different ideas as to which are the best proportions as to length of wire, gauge, and area of diaphragm, and, I think, always will be, as I have seen two diaphragms, cut from the same sheet and exactly the same size, giving widely different results with the same adjustment.—ROTOR.

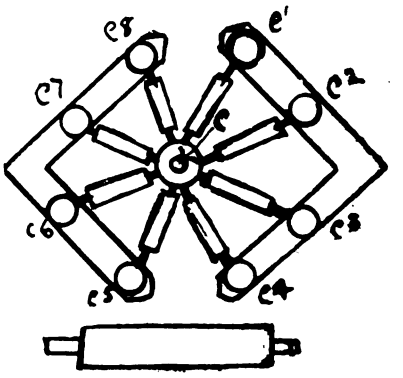
Answer to No. 432 (*awarded* 5*s.*).—Any microphone may be turned into a loud-speaking one by simply increasing the current; but increasing the current would shorten its life, so that this method is not practical. We could, however, use two or more microphones, and thus increase our speaking current; if, for instance, the resistance of one microphone at rest is six ohms, two in parallel would be three ohms. It will be seen that it would be wasteful in battery power, but we have an advantage, as the speaking current would be twice that of one. In making up a transmitter, it must be remembered that the most sensitive one is not the best, as it takes up vibration outside the range of a human voice; the one which has the highest resistance at rest and the lowest on deep notes will be found to speak the loudest, as we then get a big range of speaking current. The form taken by the speaking board might be square, a transmitter in each corner and one in the centre, or if three are wanted the form might be triangular. If you want to make up a cheap transmitter for your own use, cut two circular pieces of metal, say, 10in. diameter, 20 S.W.G. (iron or brass), cut out a ring of cotton wool, 10in. outside and 8in. inside diameter, place one disc on a table or any convenient place, then place the cotton-wool ring on the disc and fill up the hollow with carbon, and on the top place the second disc. The connections are taken one from each disc. A great factor in loud-speaking telephones is the receiver. The diaphragm might be made, say, about 10in. diameter, but it must not be made thin, for a thin diaphragm will not give clear sounds; in other words, it vibrates after the current has stopped. The magnets must be placed in the centre and close together—that is, where a minimum pull will give a maximum deflection. I have found the Gower form easy to make, and they give very good results. For a diaphragm of 10in. diameter, 18 S.W.G. is about the correct thickness, and ought to be made out of pressed sheet steel.—T. W. S. H.

Answer to No. 432 (*awarded* 5*s.*).—The questioner wants to make exactly what everybody working on the telephone have been trying to make—viz., an instrument to give the maximum loudness and distinctness of tone. A brief description of one of the latest and, as far as I have seen, the best instruments should give the information desired.



eneral Appearance of Instrument.

The microphone consists of a central block of circular carbon, C, from which radiate eight carbon pencils each terminating in a carbon block. The four right-hand blocks are connected by a copper strip and form one terminal of the instrument, and the left-hand four blocks form the other. This system of pencils and blocks is fixed upon a pine board, 9in. wide by 5in. deep by ⅛in. thick. This pine board acts as the diaphragm. This instrument is



known as the Post Office telephone. The latest development in receivers is also employed by the Post Office which is a modification of the well-known Bell receiver, the difference being that the straight permanent magnet is replaced by a long U-shaped magnet with soft-iron pole-pieces; there is a coil at the end of each limb of No. 38 S.W.G. silk-covered wire with a resistance of 120 ohms.

I would refer "W. A. T." to a little book by T. E. Herbert—"The Telephone System of the British Post Office"—where nearly every instrument is illustrated and fully described in theory and practical detail.—C. L. E. S.

LEGAL INTELLIGENCE.

NEWCASTLE ELECTRIC SUPPLY WORKS.

Illegal Discharge of Steam.

The Newcastle Electric Supply Company, Limited, were summoned before the local magistrates last Friday for "that they, on Nov. 28, did unlawfully discharge, so as to be a nuisance to the public, certain steam, ejected from the condenser of the fixed steam light generating station, at Pandon Dene, contrary to Section 99 of the Newcastle Improvement Act, 1899.

Mr. Byrne, in opening the case for the prosecution, said that on Nov. 29 steam was seen to issue from the works of the Newcastle Electric Supply Company, which resulted in small fine drops falling on the pavement to the annoyance of the public. The steam arose from the condenser of the engines used in driving the dynamos to generate the electricity which the company supplied to the town.

In the course of the evidence the fact was elicited that the company had erected a tower at a cost of £3,000 with a view to getting rid of any nuisance. For the last two years, it was stated, the defendants

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had been contemplating removing their generating station and appliances from Pandon Dene to Wallsend, where a new station was opened in June this year by Lord Kelvin. From that time the defendants had brought the current generated at Wallsend into the Newcastle district, because they had been stopped in their work by objections on the part of the Newcastle Corporation, who had been the means of making the company lose all the valuable time of the summer months. The consequence was that many months' delay had occurred in carrying out the change. It was further stated in evidence that in about two months from now the company would have moved the appliances from Pandon Dene to Wallsend, and then there would be no nuisance.

The Bench eventually adjourned the case for seven weeks, the presiding magistrate expressing the earnest hope that the company would have no more difficulties, and that at the end of that period they would hear that arrangements had been completed for the supply of electricity from Wallsend.

A PATENT CASE.

The case of the English Electro-Metallurgical Company, Limited, *v.* the Glasdir Copper Mines, Limited, was heard in the Court of Appeal, before Lords Justices Vaughan Williams, Romer, and Cozens-Hardy, on Wednesday, on an appeal by the defendants from an order of Mr. Justice Joyce granting an injunction restraining Mr. Nicholson, who had been appointed receiver in a debenture-holders' action, from using a patent the license to work which had been granted by the company.

It appeared from counsel's statement that the patent in question was for the treatment of ores, and under an agreement of October, 1898, Mr. F. E. Elmore (the patentee) granted a license to the copper company, which had mines at Dolgelly, North Wales, the consideration being 30,000 fully-paid £1 shares in the company. The license contained a covenant that the company would not, without the consent in writing of the licensor, assign, mortgage, or grant sub-licenses ; but on Nov. 8 it was ascertained that the receiver who had been appointed in the action was proposing to work the patent. An injunction was, therefore, sought for on the ground that the license was not included in the property charged by the debentures, and his Lordship in the Court below acceded to this view.

The Court decided that the license was not included in the security charged, and dismissed the appeal, with costs.

THE ACCUMULATOR SYNDICATE.

This company presented a petition for compulsory winding-up before Mr. Justice Wright in the Winding-up Court on Wednesday ; but counsel for the company stated that since the petition was put in a firm had approached the company and agreed to take over its patents. The directors thought that they might make a profit out of the transaction.

His Lordship allowed the matter to stand over generally, with liberty to apply.

COMPANIES' MEETINGS AND REPORTS.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

Directors: The Hon. Henry Marsham (chairman) ; Major Leonard Darwin ; George Henderson, Esq.; A. Weston Jarvis, Esq., C.M.G.; Charles H. Moore, Esq.; Abraham Scott, Esq.; Robert Kaye Gray, Esq. Extraordinary directors: Matthew Gray, Esq.; S. Wm. Silver, Esq.

Report of directors (with abstract of accounts) for the year ended Sept. 30, 1901, to be presented at the thirty-eighth ordinary meeting of the shareholders, to be held at the Cannon-street Hotel, E.C., on Dec. 17, 1901, at 12 noon :

The accounts show, after provision for doubtful debts, a net profit for the past 12 months of £56,057. 1s. 5d. Adding £48,750. 6s. 10d. brought forward, and deducting £12,500 interim dividend paid in June, there remains a disposable balance of £92,307. 8s. 3d. The directors recommend the distribution of a dividend of 15s. a share, free of income tax, amounting to £37,500, making, with the interim dividend paid in June, a total payment of 10 per cent. for the year, and leaving £54,807. 8s. 3d. to be carried forward. The general business shows a slight falling off when compared with last year. The cost of raw material, which had been high at the beginning of the year, became lower at its close. The cable steamer "Silvertown" completed the laying of the Waterville (in Ireland) and Weston-super-Mare cable, the manufacture and shipment of which was mentioned in the last report. The "Buccaneer" has also been employed. Since the closing of the financial year the "Dacia" has been employed by the Spanish Government and by the Western Telegraph Company, and after her return to London will carry to Brazil and lay a cable which has just been manufactured. The works at Silvertown and Persan have been maintained in their usual state of efficiency, novel machinery being introduced at the former and land for the extension of the latter having been acquired. Mr. S. Wm. Silver and Mr. Matthew Gray, having resigned their seats on the Board, have been appointed extraordinary directors of the Company. The vacancies thus created have been filled by the appointment of Mr. George Henderson and Mr. Charles H. Moore. The directors regret to report the death of Mr. James McKinlay, who, with great advantage to the Company, occupied the position of cashier and buyer at the Company's Silvertown works for the last 34 years. Mr. Abraham Scott and Mr. George Henderson, the retiring directors, offer themselves for re-election.

BALANCE-SHEET.

Dr. Capital and Liabilities.	£	s.	d.
Authorised share capital	812,000	0	0
Share capital—amount paid on issue of 50,000 shares of £10 each	500,000	0	0
Mortgage debentures	300,000	0	0
Reserve fund	450,000	0	0
Debts and loan owing by the Company	113,355	10	0
Bills payable	21,196	8	9
Unclaimed dividends	238	0	0
Profit and loss account: balance at Sept. 30, 1900 £86,250 6 10			
Less dividend paid December 37,500 0 0			
48,750 6 10			
Profit for the year ending Sept. 30 56,057 1 5			
104,807 8 3			
Less interim dividend paid June 6 12,500 0 0	92,307	8	3
	£1,477,097	7	0

Cr. Assets and Expenditure.	£	s.	d.
Freehold and leasehold premises (Silvertown, Persan, London, and Liverpool), machinery and steamships	531,476	0	4
Debts owing to the Company	155,638	1	3
Bills receivable	7,262	12	6
Cash with bankers and in hand	23,349	2	0
Stock-in-trade, including 150 miles of cable laid	364,308	1	8
Debentures and shares in other companies	182,726	6	0
Cash, stock, debts, etc., at Persan and agencies, after deducting liabilities	212,337	3	3
	£1,477,097	7	0

Dr. Profit and Loss Account.	£	s.	d.
Salaries, commission, rent, rates and taxes, repairs, and general expenses	62,345	13	10
Mortgage debenture interest	12,000	0	0
Bad debts	896	1	1
Income tax	2,321	19	1
Depreciation written off buildings and machinery	18.642	0	0
Directors' remuneration	2,973	0	0
Balance—profit for the year	56,057	1	5
	£155,235	15	5

Cr.	£	s.	d.
Gross profit for the year, after making provision for doubtful debts	155,235	15	5
	£155,235	15	5

NEW COMPANIES REGISTERED.

United Electric Light and Power Supply Company, Limited.—Capital, £15,000. Objects: to acquire from O. Moon and J. A. Loughlin, for £3,000, a concession granting the exclusive right of supplying electricity to the town of Guimaraes, in the province of Minho, Portugal, and to carry on in Great Britain, Ireland, Portugal, or elsewhere the business of suppliers of electricity for light, heat, and power, electrical and mechanical engineers, makers of cables, wires, lines, accumulators, lamps, works, and electrical apparatus, etc.

"Leador" Incandescent Light, Limited.—Capital, £30,000. Objects: to carry on the business of manufacturers of and dealers in incandescent and other lamps, etc.

Geneva Tramways Company, Limited.—Capital, £850,000. Objects: to carry on in the city of Geneva and elsewhere the business of a tramway company, to hold shares and securities of any British or foreign tramway companies, to acquire all or any of the shares in La Compagnie Genevoise des Tramways Electriques, etc.

Clayton Engineering and Electrical Company, Limited.—Capital, £60,000. Objects: to acquire all or part of the undertaking, business, assets, and liabilities of the Clayton Engineering and Electrical Construction Company, Limited, and to carry on the business of common carriers, carriers of passengers, live stock, produce, goods, minerals, and merchandise, electrical, mechanical, hydraulic, and general engineers, electricians, etc.

Edison-Bell Consolidated Phonograph Company, Limited.—Capital, £27,500. Objects: to acquire the business of the Edison-Bell Consolidated Phonograph Company, Limited, and to carry on the business of dealers in phonographs, graphophones, telephones, and sound recording and reproducing instruments, makers of phonogram cylinders, tablets, magnets, motors, and electrical and other apparatus, etc.

Reading.—The Corporation invite tenders for the supply and erection of water-tube boilers, superheaters, and mechanical stokers, fuel economiser, piping, feed pumps, etc., compound condensing direct-coupled engines, surface condensers, air pumps, circulating pumps, piping, etc., electric generators, switchboard and connections, electric lighting, overhead travelling crane, motor trucks, motors and electrical equipment for cars, car bodies, trolleys, and miscellaneous minor works and fittings. Tenders by Dec. 28. Details in our advertisement columns.

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APPOINTMENTS VACANT.

Junior Assistant Electrical Engineer, Hanley, £100 per annum, Dec. 18. Full particulars in our advertisement columns.

Clerk, Hackney, £200 per annum, Dec. 16. Full particulars in our advertisement columns.

Shorthand Clerk and Typist, Hackney, 35s. per week, Dec. 16. Full particulars in our advertisement columns.

Switchboard Attendant, Carlisle, 25s. per week, Dec. 16. Full particulars in our advertisement columns.

Chief Assistant Engineer, Grimsby Corporation electricity Department, £150 per annum, Dec. 23. Full particulars in our advertisement columns.

Engine Driver, Birkenhead Corporation electric tramways, 35s. per week of 56 hours, Dec. 19. Full particulars in our advertisement columns.

NEW COMMITTEES.

The following additional committees have been appointed:

BACUP.—*Electricity*: Alderman Astley, vice-chairman.

BIRKENHEAD.—*Tramways*: Aldermen Cook, Gamlin, B. Jones, and Singleton; Councillors Curphey, Edwards, E. T. Evans, Grice, Laird, Lilwall, Oates, H. L. Pearson, Snape, and Wall. *Electricity*: Alderman Lees; Councillors Bennett, Dalzell, Edwards, Griffiths, Lilwall, McGaul, Moon, H. L. Pearson, T. T. Rees, J. G. Robinson, Tooth, and Wall.

EALING.—*Electric Lighting*: Aldermen Drew-Bear, Kasner, and Tyer; Councillors Bowley, Farr, Hardman, Peal, and Timpson.

MAIDENHEAD.—*Electric Lighting*: Councillor Pearce, chairman; Councillor Tilly, vice-chairman.

WOOLWICH.—*Electricity*: Councillor Clarke, chairman.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Stirling.—The Town Council will receive tenders for motors for hiring purposes by Dec. 16.

Maidstone.—The Corporation invite tenders for wiring and fitting various buildings by Dec. 19.

Leigh.—The Electricity Department of the Town Council invite tenders for boilers, condensers and dynamo feeder panels by Dec. 16.

Oban.—The Burgh Commissioners will receive tenders for three 60-kw. steam dynamos, with two boilers, economiser, etc., by Dec. 18.

Horsham.—The Urban District Council invite tenders for the supply of meters (direct current) and cut-outs. Tenders by Dec. 17. Details in our advertisement columns.

Bournemouth.—The Town Council invite tenders for feeder cables, pilots, arc lighting cables, conduits, etc. Tenders by Jan. 6. Details in our advertisement columns.

Leeds.—Tenders are invited for reinstallation of electric bells at Hunslet and Holbeck Baths. Specification, etc., may be obtained from Mr. Bond, baths superintendent, Cookridge-street. Tenders by 21st inst.

Brussels.—The administration of the Belgian Government Telegraphs will receive tenders for 7,300 telegraph posts by Jan. 8, 1902. Specification No. 12 may be obtained at the office of the department, Brussels.

Queenstown (Ireland).—The Urban District Council invite tenders for the public lighting of No. 2 area of the township from Jan. 1, 1902, for one or three years. Further particulars may be obtained from the Clerk. Tenders by Dec. 20.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of steam, exhaust, feed, and drain pipes, feed pumps, feed heater, feed tank, tools, etc. Tenders by Jan. 8. Details in our advertisement columns.

Hampstead.—The Metropolitan Asylums Board invite tenders for the installation of an electric fire-alarm system at the North-Western Fever Hospital, Lawn-road, Hampstead, N.W. Tenders by Dec. 19. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply and erection of cast-iron condenser and water pipes, and some copper steam piping, valves, etc., for their Hylton-road electric lighting station. Tenders by Dec. 20. Details in our advertisement columns.

Hornsey.—The Urban District Council invite tenders for the supply and erection of steam, exhaust, water, and other pipes, valves, tanks, footplates, and accessories, and elevator and transporter, electric motor and switch gear. Tenders by Jan. 15. Details in our advertisement columns.

Christiania.—The Norwegian State Railway invite tenders for the supply of telegraph material. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m. Tenders by Dec. 18.

Hammersmith.—The Council invite tenders for the supply of extra high-tension electric light mains, low-tension distributing electric light mains, service cable and accessories, draw-boxes frames, covers, etc., and cast-iron pipes. Tenders by Dec. 18. Details in our advertisement columns.

Louvain (Belgium).—The contract for the lighting of Louvain by gas will expire on Jan. 1, 1905. The Municipality are therefore prepared to receive, before Dec. 31, 1901, proposals for lighting the city, either by gas or electricity, or by the two systems combined, from gas or electric light companies. Address the Burgomaster, Louvain, Belgium.

West Ham.—The Council invite tenders for four sets of surface condensing plant, each to deal with 40,000lb. of steam per hour, complete with electrically-driven air and circulating pumps; and one travelling crane, to carry 30 tons, span 67ft. Tenders by Jan. 14. Details in our advertisement columns.

Madrid.—Tenders are invited for installing and working the electric light at a prison. After 15 years the installation is to become the property of the Government, who will contribute a maximum of 40,000 pesetas per annum. Particulars may be obtained from the Junta local de Prisiones, Madrid. Tenders by 3 p.m. on Dec. 26.

Glasgow.—The Corporation invite tenders for the supply of the following material: 2,000, 3,000 or 4,000 tons steel straight track rails; 200, 300, or 400 tons steel curved rails; 100, 150 or 200 tons steel fishplates. Specification, etc., can be obtained on application to Mr. John Young, general manager, 86, Renfield-street, Glasgow. Tenders by Dec. 20.

Liverpool.—The Midland Electric Corporation for Power Distribution, Limited, invite tenders for the supply and erection of two-phase motor-generators, boosters, high and low-tension switchboards, etc., and the supply and erection of a battery of accumulators, to be installed in their sub-station at Bilston, Staffs. Tenders by Dec. 20. Details in our advertisement columns.

Nantwich.—The Urban District Council invite tenders for the supply and erection of boiler-house plant: one water-tube tube and one Lancashire boiler, fittings, steam and exhaust pipes, etc.; engine-house plant: continuous-current steam dynamos, pumps, etc.; switchboard, etc., underground mains, lamp posts, etc., accumulators, meters, crane, etc., dust destructor. Tenders by Jan. 6, 1902.

Barnstaple.—The Town Council invite tenders for the supply and erection of three straight water-tube or Economic boilers, fittings, steam and exhaust piping, condensers, three high-speed engines (220 i.h.p. each), three 125-kw. c.c. dynamos, switchboard, underground mains, lamp-posts, etc., meters, accumulators, crane, etc., artesian well. Tenders by Jan 16. Details in our advertisement columns.

Madrid.—The Public Works Department invite tenders for an electric tramway from San Sebastion to Toloso, with power to work same for a maximum of 60 years, after which the undertaking becomes Government property without compensation. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Rockhampton (Queensland).—The Municipality invite applications from companies desirous of undertaking the construction and working a system of electric tramways under the Queensland Tramways Act of 1882 and the Amendment Act of 1890, within the municipality of Rockhampton aforesaid. Rockhampton, with a population of 15,461, is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882 and the Amendment Act of 1890, copies of which may be seen at the office of this paper. Applications to be forwarded to Mr. H. W. Johnson, mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31.

RESULTS OF TENDERS.

Mansfield.—The Council have accepted the tender of Heenan and Froude, at £5,068. 5s., for a refuse destructor.

Southport.—The Town Council have accepted the tender of Dick, Kerr, and Co., for the supply of four additional double-decked tramcars, at £575 each.

Maidenhead.—The Town Council have accepted the tender of the Clayton Engineering and Electrical Company, Limited, at £1,812. 10s. for steam dynamos.

Batley.—The Electricity Committee have accepted the tender of Clayton, Son, and Co., Limited, Hunslet, for the supply of boilers, steam pipes, etc., for the electric generating station.

Leigh.—The Town Council have accepted the tender of the Anchor Cable Company, Limited, Leigh, for the supply during the ensuing 12 months of electricity cables and accessories.

Wolverhampton.—The Town Council have accepted the tender of the Electric Construction Company, at £323. 6s., for the supply of motors and electrical equipment of the cold stores and ice-manufacturing plant.

Edinburgh.—The contract for the electric lighting and heating of the Edinburgh Museum, value £3,830, has been placed by the Office of Works with the National Electric Wiring Company, Limited, Victoria-street, S.W.

Fulham.—The Borough Council have accepted the tenders of the General Electric Company for lamps, globes, switches, etc., for the 22 arc lamp pillars, to be erected in Wandsworth Bridge-road, at £421. 5s., and for replacing the existing switches in the present 87 arc lamps, with a new pattern of switch, at £316.

Rochdale.—The Corporation have accepted the tender of Yates and Thom, Blackburn, for the supply of three Lancashire boilers, econo-

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miser, and two mechanical stokers, and for two ejector condensers and circulation pumps, one feed pump, one grease extractor, and extensions to the present steam, exhaust, condenser, and feed pipes.

Woolwich.—The Borough Council have received the following tenders for free or assisted wiring. Accepted tenders:—Nunn, Watts, and Co., 82, Mark-lane, E.C.; Norman Engineering Company, 489, Lordship-lane, S.E. Also tendered: Geipel and Lange, Parliament-mansions, S.W.; Childs and Co., Powis-street, Woolwich.

Kirkcaldy.—The Town Council have accepted the following tenders for the work of the tramways: British Insulated Wire Company, Limited, Prescot, overhead construction, £3,487; Improved Glow Lamp Company, London, arc lamp-posts, £853; Cox-Walkers, Limited, Darlington, switchboard and motor-generators, £2,746.

Ayr.—The Corporation have decided to accept the following tenders in connection with the extension of the electric tramways from St. Leonard's Church to Burns's Monument, a distance of about 1¾ miles: D. Murray, Glasgow, permanent way, £7,611; Lorain Steel Company, rails, £2,577; Lowdon Bros. and Co., Dundee, overhead equipment, £1,820; Callender and Co., London, cable, £1,292. It is also understood that six additional cars, costing about £600 each, will be ordered from Messrs. Hurst, Nelson, and Co., Motherwell.

Newport (Mon.).—The following tenders have been recommended to the Town Council for acceptance for power-house equipment: Sir Hiram Maxim and Co., steam-piping, £2,835; Britannia Company, switchboard, £1,091. 10s. 6d.; W. T. Henley's Telegraph Works, Limited, cables, £3,874. 10s. 1d.; Callender Cable and Construction Company, cableways, £3,514. 19s. 6d.: W. T. Glover and Co., overhead construction, £7,937. 3s. 7d.; British Westinghouse Company, 30 electric motorcars, £14,424. 10s.; Newbold and Co., repair shop equipment, £825.

Liscard (Cheshire).—The Wallasey Urban District Council have received the following tenders for the wiring and fitting for an electrical supply of certain buildings, situate in Seaview-road, Liscard:—Morton and Sampson, Warrington, £330 (accepted); Howe Electrical Engineering Company, Liverpool; National Electric Wiring Company, Limited, Liverpool; R. J. Nicholson and Co., Manchester; Electric Lighting and Fittings Corporation, Limited, Liverpool; Northern Electrical Company, Doncaster; Wells and Co., Liscard; G. A. Steinthal, Manchester; De Lacy Bros., Liverpool; E. Evans and Sons, Seacombe.

BUSINESS NOTES.

TRACTION.

Dudley.—The new tramway sidings in the Market-place are now down.

Perth.—The Town Council have decided to acquire the tramways by arbitration.

Horwick.—Plans of the proposed Preston-to-Horwick light railway have been deposited with the District Council.

Berlin.—The cost of the High-Level and Underground Railway, which is now finished, is estimated at £1,750,000.

Wombwell.—The District Council have received plans of the proposed Barnsley-to-Doncaster light railway scheme.

Hull.—The question of workmen's fares on the Corporation tramways has been referred to a sub-committee for consideration.

Weston-super-Mare.—The tramway scheme for this popular seaside resort has received the approval of the Town Council.

Walker.—The Tyneside Tramways Company's proposal for a tramway in Shields-road will be opposed by the District Council.

Rochdale.—Between five and six miles of the new electric tramways have been already laid, and about 24 miles yet remain to constructed.

Auckland (N.Z.).—It is anticipated that the work of constructing the electric tramways in this city will be completed by the New Year.

Douglas.—The Tynwald Court Committee have reported in favour of the purchase by the Corporation of the Douglas tramways for £50,000.

East Barnet.—A poll of the district is to be taken with regard to the proposed application of the Herts County Council for a light railway order.

Nelson.—The electrical engineer has been instructed to get out specifications and plans for the proposed light railway to the Barrowford boundary.

Bury.—The Town Council have rescinded their resolution in reference to the alternative route for tramways up Tithebarn-street and Parsons-lane.

Stockport.—The Town Council have carried a resolution to apply for a provisional order to authorise the construction of eight new tramways in the borough.

Wallsend.—A deputation from the Newcastle Corporation will shortly wait upon the Wallsend Town Council with reference to the tramways being extended to this place.

New Maldon.—A committee of the District Council has been appointed to deal with the proposal of the London United Tramways Company to extend tramways in the district.

Brighton.—In its first week's working the first section of the municipal tramways carried 115,000 passengers, which is nearly equal to the entire population of the borough.

Glasgow.—Since the beginning of the financial year on June 1 the drawings from the electric tramways have amounted to £338,301, as against £255,222 in the corresponding period of last year, an increase of £83,079.

West Hartlepool.—Lieutenant-Colonel Von Donop and Mr. Trotter, Board of Trade inspectors, made an inspection of the new tramway between West Hartlepool and Seaton Carew on Wednesday.

Folkestone.—A service of motorcars is now running between Folkestone, Hythe, and Shorncliffe, over 50 journeys being made daily. The venture is reported to have met with much success.

Appointment.—Mr. C. C. Howard, of Liverpool, has been appointed traffic manager of the Bolton Corporation tramways, in the place of Mr. Harry England, who has left Bolton to take up a similar position in Sunderland.

Branksome.—A notice has been received by the Urban District Council from the Poole and District Electric Traction Company of their intention to construct an extension of tramlines along the Parkstone-road.

Romford.—At their last meeting the Urban District Council decided to promote a Bill to obtain powers to construct electric tramways in Romford and Dagenham. The scheme also includes an electric light supply.

Dundee.—Illuminated route indicators are now being fitted on the tramcars plying between Lochee and High-street and *vice versâ*. Two powerful electric reflectors are also being placed on the upper decks of the Lochee route cars.

Bromley (Kent).—The Urban District Council have refused to consent to a joint scheme of tramways for Bromley, Beckenham, and Penge. The Council have now appointed a committee to draw up a scheme for their own district only.

Reading.—The Board of Trade have given their approval to the plans for the proposed doubling of the tramline at the corner of Broad-street and St. Mary's Butts. The Council have decided to advertise for tenders for tramway contracts Nos. 2 and 3.

Ayr.—The Town Council on Monday resolved to proceed with the extension of an electric tramway to the Burns Monument, 1¾ miles additional, at the estimated cost of £16,000. The contractors have agreed to finish their various contracts by April 1.

Edinburgh.—The Court of Sessions, Edinburgh, have refused the application of the Corporation for an interim interdict against the Edinburgh Tramway Company's service of Sunday cars. The service of cars on Sundays will accordingly be maintained.

Colchester.—The Board of Trade have approved the widening of Queen-street for the tramways. The Town Council have agreed to ask the Board to sanction a loan for purchasing, as a site for tramway sheds, premises between Magdalen-street and Military-road.

Walsall.—At the meeting of the Town Council on Monday a resolution was adopted that contracts be entered into for the purchase, at an estimated cost of £15,500, of 9,000 tons of granite setts required for carrying out the tramway extensions authorised by the Council.

Eton.—The Rural District Council have directed that the plans, sections, etc., deposited with reference to the proposed electric tramway from Hounslow to Slough and Datchet, to cost £63,000, be referred to the Highways Committee for the surveyor to report on the matter.

Partick.—A discussion took place at the last meeting of the Town Council on a statement that the speed of the electric cars was excessive. A compromise between the Glasgow Tramways Committee and a committee of the Partick Council was decided to be arranged to settle the question.

Newport (Mon.).—The electrical engineer (Mr. Parshall) estimates the total cost of plant and works for the complete equipment of the power-house and car-sheds, linework, distributing system, and rolling-stock at £105,076. Of this amount £42,773 has already been let on contracts.

Selby and Goole Light Railway.—This scheme is now taking practical shape. Application has been made to the Light Railway Commissioners for a provisional order enabling a company to be formed, and the capital is fixed at £120,000. It is proposed to construct the line within five years.

Sheffield.—The city surveyor has been authorised to continue the tramways on Abbeyland-road from Hastings-road to Millhouses-lane. A special sub-committee has been appointed to enquire into and report upon the present administration in connection with the various tramway departments.

Burton.—A meeting convened by the Horninglow Ratepayers' Association has decided by 58 votes to 23 against the introduction of electric tramways in the town, but in the event of its being decided to proceed with the scheme, a resolution was passed in favour of Corporation management.

Newcastle.—The official inspection of the Corporation tramways, preparatory to their being used by the public, was made on Tuesday by Colonel Von Donop and Mr. Trotter, of the Board of Trade. Subject to their favourable report, the cars will begin running on Monday next on the Byker, Gosforth, and Arthur's Hill routes.

Blackburn.—The tramways manager's report on the working of the trams for the month ending Oct. 31 shows that 561,001 passengers were carried, as against 529,260 in the corresponding period last year; 63,671 miles were run, against 47,123; the receipts being £3,221. 14s. 1½d., against £2,468. 3s. 3d., an increase of £753. 10s. 10½d.

Aberdeen.—The Board of Trade have intimated to the Town Council that they are desirous of obtaining complete and accurate information on the subject of accidents on tramways worked by electrical or any form of mechanical power, and requesting that they may be furnished from time to time with reports of accidents occurring on the Council's lines.

Llanelly.—At Monday's meeting of the Borough Council a vigorous protest was made against the delay which had occurred in carrying out the scheme of electric traction and lighting in the town.

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The Council adopted the recommendation of the Estate Committee calling upon the Insulated Wire Company to carry out their obligations to the Council.

Handsworth.—The District Council have given their Highways Committee power to take such action as they may think necessary for the relaying of the lines in Handsworth as speedily as possible, and also to request the company to make a 1d. stage between Vyse-street and Grove-lane, and to extend the time of workmen's tickets until 8 a.m. instead of 7.30.

Solent Tunnel.—Official announcement is made that the directors of the Freshwater, Yarmouth, and Newport Railway Company have carried on negotiations with gentlemen interested in the Solent tunnel scheme with the object of selling the railway, which is just over 12 miles in length. The purchase price has been fixed at £85,000, and a deposit has been paid.

Liverpool Overhead Railway.—An "Ordinary Shareholder" writes to the *Liverpool Courier* to the effect that this company "are losing now at the rate of over £4,000 a year. This is by reason of tramway competition, and the only way to meet such is a reduction of fares—say 1d. per class; otherwise there will be no more dividends for the ordinary shareholder."

Ashby-to-Burton Light Railway.—A committee has been formed to draw up a petition to lay before the Swadlincote Urban District Council stating that the ratepayers of Newhall and Stanton welcome the proposed light railway from Ashby to Burton, but they wish it to run right through the main street of Newhall and Stanton, as it will bring more custom and be of more service to the towns.

Nottingham and Derby Light Railway.—The Notts Merchants and Traders' Association have adopted a resolution, observing with pleasure the intention to apply to Parliament for powers to construct electric light railways in the counties of Nottingham and Derby, but regretting that rival schemes are being promoted, and hoping that money may not be wasted in rival parliamentary contests.

Lowestoft.—A recommendation that the borough surveyor be appointed as engineer for the construction of the tramway track and necessary buildings, not including the provision of the rolling-stock and the electrical equipments, and be paid, in addition to his salary, £140 per mile single line upon the tramway track, and £87 upon the construction of the car-sheds, has been referred back to committee.

Light Railway Orders.—The Board of Trade have confirmed orders authorising the construction of light railways in the rural district of Halesowen, in the county of Worcester; in the county of Essex, to join the proposed Elsenham, Thaxted, and Bardfield Light Railway with the Colne Valley and Halstead Railway; and in the county of Somerset, from Bridgwater to Nether Stowey and Stogursey.

Rome.—A message from Rome states that the Allgemeine Elektricitats-Gesellschaft has petitioned from the Italian Government the concession for constructing an electric railway between Rome and Naples. The company asks an annual subvention of 5,000 lire per kilometre, in exchange for which it will share the profits with the State, after deduction of 60 per cent. for the expenses and 5 per cent. for the reserve.

Cardiff.—The Town Council on Monday resolved to entrust the reconstruction of the tramways for electric traction to the borough engineer (Mr. Harpur), the work to be completed within six months from July 1 next. Tenders for the work will be advertised for shortly. The town clerk was instructed to serve notice upon the Cardiff District and Penarth Harbour Tramways Company to acquire the lines between Grangetown and Splott.

Glamorgan.—The Parliamentary Committee of the County Council recommended that the application of the Aberdare and Mountain Ash District Councils for consent to lay tramways be granted, with the stipulations that the road be widened to 24ft., with footpaths where possible; that the passing places be pitched; and that a clause be inserted enabling the County Council to connect future tramways, and to work through running cars at a fair rate.

Presentation.—The employés connected with the Southport Corporation electric tramways have made a presentation to Mr. R. J. Wilton on his resigning the management of the Corporation tramways department to take up the position of constructive manager to Messrs. George Hill and Co., electric equipment manufacturers, Cornbrook, Manchester. The gifts took the form of a walnut spirit tantalus with silver mounts and a handsome silver cruet.

Rhondda.—The Urban District Council have received intimation that the Board of Trade have declined to confirm the order granted by the Light Railway Commissioners for laying down an electric line between Porth and Tonypandy. This result has been brought about by the strong opposition which the Council made to the scheme. This is explained by the fact that the Council are promoting a Bill in the next session of Parliament for a scheme of tramways.

Darlington.—The Town Council adopted a resolution at their last meeting to construct and work municipal electric tramways, and to borrow £100,000 for that purpose. The voting for municipalisation was 17 to 3. At the same meeting the Council further agreed to appoint a committee to consider and report as to the terms on which the Corporation should offer to supply the North-Eastern Railway Company with electrical energy for lighting and power purposes.

Dysart.—In connection with the proposal to extend the tramways and electric lighting to Dysart, the Tramways Committee for Dysart point out in a minute on the subject that they do not consider electric lighting suitable for their burgh, while the tramway line would serve Dysart well enough if carried as far as West Port. To carry it beyond that would probably be an advantage to the system generally as a feeder, but not to Dysart, and they should not, therefore, have to bear the further extension.

Grimsby.—On Saturday last the electric tramway service was opened in the town. The system is owned by the Provincial Tramways Company, the current for working the cars in the borough being obtained from the Corporation electricity works, whilst that for the line from Grimsby to Cleethorpes is supplied by the company's own station. The running powers have been leased from the Corporation for 21 years, at an aggregate rental of £30,000, and some two dozen cars are employed.

Motor Racing in England.—Messrs. D. Farman and J. V. F. Scudder have written to the Press with regard to the proposed motor race, over a distance of about 110 miles, for £1,000. They state that, owing to pressure brought upon them by the Automobile Club of Great Britain, and to the fact that the proposed race might imperil the extension of the present speed limit in Great Britain, they have been reluctantly compelled to transfer the *venue* of the race to the Continent at an arranged date, before the end of this year.

Birmingham.—Under the title of the Birmingham Motor Passenger Company, Limited, a syndicate is promoting a scheme to place a service of motorcars on several of the streets of this city. In view of the strong opposition to the tramway proposals to Edgbaston and Harborne, the motor scheme has aroused much interest in that quarter of Birmingham. It is reported that a local firm of solicitors has signified that a London syndicate has empowered them to apply to Parliament for powers to construct a number of tube railways for this city.

Isle of Thanet Electric Tramways Co.—This Company have made a further issue at par of £150,000 4 per cent. debenture stock and 30,000 5 per cent. cumulative preference shares of £5 each. The Company owns about 10 miles electric tramways in Thanet, Kent, all of which are constructed on the overhead system. The generating station is designed to supply electricity both for traction and lighting for the whole district. Sub-stations have been erected at Ramsgate and Margate, and cables are laid from the generating station to the sub-stations.

Hebden Bridge.—The Hebden Bridge District Council and the Halifax Tramways Committee are at a deadlock with regard to the two following points in connection with the tramway scheme—viz., the laying of high-tension cable to the new transforming station at Hebden Bridge and the fixing of the trolley standards on the high road after leaving Falling Royd Bridge. The District Council have declined to allow the Corporation to proceed with the laying of the cable to Oldgate until satisfactory arrangements are made for the fixing of the standards throughout the district.

Burnley.—The work of relaying the tramway from the Nelson end is proceeding. At the other extreme the centre poles are up from Padiham to Whitegate, and the overhead equipment will be completed to Padiham before long. It must, however, be four or five weeks before a public service can be run to Padiham. The Board of Trade inspector is expected in the early part of next week. So far from the overhead equipment delaying the work, as has been previously stated, the contractors and electrical department affirm that this part of the work will be finished before the trunk-line track.

Light Railways Legislation.—A Departmental Committee of the Board of Trade has been appointed for the purpose of considering and reporting what additions or amendments to the Light Railways Bill, 1901, it would be desirable to propose, having regard to the provisions of the Tramways Act of 1870 and the Light Railways Act of 1896. The members of the committee are: Sir Francis Hopwood, K.C.B., C.M.G. (chairman), Sir John Edward Dorington, Bart., M.P., Colonel Sir Herbert Jekyll, K.C.M.G., Mr. Sydney Morse, Mr. Arthur T. Tring, Mr. George White, and Mr. W. J. Jeeves.

Light Railway Schemes.—No less than 44 applications for orders authorising the construction of light railways were deposited with the Light Railways Commission in the course of the last month, involving a total mileage of about 386 miles, of which 379¾ miles are in England and the balance—6¼ miles—in Wales. Of the 42 applications in England 30 are entirely new, 10 seek powers for extending their systems, and two for amendments; while of the two applications in Wales, one is new and the other an amendment. Thirty-eight of the applications propose to use electricity as the motive power and four will use steam.

Greenock.—The Procurator-Fiscal has asked the Corporation for instructions to make application to Port Glasgow Corporation for consent to supply electrical energy to the tramway company within the burgh of Port Glasgow, the application to be under reservation of all rights that Greenock may have in the matter. A special meeting of the Corporation will be held to consider the proposal. Meanwhile the company have asked for an extension of the period within which they were to reply to the Corporation's request that a new arbitrator be appointed to deal with the Sunday car controversy. An additional eight days has been granted.

Plymouth.—The Board of Trade have intimated to the Tramways Committee that they are unprepared to approve of the construction of a circular turnout at the Octagon, and stating they are advised that the object could be attained by other arrangements at less cost. On this subject the borough surveyor is in communication with the Board's inspector. The borough surveyor has been instructed to lay points and crossings between the corner of Ebrington-street and the market, and the electrical engineer to provide the overhead electrical equipment. An effort is to be made to obtain the sanction of the Board of Trade to the running of tramcars into the market.

Camberwell.—The Borough Council are recommended to present petitions against the following "tube" schemes: East London, City, and Peckham Railway; Crystal Palace Light Railway; Victoria, Kennington, and Greenwich Railway; and City and Crystal Palace Railway. The Works Committee recommend the Council to give their consent to the construction of a tramway by the London County Council from Camberwell-green *via* Denmark-hill, Champion-hill, Grove-lane, Dog Kennel-hill, and Lordship-lane to a point near Crystal Palace-road, and that the Council contribute one-third of the cost of the necessary

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street widenings in the borough, such contribution not to exceed the sum of £34,000.

Shipley.—The negotiations between the Bradford Corporation and the Shipley District Council with reference to the conversion to electric traction of the tramways running from the Frizinghall boundary to Saltaire, which are owned by the District Council, have resulted in a deadlock. General terms have been agreed upon, but the two bodies have failed to make an agreement as to the provision of the traction cable. The Shipley Council now wish the matter settled by the Board of Trade. In the meantime the Shipley Council have decided to go on with the work of reconstruction so that the system of electric traction from Forster-square to Saltaire may be completed with as little delay as possible.

Bristol.—An exciting accident occurred on the Blackboy-hill tramway on Monday By some misunderstanding the brake of a car which had arrived at the terminus at the top of Blackboy-hill was taken off, and when the trolley was connected with the overhead conductor again for the return journey the car immediately started off down the hill, gathering great speed on its way. Eventually, it dashed into another car which was stationary at one of the halting places, and the two cars jumped the rails on to the pavement. Great damage to the cars was done, but nobody was injured, both vehicles being without passengers at the time. No official details have yet come to hand, but it is stated that the boy who changed the trolley took off the brake which the driver had just put on.

Acton.—A large public meeting held at this place on Tuesday unanimously passed resolutions protesting against the Middlesex tramway agreement. The first resolution deplored the action of the County Council in entering into an agreement to surrender its rights over a large part of Western Middlesex to the London United Tramways, Limited, without consultation with the local authorities concerned, and without adequate public discussion; while the second expressed the opinion that no further agreements should be entered into respecting tramway matters which would have the effect of granting concessions to private companies, or of binding the future action of the County Council until the various districts concerned have had an opportunity to discuss such policy. The Acton Urban District Council have also passed a resolution profoundly deploring the action of the County Council, and protesting against "such a betrayal of the interests of the inhabitants of Acton and neighbouring districts."

Southport.—At their last meeting the Town Council passed a resolution approving an application to the Board of Trade to construct a loop line on the Scarisbrick new road section of the electric tramways, the cost being estimated at £10,000, and to enable them to construct additional tramways in the Cemetery-road and Duke-street districts. It was stated that Mr. R. J. Wilton, the tramways manager, had resigned, owing to his having been appointed constructing manager to Messrs. G. Hill and Co. Reductions in fare and contracts on several sections of the electric tramways were notified. The Corporation have agreed to grant the tramways company temporary running powers on the Sefton-street line after Jan. 1 next. The Corporation have also agreed to meet the company in a suggestion to issue a yearly "contract" available over the whole of the lines of the company and the Corporation at a charge of £5. The charge for contracts on any one route will be £2. 10s.

Yarmouth.—The Town Council at their meeting on Tuesday decided by 19 votes to 18 to reject the offer of the British Electric Traction Company for a lease of the Corporation tramways, which are in course of reconstruction for electric traction. The proposed lease was for 21 years, with option to the Corporation to determine at the end of 14 years. The points of difference between the company and committee were mainly two—viz., the fixed sum to be contributed by the company per route mile per annum in respect of the maintenance of roads, and as regards the price of electrical energy for working the cars. The fixed sum offered by the company for maintenance was £75, and for supply of energy from the Corporation they proposed 2d. per unit for the first 200,000 units and 1½d. for all above. An amendment that the committee's report be referred back with a view to the resumption of negotiations with the company was defeated, and, in accordance with the committee's recommendation, the company's offer was rejected.

Law of Tube Railways.—Mr. G. M. Freeman, K.C., read a paper dealing with the legal problems connected with the construction of "tube" railways last week before the Auctioneers' Institute. In the course of his remarks he pointed out that if "tube" railways were constructed under the general law the promoters would have to pay first for the land taken, and as ownership went down to the centre of the earth they would not be relieved by going in a tunnel. A clause had, however, generally been introduced into the Acts authorising the promoters to take an easement only under lands. Parliament appeared to have been under the impression that the roads belonged to the local authority, but only such depth belonged to them as was necessary for repairs, sewers, etc., all below remaining the property of the adjoining landowners. In conclusion, Mr. Freeman expressed his view that all owners of property who could prove damage should be entitled to compensation, and he considered that all landowners whose property was likely to be affected should have the right to go before the Parliamentary Committee and put their cases.

London County Council.—At their usual weekly meeting on Tuesday the London County Council approved the recommendation of the Highways Committee, "That the underground system of electrical traction be approved for use on the London county tramways between (*a*) Kennington-road, at its junction with Westminster Bridge-road, and St. George's-circus; (*b*) the Elephant and Castle, *via* New and Old Kent roads, and New Cross-gate; (*c*) the Elephant and Castle and St. George's Church, Borough, and thence to the junction of New and Old Kent roads; (*d*) the Elephant and Castle, *via* Walworth-road and Camberwell-road, and New Cross-gate; (*e*) Camberwell-green and the terminus near Vauxhall Bridge; and (*f*) Kennington Park-road and Brixton-road." The committee's report on the subject appeared in our last issue. The Council further approved the Tramway and Improvements Bill submitted by the Parliamentary Committee for powers to enable the Council to construct the following tramways: North of the Thames—Seven Sisters-road (existing lines), *via* Amhurst-park to Upper Clapton-road (existing lines); Chelsea Bridge (north end), *via* Grosvenor-road, to a point near Lambeth Bridge; Hampstead-road, across Euston-road and along Tottenham Court-road, to a point near Oxford-street; Edgware-road (from a point near the Marble Arch), to the county boundary at Cricklewood; Hammersmith Broadway, *via* Queen-street, Fulham Palace-road, High-street, Fulham, and Putney Bridge to the Lower Richmond-road; along the Victoria-embankment from a point near Westminster Bridge to a point near Blackfriars Bridge; along Elgin-avenue, from Maida-vale to Harrow-road. South of the Thames—Clapham Common, south side (existing tramways), *via* Clapham Common, Battersea Rise, Wandsworth Common (north side), East-hill, and West-hill, to the county boundary in Kingston-road; Deptford (existing tramways), *via* Blackheath road and hill, Shooter's-hill-road, to the Herbert Hospital, and from thence *via* Woolwich Common-road, the road to the west of St. George's (garrison) Church into New-road, and Thomas-street and Green's-end to Beresford-square, Woolwich, and returning along New-road and Mill-lane to a point in Woolwich Common-road near Nightingale-place; New Cross-road to High-street, Lewisham; Streatham High-street *via* Streatham High-road, to the county boundary at Norbury; Camberwell Green, *via* Denmark-hill, Champion-park, Grove-vale, and Lordship-lane, to a point near the intersection of that thoroughfare with Crystal Palace-road; Trafalgar-road, Greenwich, *via* Blackheath-lane, to a point near the southern approach to the Blackwall Tunnel; Herbert Hospital, *via* Wellhall-lane, to Eltham; the Bill also seeks powers to run necessary omnibus services, and also to widen various thoroughfares. The Council also formally approved the Bill for the construction of a shallow underground tramway from the Victoria-embankment to Theobald's-road, particulars of which have already appeared in these columns.

LIGHTING AND GENERAL.

Share Market.—Both electric supply and traction shares were in moderate demand during the week.

Sale of Plant.—Particulars of a sale of motors and dynamos will be found in our advertisement columns.

Sheffield.—Increases of salary have been granted to a number of the staff of the electric lighting department.

Wirral.—The application to the Board of Trade with regard to the proposed lighting of the district has been sealed.

Kingswinford.—It is expected that electric current will be ready for distribution in the district early in the New Year.

Branksome.—The Urban District Council are making enquiries as to the cost of electric lighting of Poole and Ashley roads.

Cubitt Town and Millwall.—The placing of arc lamps in the main roads of Cubitt Town and Millwall has been decided upon.

Chichester.—The surveyor is about to carry out a system of electric call bells for the fire brigade at a cost not exceeding £100.

Eccles.—The plans of the proposed extensions to the generating station have been approved, as recommended by Mr. Wordingham,

St. Andrews.—The Town Council have approved of the draft agreement to Messrs. Crompton and Co., referred to in our last issue.

Banbury.—A draft agreement with a local company with regard to the electric lighting of the borough has been approved by the Council.

Bursiem.—The Electric Lighting Committee are about to visit various places with the object of obtaining information as to electric lighting.

Worksop.—An enquiry will be held shortly into the Urban District Council's proposed borrowing of £8,000 for electric lighting extensions.

Nelson.—The Electricity Committee have appointed a special sub-committee to consider applications for current for motive power for long periods.

Lowestoft.—On Nov. 29 194 private consumers were receiving current, representing 9,567 8-c.p. lamps. A number of mains are being extended.

Barnstaple.—The Electric Lighting Committee are in communication with Mr. Trentham about the carrying out of an electric lighting scheme for the borough.

Littleborough.—The Electricity and Tramways Committee have been asked to take the necessary steps, as early as possible, to establish a supply of electric light in the district.

East Molesey.—The resolution passed by the Rural District Council in August authorising the clerk to apply for a provisional order for electric lighting has been rescinded.

Loughborough.—The Guardians have accepted an offer from the National Telephone Company agreeing to accept the Guardians as subscribers at £3. 10s. a year and 1d. per call.

Paisley.—The Town Council have decided to apply for a provisional order for further borrowing powers, to the extent of £30,000, for extension of the electric lighting undertaking.

Scarborough.—Messrs. Stephenson, W. S. Rowntree, Taylor, Boyes, and Broadwood have been appointed a committee to consider the question of establishing a municipal telephone service.

Cowdenbeath.—The Town Council are borrowing £1,800 from the Public Works Loan Board to defray the cost of the lighting of the streets by electricity, particulars of which appeared in our issue of Nov. 15.

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Westhoughton.—The Council have sealed a memorial to the Board of Trade applying for a provisional order empowering the Council to supply electrical energy for lighting or other purposes in their district.

Beckenham.—There appears to be considerable trouble with reference to the gas supply at the Alexandra Schools, and Mr. Hooper has been asked to report as to the approximate cost of the electric light for the schools.

Cheshunt.—The Urban District Council have referred the consideration of the electric lighting order to a special committee, with power to employ expert evidence, if deemed necessary, at a cost not to exceed £10. 10s.

Muscat.—It is announced that telegraphic communication has been opened with Muscat, Arabia, and that telegrams can now be forwarded at 3s. 7d. a word *via* the Indo-European Company's cables, and at 3s. 3d. a word *via* Turkey.

Lightning Change.—Precisely at midnight on Saturday the old telephone exchange at Gloucester-road, South Kensington, was closed. At a minute past midnight the new exchange, with greatly improved methods, was opened at Sussex-place.

Waterford.—The consideration of the report of Messrs. Lacey, Clirehugh, and Sillar in reference to the electric lighting scheme, and of a resolution that the Corporation proceed to carry out the electric lighting scheme, has been adjourned for six months.

Bradford.—At Tuesday's meeting of the City Council a discussion took place upon a motion for the appointment of a special sub-committee to consider and report whether it is advisable that the Corporation should establish a municipal telephone system.

Blackburn.—The council of the Blackburn Chamber of Commerce have requested the Corporation to accede to the request received from other local authorities to call a representative meeting to consider and report on the question of a new municipal telephone exchange.

St. Marylebone.—The Lighting Committee in their report upon the London County Council's Electric Supply Bill recommend the Borough Council to approve of Clause VI., but to deprecate any further interference with the local self-government of the various boroughs.

Salisbury.—The application of the Salisbury Electric Light and Supply Company, Limited, to temporarily erect and light two specimen arc lamps in the city, and to inform the authority as to the cost of lighting the city in whole or part, has been acceded to by the Town Council.

Salford.—The Council have passed a resolution to assist in the promotion of a Bill to constitute a Board, consisting of representatives of corporations and district councils within the Manchester telephone area, for the purpose of providing a system of public telephone communication.

Cleethorpes.—The Urban District Council have decided to provide for a sum of £32,500 in the Improvement Bill for the purchase of the Cleethorpes generating station and plant from the Grimsby Street Tramways Company, and for the supply of electrical energy and lighting purposes.

Gravesend.—The Town Council invite tenders for a loan of £31,500 for purposes of electric lighting and power, repayable in 25 years, on the annuity system, by equal half-yearly payments of principal and interest combined. Repayment will be secured on the rates of the borough.

Ayr.—It has been decided that the charge for current for power purposes be as follows: first 500 units, 4d. per unit; above 500 and up to 1,000 units, 3d.; above 1,000 and up to 2,000 units, 2½d.; above 2,000 and up to 5,000 units, 2d. The charge for a larger number of units is to be by special agreement.

Stockton.—At the last meeting of the Town Council, Mr. Ford reported that Messrs. McLaren had had the new electric plant running so far satisfactorily. Fifteen additional consumers were connected to the mains during October, and an application had been received for a permanent supply to the Grand Theatre.

New Appointments.—Mr. Charles R. Brown, of Messrs. J. H. Holmes and Co., has been appointed chief assistant to the superintendent engineer of the Bradford Corporation.—Mr. Neville Walton, of Weston-super-Mare, has been appointed third assistant at the Corporation electricity works, King's Lynn.

Rosling and Fynn, Limited.—We are informed that the name of the company formerly trading under the name of Rosling, Appleby, and Fynn, Limited, electric and mechanical engineers, manufacturers of dynamos, motors, and alternators, etc., Trafalgar Works, Bradford, has been altered to Rosling and Fynn, Limited.

Finsbury.—The Borough Council have resolved that a special committee of 12 members be appointed to enquire into and report upon the electric light and power undertakings in the borough, and to consider the best means of obtaining the necessary powers to acquire such undertakings or to lay down a competing installation.

Mitchelstown.—On Thursday last week a deputation, consisting of a committee recently formed to provide the means for lighting Mitchelstown with electric light, obtained the Rural District Council's sanction to the raising of a loan of £2,000 for the purpose. Further prompt action will be taken, and Michelstown will probably be lighted in the winter of 1902 with electric light.

Barnsley.—It is contradicted that the Guardians of Barnsley Union have agreed to accept the Corporation's terms for the supply of electric light to the workhouse. As a matter of fact they decided in committee on Tuesday week, by a majority of one, not to accept it from the Town Council at any price, and are to proceed with an installation of their own if the Local Government Board will sanction the borrowing of the money required for the purpose.

"The Railway Diary and Officials' Directory," 1902.—We have received from Messrs. McCorquodale and Co., Limited, a copy of the "Railway Diary and Officials' Directory," and also a copy of the "Railway Almanack" for the ensuing year. This book is published at 1s., and is in every part similar to previous issues, except that the tables are brought up to the middle of 1901.

St. Annes-on-Sea.—A letter from the Blackpool Electric Tramways (South), Limited, asking whether the Council are ready and willing to supply electricity for working the tramways, as authorised by the Act of Parliament, within the Council's district, and if so, how soon and at what price they could be prepared to supply it, is before the Electric Lighting Committee of the Urban District Council.

Electric Construction Co., Limited.—We are informed that this Company will open a branch office at Prudential-buildings, King-street, Manchester, on or about 20th inst. Mr. Sidney Crouch, A.M.I.E.E., has been appointed the representative of the Company for Lancashire, Yorkshire, and neighbouring districts. Mr. Crouch has for several years represented Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne, in the Manchester district.

Ormskirk.—The question of electric light was discussed at the last meeting of the Guardians, and it was resolved that before any further action was taken a communication be addressed to Messrs. Wright, Beckett, and Co., enquiring whether, in connection with the proposed light railway, the company would be in a position to supply the electric light, and, if so, when and upon what terms.

Copper.—Copper lost a further 20s. per ton on Wednesday. In the morning there was a continuance of heavy selling at £55, and £54 is the final quotation for cash and three months. Settlement price, £55. About 1,200 tons changed hands. Selling has been continued by the same dealers, but less vigorously than hitherto. At the close there were a few realisations, and buyers were difficult to find.

Explosion.—An explosion, originating in a transformer chamber connected with the local electric light company's main, occurred at Rochester on Saturday. The flagstones covering the chamber were blown into atoms, and scattered in all directions. Two women were thrown down by the shock, and very much scared, but were not seriously injured. More than one window in the vicinity was broken.

Stock Exchange.—The Stock Exchange Committee have been asked to allow the following securities to be quoted in the official list: General Electric Company (1900), Limited, 7,000 vendors' 5 per cent. cumulative preference shares of £10 each, fully paid, Nos. 1 to 7,000, and £50,000 vendors' 4 per cent. first mortgage debenture stock; Western Telegraph Company's further issue of £51,223 4 per cent. debenture stock (redeemable).

Darlington.—The last report of Mr. Lunn, the borough electrical engineer, is as follows: "Since the date of my last report five consumers and 234 8-c.p. lamps have been connected, bringing the total up to 127 consumers and 9,811 8-c.p. lamps. I have applications from 14 consumers, who will require 676 8-c.p. lamps. The number of units generated during the last fortnight is 15,780, and the cost per metered unit for coal is ·53d."

Grays (Essex).—Mr. Long, electrical engineer to the Urban District Council, in his last report states that there have been 44 applications for a supply of electric energy, representing the equivalent of 3,533 lamps of 8 c.p. Twenty street lamps have also been connected. From Oct. 21 to Nov. 21 the refuse consumed had been 151 tons, and the coal 12½ tons. If there had been sufficient refuse, he considered that no coal would have been required.

Hull.—At the last meeting of the City Council it was decided to offer to supply current for power as follows: exceeding 100,000 units per annum, but not exceeding 250,000, 1½d. per unit net; exceeding 250,000, but not exceeding 500,000, 1¼d. per unit net; exceeding 500,000, 1d. per unit net. The consumers to enter into an agreement to take the supply for at least three years, and to provide (if required) proper accommodation for transformers on their own premises.

London County Council.—On Tuesday the Council agreed to lend the Battersea Borough Council £10,000 for an electric light installation; the Hackney Borough Council £35,800 for an electric light installation and dust destructor; and the St. Pancras Borough Council £18,210 for an electric light installation and meters. The London County Council (Electric Supply) Bill dealing with the purchase of undertakings for the supply of electricity in London was approved.

Beverley.—The Town Council on Monday decided upon the introduction of the electric light. The Local Government Board, to whom application has been made for leave to borrow £15,000, has asked for particulars. A letter has also been received from the Board of Trade stating the system to be adopted for the supply of electricity under the order, and the form in which the Board propose to approve of it. The system described by the Board of Trade and the conditions are to be carried out.

Electric and General Investment Co.—The directors have declared the following interim dividends: At the rate of 6 per cent. on the preference shares for the six months ending 31st inst., being 3s. per share to the shareholders registered in the books of the Company on that date; 10 per cent. on the capital paid up on the ordinary shares, being 2s. per share for the six months ended the 30th ult. to the shareholders registered in the books of the Company on Nov. 30. Both dividends will be paid, less income tax, on Jan. 1, 1902.

Electrical Exhibition.—It has been decided to hold an electrical exhibition in Doncaster some time in January next, and we are informed that Mr. W. Wyld, A.M.I.M.E., A.M.I.E.E., the borough electrical engineer, is now ready to give the requisite information to intending exhibitors, who should communicate with him as soon as possible. No charges whatever are being made, and it is possible, too, that current will be supplied free of charge to drive small motors, fans, heaters, radiators, etc., but this is a matter which will, of course, depend upon the nature and the amount of the demand.

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Electrical Training for Railway Employes.—Recognising the important part electricity will play in railway traction in the near future, Lord Claude Hamilton on Friday, on behalf of the directors of the Great Eastern Railway Company, promised a donation of £1,100 towards the formation of classrooms and electrical laboratories at the mechanics' institute attached to the Stratford works of the company.

Westminster Electric Supply Corporation.—An extraordinary general meeting of the shareholders of the above Corporation will be held at the offices, Eccleston-place, S.W., on Dec. 19 at 11 a.m., when a resolution providing that the capital of the Company be increased from £550,000 to £800,000 by the creation of 50,000 new shares of £5 each, which was passed at an extraordinary general meeting on Dec. 4, will be submitted for confirmation as a special resolution.

Bury.—A sub-committee has been appointed to enquire into the estimated cost of supplying electric light to the new markets. The electrical engineer's report as to the extension of plant required for tramways purposes will be discussed next month. An application from the Bury Guardians with reference to the cost of supplying electricity to a new hospital which it is proposed to erect, and generally to the workhouse, has been referred to the electrical engineer for report.

Richmond.—The Town Council have passed the following resolution: "That the Town Council of Richmond regret that the scheme proposed by the Postmaster-General for telephonic communication does not establish effective competition as recommended by the Select Committee of 1898, and does not secure to the public the advantages of the efficient and cheap service which they have been led to expect." The Council have decided to send delegates to the conference at the Guildhall on the 23rd inst.

Walsall.—Application is to be made for sanction to the appropriation by the Council of land for the purposes of electric lighting, and which is required for the erection thereon of a transformer station, to be used for supplying the tramways with current. The Electric Lighting Committee will be charged an annual rent of £10. The salary of Mr. A. Wyllie, the electrical engineer, is to be increased from £300 to £400 per annum, as from Nov. 1 last, with further increases of £50 per annum up to £500.

Morley.—The charge for 16-c.p. Edison and Swan lamps supplied by the Corporation's electricity department has been reduced from 1s. 3d. to 1s. 2d. each. Mr. H. Drewett, the electrical engineer, in his last report states that the output from the electricity works during the four weeks ended Nov. 16 was 11,191 units, against 8,897 for the corresponding period of last year, being an increase of 25·75 per cent. There had been 120 lamps connected during the month, the total number of lamps up to date being 8,353.

Kensington.—The Borough Council have agreed to notices received (1) from the Brompton and Kensington Electric Lighting Company, relative to proposed extensions of their mains in Brompton-road, Kensington-road, and Kensington High-street; (2) Notting Hill Electric Lighting Company, Holland-street; and (3) Brompton and Kensington Electricity Supply Company, Redcliffe-gardens, with the exception of part of the roads referred to in the first notice and which are within the jurisdiction of the city of Westminster.

Dumfries.—The Town Council have received an offer from Messrs. Crompton and Co., who are prepared to take over the powers of the Corporation, erect stations, carry through the work, supply the public, and pay to the Corporation £150 per annum for the first five years and £250 thereafter. A deputation has been appointed to visit Old Trafford to see the Mond gas in operation and ascertain whether it was suitable as a motive power for the generation of electricity. Discussion on the matter is postponed until after the deputation's report.

Glasgow.—When the Glasgow Corporation Gas Bill came before the last meeting of the City Council a discussion arose upon Clause 21, which empowers the Corporation to provide, sell, let for hire, and fix up, alter, remove, but not to manufacture, lamps, meters, motors, electric lines, fittings, apparatus, etc., an amendment that power should be taken not only to hire or supply, but also to manufacture, was not seconded. In the course of discussion several members urged that the words "shall not manufacture" should be deleted. This was agreed to, and the clause was then approved.

Brighton.—At the last meeting of the Town Council attention was drawn to an item in the electricity works account with respect to the payment of £5,000, being the fifth instalment on account of the contract for constructing concrete foundations, wharf, and timber piling, timber dam, and concrete weir for the new electric power-house, Southwick. The small progress that has been made with the scheme was complained of, and it was stated that the Lighting Committee intended to call in an expert in connection with the undertaking, and at a very early date the Council will be asked to consider the position.

Hampstead.—The Lighting Committee's last report states that the cost of the coal consumed at the electric lighting station for the year ended at Lady Day last was £11,452, which was equivalent to 1·57d. per unit sold, as compared with 1·24d. per unit during the previous year. The engineer has reported that the condensing plant already in use had effected a saving in the coal consumed of £770 between April 1 and the end of October, and tenders will now be invited for additional condensing plant, at an estimated cost of £9,000, which it is estimated will effect a further saving in the cost of coal of about £2,000.

York.—The Corporation's electric lighting scheme appears to be a successful venture. There are now 16,000 lamps connected and 6,700 awaiting connection. Mr. Midgley estimates that by the winter of 1903 the demand will reach 43,000 lamps. Important extensions are already planned, and should be completed by August next. A second engine and boiler house will be built, and it is proposed to put in three boilers of 800 h.p. each, and two engines of 1,000 h.p. The expenditure on these important extensions is estimated at £50,000. In addition to 250 private consumers and the street-lighting, electrical power is being supplied to several local firms.

New Issue.—The Isle of Thanet Electric Tramways and Lighting Company, Limited, are just issuing £150,000 4 per cent. debenture stock and 30,000 5 per cent. cumulative preference shares of £5 each at par. The company, whose share capital is fixed at £300,000, possesses a system of electric tramways running through Ramsgate, Broadstairs, St. Peter's, and Margate, in the Isle of Thanet, county of Kent. They also hold orders for the supply of electricity for lighting and power in Broadstairs and the Isle of Thanet rural district. The benefit of the electric lighting order for Margate obtained by the Corporation of Margate has also been transferred to the company by the Corporation.

Fulham.—Mr. J. L. Morris, one of the engineers-in-charge at the electric lighting works having resigned, Mr. S. T. Shepherd, who is the only one remaining of the three engineers originally appointed, is to be appointed senior engineer-in-charge, and Mr. W. E. Rogers, who is a switchboard attendant, is to be made engineer-in-charge, with increases in their salaries. Mr. Rogers was in charge of a shift at the Post Office electric lighting station at Mount Pleasant, and he was lately one of the selected candidates for the position of engineer-in-charge at another electric lighting works. The steam exhaust mains in connection with the exciter engines are to be increased in size, at an estimated cost of £421.

Bermondsey.—The Electric Lighting Committee of the Borough Council have approved of the expenditure of a sum not exceeding £1,000 for the purpose of wiring and putting in fittings to the premises of those requiring electric lights from the Council's works. The committee have taken this action notwithstanding that the Local Government Board has stated that the expenditure could not properly be incurred under the Local Authorities' Expenses Act, and that the Board of Trade has expressed the opinion that there was nothing in the electric lighting order which empowered the Council to execute any work on the consumers' premises. The Borough Council have approved the committee's action.

Norden.—The surveyor, in his monthly report, stated that the heavy rain and wind about the middle of November did considerable damage in Woodhouse-lane and Wolstenholme. Five of the electric light poles were blown down and many of the lamps were damaged. New poles were fixed as soon as the weather would permit, but in consequence of the bad weather the lamps had not been lighted, as the wiremen could not work. The chairman subsequently gave notice that at the next meeting of the District Council it will be proposed that instead of 25-c.p. lamps being used on alternate poles, as at present, 16-c.p. lamps be placed on every pole. Under this system the lights, instead of being 108 yards apart, would be 54 yards apart.

City Lighting.—On Monday the special committee recently appointed to deal with the question of electric light and the representatives of the London Electric Lighting Company discussed the terms of a settlement of outstanding differences. The special committee proposed to the Court of Common Council last night that the old contracts existing between the Corporation and the company and all litigation in respect thereto should cease, and that a new contract be entered into with reference to the lighting of the principal streets at a sum agreed upon. The company is to be freed from all liability in regard to the lighting of the side streets, and they are to give a domestic supply of electric current to the Corporation, as a public body, at 4d. per unit.

South Africa.—The *British and South African Export Gazette* says: "One of the newest schemes for the creation of electric energy for agricultural and industrial purposes has been put forth by Prof. Morrison, of Victoria College, Stellenbosch. He suggests that the Orange River Falls should be utilised to provide electric power for the Cape railways. The huge mileage of the system is, however, held by some to render the scheme impracticable. The machinery recently ordered through Messrs. Reunert and Lenz for the Cape Peninsula Electric Lighting Company, Limited, will shortly be shipped. The De Beers Company have placed an order for 25 miles of three-core extra high-tension cables for their new central-station scheme at Kimberley with the British Insulated Wire Company, Limited, London, S.W."

London Gazette.—The last day for receiving proofs in the estate of G. F. Rogers, electrical engineer, 41, Maxilla-gardens, Notting Hill, and 5, Great Winchester-street, London, is 21st inst. Mr. A. H. Wildy, official receiver, Bankruptcy-buildings, Carey-street, E.C., is trustee. The partnership existing between C. V. Fisher and A. E. Allison, electrical engineers (trading as Fisher and Allison), 3, Cleveland-street, Doncaster, York, has been dissolved by mutual consent. The partnership existing between W. Frazier and H. P. Frazier, electricians (trading as H. P. Frazier and Co.), 23, Congreve-street, Birmingham, has been dissolved by mutual consent. The last day for receiving proofs in the estate of C. A. Church, manufacturing electrical engineer (trading as H. Conolly and Co.), 42, Hampstead-road and 120, Kentish Town-road, is 21st inst. Mr. L. H. Lemon, 32, King-street, Cheapside, E.C., is the trustee.

Walker.—The District Council have adopted a report of the Electric Lighting Committee, recommending that the Council appoint a skilled electrical clerk of works. The committee reported that in the action brought by Messrs. Richardson and Co., the judge granted an injunction against the Council restraining them from cutting or injuring Messrs. Richardson's mains under Fisher-street, with costs. In the action brought by the Council against Messrs. Richardson and Co., the judge decided that the company had illegally constructed a vault, arch, or cellar under Fisher-street in contravention of the Act, and that the Council were entitled to pull down, alter, or otherwise deal with the same as they might think fit, and to recover any expenses incurred from Messrs. Richardson, and accordingly gave judgment for

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the Council, with costs. The Council will proceed to act upon the judgment in their favour.

Swansea.—The last report of the engineer, Mr. C. A. L. Prusmann, gives the total number of applications received for electric lighting in Swansea as 178, with a total demand for 21,361 8-c.p. lamps. This gave on Oct. 2 an increase of 11 per cent. approximately in the number of consumers, with an increase in the number of lamps applied for of 23 per cent. The total number of consumers actually connected is 155. The engineer considers that the undertaking has reached the stage at which it becomes absolutely necessary to run two shifts, which will involve a very considerable increase of staff. The number of public arc lamps now in use is 38, and the street incandescents in use number 75. The mains being small, it is intended, for fear of a breakdown, not to connect new customers till after Christmas. Steps are being taken to end the contract with the consulting engineer, Mr. Manville. The Corporation Committee have decided to offer the Harbour Trust electric lighting for the dock, etc., at 1½d. per unit on a minimum quantity of 300,000 units per annum.

Battersea.—The Lighting Committee, in their report upon the London County Council's Electric Supply Bill, recommend that the necessary steps be taken with a view to the insertion of a clause in the Bill enabling the Borough Council, should they deem it advisable at some future time, to amalgamate with the local authorities adjoining for the purpose of supplying electrical energy. With regard to the Board of Trade's intention to introduce during the ensuing session of Parliament a Bill on the sames lines as the Bill of last session, the same committee recommend that the Board of Trade be informed that the Council are in favour of the Bill as introduced by the Board last session. The electrical engineer has reported that up to the present time the number of applications for the supply of electricity, including the Council buildings, amount to 117, with an aggregate equivalent to 11,087 8-c.p. lamps, the number of actual consumers being 91, with an aggregate equivalent to 8,075 8-c.p. lamps. Applications for motive power equivalent to 23½ h.p. have been received, and motive power equivalent to 6¼ h.p. is being actually used.

Manchester Electrical Works.—"It is a long time now since," says the *Financial Times*, "we heard anything about the Manchester Electrical Works, Limited. It is a concern started about five years ago, and had some connection, direct or indirect, with the hapless Woodhouse and Rawson United. It sold what works it possessed in 1898 for about £900, a guarantee, coupled with what the directors considered collateral security, being given by Mr. Rawson that the shareholders' money would be returned in full, with 5 per cent. interest. The text of a circular issued by the liquidator on Dec. 6 is given, from which we note that the chief asset at the date of the company going into liquidation consisted of amounts due upon certain shares. These amounts have been called up in full; and, if paid, they would have allowed a cash distribution of about 4s. in the £ after deducting for the costs of the liquidation. It appears that more than half the sum due is still unpaid. The liquidator intends to now declare a dividend to those entitled to it so far as the funds will allow, and to make a further distribution at an early date after enforcing payment of calls. He also states that the negotiations regarding the Woodhouse and Rawson filament have been suspended."

Grantham.—Mr. E. A. Sandford Fawcett has held an enquiry into the application of the Town Council for power to borrow £2,000 for the establishment of a municipal telephone system in the borough of Grantham and in the parishes of Colsterworth, Great Ponton, Little Ponton, Spittlegate Without, Easton, North Stoke, and South Stoke, and a radius of 10 miles of Grantham. At present only one rural line will be constructed from Grantham and Buckminster, but it is anticipated that before long another line will be asked for to Belvoir. The estimated cost of the system is £1,560, exclusive of alterations to the Guildhall, which will be used as a central station, leaving £376 in hand to enable the Council to proceed with rural extensions as demand arises. It is believed there will be 40 trunk-line subscribers and 40 local subscribers, and the proposed charges are for local subscribers resident in Grantham, or within a mile, £3 per annum, and 10s. per annum extra for each mile after the first; for trunk-line subscribers, £6 per annum for residents in or within a mile of Grantham, and £1 per annum per mile extra after the first mile. The Earl of Dysart has guaranteed to pay half the cost of the loss up to £50 per annum for the first three years, after which it is expected the system will be worked at a profit.

Manchester.—At a recent meeting of owners and ratepayers in the city of Manchester, the Lord Mayor moved the following resolution: "That this meeting hereby consents to the promotion by the Council of the city of Manchester (in conjunction with any other local authority or authorities) in the next session of Parliament of a Bill (the short title of which is intended to be 'The Manchester District Telephone Board Bill, 1902'), to constitute a Board consisting of representatives of corporations and district councils within the Manchester telephone area, or some of them, for the purpose of providing a system of public telephonic communication in the area, for enabling the Postmaster-General to grant to the Board and the Board to accept licenses for telephonic purposes under the Telegraph Acts, 1863 to 1897, and the Telegraph Act, 1889, and to confer and impose upon the Board and the several constituent authorities all necessary and proper powers and obligations in that behalf. That the expense (or the part thereof payable by the Council) of promoting such Bill shall be charged upon the city fund and city rate, or on such other fund or rate as the Council shall deem advisable." After discussion, the question was put to the vote and declared carried. A poll was demanded.

Cardiff.—The last report of the engineer and manager (Mr. Arthur Ellis) in regard to works charges, showed that the cost per unit generated at the works had been reduced a further ½d. to 1·945d.; the latter price included all costs, interest, and redemption. During November 153,401 units were generated, which was 30,000 units more than in any other month. The question of asking the Tramway Committee to put in their station two 1,600-h.p. engines for continuous current for lighting purposes and for power supply was discussed by the Electrical Committee at its meeting last week. The present system of alternating current is to be changed over to continuous current during the coming year. The committee were occupied for a considerable time in endeavouring to find how the costs would be allocated to each department, and the opinion was expressed that the two committees should be combined. The engineer was instructed to report on the cost of temporarily lighting Cathedral-road and Castle-road with electricity. The permanent lighting of those streets will remain in abeyance until the electric tramways are running. The committee decided to supply energy to the Mountstuart Dry Dock sufficient to run a 100-h.p. motor, with a guaranteed consumption of 50,000 units per annum at 1d. per unit, on a 35,000-unit consumption at 1¼d. per unit, and on 25,000 units at 1½d. per unit.

Pacific Cable.—Silently but steadily have the preparations for the Imperial cable been going on since the grant of £2,000,000 was made for that purpose. It will be remembered that the cable will start from Southport, near Brisbane, in Queensland, to Norfolk Island (800 miles), whence it bifurcates to Suva, Fiji Islands (900 miles), and to Douglas Bay, N.Z. (460 miles). The above sections are known as the southern section, and the work is so far advanced that a steamer will leave London shortly with the cable, which is expected to be laid in March or April next, and which will be opened early next summer. From Douglas Bay the cable goes to Fanning Island (3,500 miles), near Christmas Island, and thence to Vancouver Island (2,000 miles), from whence direct communication with Europe is assured *via* Canada. The whole undertaking will be opened for traffic at the end of next year, and will be worked by the Pacific Cable staff at the various points named. No definite appointments have been made at present, but the general manager, Mr. C. H. Reynolds, late director-general of telegraphs in India, is on the point of leaving for Australia in order to make arrangements with the Colonial Government for the opening of the southern sections. All the necessary buildings are being erected for the Pacific Cable Board by the various Governments under whose jurisdiction the landing points are situated. The cable, which is guttapercha insulated, consists of a single solid centre core, surrounded by three copper tapes. This cable is guarded by steel wires, and is being manufactured by the Telegraph Construction and Maintenance Company, Limited. The Board is constituted as follows—President: Sir Spencer Walpole. Imperial representatives: Mr. G. E. Gleddon, C.M.G., and Mr. W. H. Mercer. Australian representatives: the Hon. H. Copeland, Agent-General for New South Wales; the Hon. W. P. Reeves, Agent-General for New Zealand; the Hon. Sir Andrew Clarke, G.C.M.G., Agent-General for Victoria. Canadian representatives: Lord Strathcona and Mount Royal, G.C.M.G.; and Mr. A. Lang. Mr. H. Latham is the secretary.

PROVISIONAL PATENTS, 1901.

DEC. 2.

24439. Improvements in electrical end connections. Henry Greg Melly, 15, Water-street, Liverpool.

24449. Electrical apparatus. John Entriken Everett, 7, Staple-inn, London. (Complete specification.)

24457. Improvements in method of and means for suspending overhead electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The Union Electricitäts-Gesellschaft, Germany.)

24470. Improvements in electricity meters. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Compagnie Anonyme Continentale pour la fabrication des Compteurs de Gaz et autres appareils, France.)

24511. Improvements in or relating to electrodes for electric accumulators or batteries. A. Bainville, 111, Hatton-garden, London. (Complete specification.)

DEC. 3.

24534. Improvements in fenders for electrically-propelled cars. Jacob Durose and Walter Tortoiseshell, 65, Brewerton-road, Glodwick, Oldham.

24535. An adjustable outside waterproof electric light fitting. Henry John Furniss, 5A, Queen-street, Derby.

24541. An apparatus for electrically singeing cotton or woollen or silk or other kinds of yarn or cloth, or applying heat to same. William Paul Steinthal and Joseph John Rickards, 41, Piccadilly, Bradford.

24552. Improvements in dynamo-electric generators and motors. John Scott Herriot and Hugh Paterson, 69, Albert-road, Levenshulme, Lancs.

24557. Improvements in fuse plugs for cut-out blocks. Joseph Sachs, 33, Chancery-lane, London. (Complete specification.)

24564. Apparatus for electrically operating and controlling the points, point locks, and signals of railways. Arthur Henry Johnson, "Winfrith," The Avenue, Bickley, Kent.

24582. Improvements in and applicable to electrical fuse boards. Arthur Ford-Lloyd, 11, Coram-street, Russell-square, London.

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24594. Improvements relating to electrically-driven machines for fixing capsules on bottles and the like, or for similar purposes. Louis Jules Borie, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24616. Improvements relating to incandescent electric lamps. Societá Italiana Di Elettricitá Giá Cruto, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Sept. 13, 1901, being date of application in Italy.) (Complete specification.)

24621. Improvements relating to electric incandescent lamps. Societá Italiana Di Elettricitá Giá Cruto, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Sept. 13, 1901, being date of application in Italy.) (Complete specification.)

24627. Improvements in electric batteries. Louis Marie Georges Rosée d'Infreville, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24628. Improvements in lanterns for electric or other lights. John Cronin Fleming, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24632. Improvements in the field magnets of dynamo-electric machinery. Charles Eugen Lancelot Brown, 46, Lincoln's-inn-fields, London.

24633. Improvements in apparatus for use in driving dynamos on railway and other vehicles. Frederick John Beaumont and William Mudd Still, 46, Lincoln's-inn-fields, London.

DEC. 4.

24644. A method of moving the points of tramway rails, from the platform of the cars, by electromagnets. John Taylor and Thomas Henry Ashworth, 32, Hatton-street, Lower Broughton, Lancs.

24666. An improvement relating to an electric generator for use on motorcar engines, gas and oil engines, with speed gear for starting same. Frederick Treeby Reid and William Shepherd, 177, Sidwell-street, Exeter.

24672. Improvements in and connected with electric motors for driving spinning machines. Herman Schönfeld, 4, Corporation-street, Manchester. (Complete specification.)

24686. Improvements in or relating to street lamp fittings for incandescent electric lamps. William Charles Cloete Hawtayne, 165, Queen Victoria-street, London.

24695. An improved tool for cutting the lead sheathing of electric conductors or the like. Frederick Tyers, 111, Hatton-garden, London.

24709. Improvements in or relating to overhead electric conductors and trolleys for tramways and the like. James Coghlan, 18, Buckingham-street, Strand, London.

24713. Combination of economy and choking coils for electric current. Samuel Barnes Griffith and Frank Billiotti, Railway Foundry and Engineering Works, Reading.

DEC. 5.

24737. Improvements in or relating to electric batteries and lamps for use with same. Malcolm Sutherland and Elias Marcuson, 61, Chandos-street, London.

24758. The improved automatic and self-adjusting electric trolley pulley for cars or other purposes. James Best and Thomas Russom, Camp Field Engine Works, Leeds.

24760. Improvements in or relating to electric incandescent lampholders. Walter Crookell, 55, Market-street, Manchester.

24797. Improvements relating to electrical motors. David Patton Burdon and Earnest Francis Cavelier, 18, Southampton-buildings, Chancery-lane, London.

24803. Improvements in controlling electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Harold W. Buck, United States.) (Complete specification.)

24804. Improvements in switching apparatus for alternating electric currents. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

24805. Improvements in electrical measuring instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Robert H. Read, United States.) (Complete specification.)

24806. Improvements in electromagnetic switches for electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Samuel B. Stewart, jun., United States.) (Complete specification.)

24807. Improvements in electric controllers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

24808. Improvements in coupling devices for electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

24809. Improvements in electric brakes. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

24810. Improvements in charging stations for electrically-propelled vehicles. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles E. Holmes and Frank B. Cox, United States.) (Complete specification.)

24811. Improvements in controllers for electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Leonard A. Tirrill, United States.) (Complete specification.)

24812. Improvements in electric railway systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

24816. Improvements in electric railways. Charles Jacob Kintner, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 6, 1901, being date of application in United States.) (Complete specification.)

24825. Improvements in methods for producing electric waves. John Ambrose Fleming and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

24834. An improvement in primary batteries. Richard Pearson, 53, Chancery-lane, London.

24839. Improvements in and relating to telephone systems. Paul Arnheim, 45, Southampton-buildings, Chancery-lane, London.

DEC. 6.

24863. An improved method of actuating the carbon-feeding mechanism of electric arc lamps of the open and enclosed types. Charles Edwin Foster, 34, Corschill-street, Mitcham-lane, Streatham, London.

24887. A new and improved method of automatically and intermittently closing an electrical circuit which can be used in connection with railways. William Edward Burgess, Dan-y-Graig, Aberbeeg, R.S.O., Mon. (Complete specification.)

24937. Improvements in polyphase alternating-current induction motors. Walter Langdon-Davies and Alfred Soames, 24, Southampton-buildings, Chancery-lane, London.

DEC. 7.

24961. An electric trolley line device. Alfred Herbert Mayes, 40, Walsingham-road, Hove, Sussex.

24987. Improvements in or relating to a combined dynamo-electric machine and a working cylinder and lubricating devices therefor, also otherwise applicable. Alfred Julius Boult, 111, Hatton-garden, London. (Niels Anton Christensen, United States.) (Complete specification.)

24989. Improvements in telephone systems. Donald Macadie, 111, Hatton-garden, London.

24992. Improvements relating to electric primary cells or batteries. Arthur Patrick Thomas Tully, 40, Chancery-lane, London.

25000. Improvements in electro-automatic mechanism for advertising devices. Fréderic de Blanco, 1, Queen Victoria-street, London. (Complete specification.)

25004. Improvements in printing telegraphs. John Moore and Charles Robert Steljes, 24, Southampton-buildings, Chancery-lane, London.

25008. Improvements in electric relays. Siemens Bros. and Co., Limited, and Alexander Gordon, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

25011. Improvements in electrically insulatory wall plates and the like. Herbert John Haddan, 18, Buckingham-street, Strand, London. (Robert Müller, Germany.)

25013. Improved means for lighting gas lamps at a distance by means of an electric current. Hugo Stoltenhoff, 55, Chancery-lane, London.

25014. Improvements in preventing sparking when making and breaking electric circuits. Arthur Bertram Rigby, of the Electrical Transmission Company, and Ernest George Scott, 4, South-street, Finsbury, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 28.

1900.

19495. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Emmet.)

21839. Apparatus for obtaining direct electrical impulses or currents from alternating electric sources. Batten.

21886. Electrical storage batteries or accumulators. Lacroix.

22021. Arc lamps. Velle.

22286. Electric switches. British Thomson-Houston Company, Limited. (Potter.)

1901.

328. Electric incandescent lamps. Riordan.

410. Apparatus for wireless telegraphy. Marconi and Marconi's Wireless Telegraph Company, Limited.

411. Apparatus for wireless telegraphy. Marconi and Marconi's Wireless Telegraph Company, Limited.

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1721. Electric indicator for indicating or signalling maximum or minimum electric pressure or current. Brander.

2587. Electric batteries. Rosset.

3334. Means for starting and regulating the speed of electric motors with rotating fields. Girault.

5921. Lifeguards for electric tramcars or the like. Newton.

15322. Liquid starting resistance for electromotors and the like. Feeny. (Allgemeine Elektricitäts-Gesellschaft.)

22110. Electric motors. Pieper and Pieper.

22290. Outlet boxes and terminals for electrical conduits. Brookes. (Thomas and Betts.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Dec. 7	622	591	+ 50	21,237	19,311
Birmingham Tramways	—	—	—	—	—	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 6	461	416	+ 45	24,643	21,864*b*
Blackpool Corporation	,, 5	222	179	+ 43	36,650	27,552
Blackpool-Fleetwood Tramways	,, 7	158	140	+ 18	20,514	19,852*b*
Bolton Corporation	,, 8	1,366	1,286	+ 80	70,876	57,276*b*
Bradford Corporation	,, 8	1,004	767	+ 237	44,740	23,293
Bristol Tramways Company	,, 7	3,816	3,066	+ 750	—	—
Carlisle Tramways Company	—	—	—	—	—	—
Central London Railway	,, 7	6,957	5,740	+ 1,217	141,252	—
City and South London Railway	,, 8	2,931	1,915	+ 1,016	48,867	37,776
Cork E. T. and L. Company	,, 5	372	348	+ 24	22,484	19,995*b*
Darwen Corporation	,, 6	185	166	+ 19	9,236	7,614
Dover Corporation	,, 7	170	167	+ 3	8,629	8,218*b*
Dublin & Lucan Electric Railway	,, 8	85	67	+ 18	2,679	2,303
Dublin U. T., electric cars	,, 6	3,331	3,328	+ 3	—	—
Dublin S. District, Electric	,, 6	686	691	− 5	—	—
Dundee Tramways Company	,, 4	666	491	+ 175	—	—
Glasgow Corporation	,, 7	10,972	9,027	+ 1,945	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 7	1,594	1,401	+ 193	39,773	32,712
Liverpool Corporation	Nov. 30	8,627	8,072	+ 555	431,215	381,603*b*
Liverpool Overhead Railway	Dec. 8	1,417	1,488	− 71	36,403	38,131
Portsmouth Corporation	—	—	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 8	3,531	—	—	—	—
Southampton Corporation	,, 5	702	626	+ 76	—	—

* Fortnightly. *b* From Jan. 1.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £715 decrease.

Barcelona Ensanche y Gracia, £10 decrease. Barcelona, £228 increase.

Brisbane, £302 increase (month of Nov., £1,286 increase).

Buenos Ayres and Belgrano Electric, £179 increase (month of Nov., £572 increase).

Calcutta, £20 decrease.

Cape Town (month of Oct.), receipts, £14,063; expenditure, £6,817.

La Capital Traction and Electric, Buenos Ayres (month of Oct.), £1,350 increase.

Mexico Electric (month of Nov.), receipts, £17,300; expenditure, £10,500.

Perth Electric, £371 increase.

Port Elizabeth (month of Oct.), receipts, £3,240; expenditure, £1,960.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅞-1
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-¼
—— Ordinary, 1-125,000	1 ..	⅛-¼
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-5¾
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5-5½
Brush Electrical Engineering, Ordinary	2 ..	1⅛-1⅜
—— Nos. 90,001-105,731	2 ..	1⅛-1⅛
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2½
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	112-116
—— Ordinary	5 ..	15½-16½
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	3-3½
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	¼-½
—— 5 per cent. Debentures	5 ..	1½-2½
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16½-17½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	23-24
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10¼-11¼ xd
—— 5 per cent. Cum. Pref.	5 ..	5½-6½
Willans and Robinson, Ordinary, 1-30,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6½-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	103-105 xd

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-102
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	8¼-8½
—— 7 per cent. Preference	5 ..	8¼-8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7½-8½
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10½ xd
Charing Cross and Strand	5 ..	7½-8½
—— 4½ per cent. Cum. Pref.	5 ..	5½-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5¾-6¼
—— 40,501-50,936	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	8½-9½
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¼-6
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4¾
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5½-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1¾
—— 6 per cent. Pref.	5 ..	3¼-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	96-100
Metropolitan, Ordinary	10 ..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	113-116
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6½-6¾
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1⅜ xd
—— £5 Shares	5 ..	7½-8 xd
—— £4½ Shares, New	4½ ..	6¾-7¼ xd
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15¼-16¼
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11¼-12¼
Electric Railways.—		
Central London, Ordinary	100 ..	107-110
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	107-110
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-119
City and South London, Consolidated Ordinary	100 ..	64-66
—— Ordinary	10 ..	6-6¼
—— 4 per cent. Debenture Stock	100 ..	113-117
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅜-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	3¾-4
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-128
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¼-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¼-6½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	8¾-9¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14-14½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¾-2
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5¾
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
—— Prov. Cert., all paid	100 ..	100-103
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅝-2⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11⅛-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	104-106
New General Traction, Ordinary	5 ..	2¼-3½
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	98-102
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-10¼
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8s. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Telephones.—		
National Telephone, Ordinary	5 ..	3⅛-3¼
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5
—— 4 per cent. Deb. Stock, Red.	100 ..	95-98
—— 3½ per cent. Deb. Stock, Red.	100 ..	100-103
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

Faraday House.—An important change in the commencement of the session is announced to come into operation at the Electrical Standardising, Testing, and Training Institution next year—viz., the new course of instruction will open on Monday, Jan. 13, 1902, instead of in the middle of February as heretofore. The entrance examination will be held on Wednesday, Jan. 8, at 11 o'clock.

The Copper Ring.—We learn that a strong effort is being made to put the copper market on a sound basis again. Advices from Paris state that the Rio Tinto Company are willing to agree to a restriction of the output of copper, provided the Amalgamated Company guarantee the maintenance of the price. The negotiations between the two companies have not, as yet, resulted in any agreement being arrived at, and the general opinion seems to be that such a contract would be extremely difficult to fulfil. At any rate, the suggested arrangement has not up to the present had any beneficial effect on the market, as every day during the past week has brought with it a regular decrease in the price of raw copper. Thus, at the time of writing, the price is down to £50 per ton.

The Inner Circle Arbitration.—We give elsewhere in this issue the report of the Hon. Alfred Lyttleton, K.C., M.P., as arbitrator on the question of the system of electrical traction to be used on the Inner Circle. A perusal of the same shows the advantage of having a trained legal arbitrator for deciding such questions. The report is remarkable for its clearness, brevity, and its sound reasoning. It is well to draw attention to the fact that Mr. Parker, the nominated expert of the Metropolitan Railway Company, did not dissent from the conclusions given in the report, or, at any rate, he did not desire to send in a separate report on the matter. It will be seen from the reasons given that the arbitrator's decision is chiefly based on the fact that with the Ganz system there had been no practical experience with the equipment suggested.

Subways.—Speaking at the annual dinner of the Society of Engineers on the 11th inst., Mr. Chas. Mason, the president, referred to the subject of subways under London streets. He declared that they were not an impracticable method of relieving the present congestion in some of the busier thoroughfares in the Metropolis. He instanced the case of Boston, where, he said, the difficulties which presented themselves in London had been successfully overcome, and tramways were running under the streets. Mr. C. Hawksley, president of the Institution of Civil Engineers, who also spoke on the subject, joined heartily in wishing that some means could be found in getting rid of the everlasting opening up of the streets for water, gas, and electric light mains, etc. He, however, reminded the company that gas had an awkward habit of escaping from the pipes, and this was a matter which would have to be seriously considered in the construction of subways.

Tests of Storage Batteries.—In a recent contribution to *Elektrotechnishe Zeitschrift* a Mr. Heim gave the results of tests of a storage battery at different temperatures. These we find shortly digested in the *Electrical World* of New York as follows: "He found that both the ampere-hour and the watt-hour capacity increased with increasing temperatures. The voltage of the cell, discharged at 20 amperes, decreased from 1·99 to 1·825 in 3½ hours at a temperature of 14deg. C., and from 2 025 to 1·825 in 6¼ hours at a temperature of 45deg. In a discharge with 32 amperes the voltage decreased to 1·825 in 1¾ hours at 14deg., in 2½ hours at 30deg., and in 3⅗ hours at 45deg. The ampere-hour efficiency decreases with increasing temperature. It was 0·86 at 45deg., against 0·95 at 14deg. The decrease of the watt-hour efficiency with increasing temperature, however, is not so great. This efficiency was 0·72 at 45deg., against 0·75 at 14deg. He thinks that the good effect of the heat upon the capacity is due to the increased circulation of the acid in the pores of the plates. He then discusses practical applications of his scheme, but it seems that there is no great hope for success, as, according to the information obtained by him from a large German storage battery manufacturing concern, artificial heating of the battery diminishes the life of the plates."

Explosions in Street Boxes.—There is now every probability that the question of the responsibility of gas companies for the damage done by leakages from their mains will be settled in the law courts. We notice that a report of the Electric Lighting Committee of the borough of Islington for Dec. 12 contains a recommendation that proceedings be taken against the Gaslight and Coke Company for the damage sustained by the Council in consequence of the explosion of gas in the electric lighting conduits and street boxes in Highbury-park on Oct. 8 last. It will be remembered that we commented on this explosion at the time, and stated that the gas company were actually looking for the leakage which caused the damage at the time the explosion occurred. We have heard so much of what the united gas companies are going to do to make electrical engineers responsible for the ordinary corrosion of their pipes, that it is quite refreshing to hear of active steps being contemplated in the opposite direction. Thus, while we quite agree that electrical undertakings should be responsible for the actual electrolytic damage caused by them to metallic pipes in the streets, we also hold that they should have equal protection against the damage done to their own conduits and street boxes by the escape of gas. The solicitor advising the Islington Council is of opinion that the Gaslight and Coke Company are liable in this particular instance, and we trust that the Council will on the strength of this opinion have the matter contested in the law courts.

Electric Lighting at Bath.—It is amusing to see the joy with which some of our gas-lighting contemporaries view the electric lighting troubles of the Corporation of Bath. Their criticisms on the same are more interesting than instructive. We are somewhat surprised to find, however, that our contemporary *Electrical Investment* is equally jubilant over the disastrous breakdowns in the electric light supply of Bath. The moral, of course, in this case is that municipal authorities are quite incapable of managing any electrical undertaking. The soundness of the argument is somewhat doubtful in view of the limited success which the company previously owning the Bath electric light undertaking had. In the competition between municipal electrical undertakings and those owned by companies, time alone can prove which of the two are the better engineered and financed. From our experience, while corporations are sometimes handicapped by not securing the best advice on electrical matters, they are entirely free from the trade interests which, unfortunately, are attached to so many of our electrical company undertakings in this country—in fact, if the comments of our financial contemporary are read together with the report on the defective system in use at Bath, it will be found that the expert advisers who in the past were responsible for the first installation of the Bath plant have been largely responsible for the failure of several other undertakings owned by companies. We do not propose to go into

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details in connection with the Bath breakdowns, because Mr. Manville has been retained to report on the whole question, and until his report is published it is not courtesy to repeat the various criticisms now available.

Nernst Electric Light, Limited.—Elsewhere in this issue will be found the report presented to the second annual general meeting of the above company, which is not of a rosy character. At the previous meeting the company informed the public that they had developed the Nernst lamp with sufficient success to warrant its manufacture in large quantities. This statement, which we tried to believe at the time, has now proved to be incorrect. The report this year states that "information as to the progress made by the Nernst concessionaire companies in other countries showed that they had so far equally failed to produce commercially saleable lamps." This admission of failure by a company whose financial success depends on the Nernst lamp is a most serious one. In another part of the report will be found a letter from Mr. James Swinburne on the subject, in which he strongly advises the production of large lamps to act as intermediaries to arc and incandescent lamps of the carbon type. We cannot quite agree with Mr. Swinburne in his statement that the commercialisation of the Nernst invention is taking no longer than was to be expected. Whatever other opinions there may be on this subject, there is no doubt that Nernst Electric Light, Limited, was floated prematurely, and that the shareholders have reason to complain of the prospectus on which their money was obtained.

The City and the Telephones.—The Corporation of the city of London are still busying themselves with the telephone agreement which, as everyone knows, has been finally concluded between the Post Office and the National Telephone Company. It was unanimously resolved at last week's meeting of the City Council to send a letter to the Chancellor of the Exchequer and the Postmaster-General, requesting that they would not ratify any agreement with the National Telephone Company with regard to charges for the telephone service until the Corporation had had an opportunity of considering the proposed agreement or agreements, and that such agreements may be fully considered by Parliament. We think the Corporation would have saved themselves a rebuff if they had taken the reply which the Postmaster-General gave to the deputation from the London County Council—*i.e.*, that the agreement with the National Company was signed and sealed, and that it did not require the confirmation of Parliament. The City Council will find that the Postmaster-General has not the aptitude which they have shown for breaking agreements, and for avoiding, where possible, the obligations of those they are unable to repudiate. The Highways Committee of the London County Council are equally incredulous with the city authorities. We see that they are obtaining the opinion of Counsel as to whether Lord Londonderry is correct in stating that the telephone agreement cannot be revoked by Parliament, and also whether such agreement is in contravention of the Telegraph Acts.

Workshop Organisation.—Before the Manchester Association of Engineers last week, Mr. A. P. Loscher read a paper dealing with the all-important subject of workshop organisation. At the outset the author complained that too many engineering works at the present day were practically void of even the most elementary forms of organisation, and did not possess either tool-rooms or stores, or any proper system for the execution of orders; whilst the cost of such orders was too often merely guesswork. Modern workshop organisation and timely specialisation of production had borne such excellent fruit in America, and in later years in Germany, that it was surprising that similar methods had not been universally adopted. The foundation of economical and successful production was the fixing of rates by scientific methods, and the fixing of maximum outputs for men and machines. What a workman could produce in a given time and what he actually did produce, presented widely different results. As regards rates of pay to workmen, he favoured the differential system, as offering better terms to willing and industrial men than any trade union even was trying to secure for its members. The absolute want of even an elementary education by a large number of working-men made it very often extremely difficult to introduce any new system of organisation, pay, or machinery. He recommended as a step towards improving this state of things that every apprentice should be compelled to attend regularly at one of the numerous evening technical schools. Compelling apprentices to work on strictly modern lines would, he thought, greatly assist in successful organisation, and would also weaken the resistance of those journeymen who were still under the influence of trade union principles.

Cables for Mines.—A number of mining and electrical problems were discussed by the members of the Midland Counties Institution of Engineers at a recent meeting held at Derby. Among the papers read on this occasion was one by Mr. L. W. de Grave on "Electric Accidents, and how to prevent them," which entailed a lengthy debate. In replying to the criticisms on his paper, the author said he favoured the concentric cable as the best that could be used in mines. A safe method in mining operations was to bury the cable in a puddled-clay trench in the middle of the road, and then properly cover it to prevent it from damage by traffic. When mice or rats ate through the insulating material, and exposed the live wire, there was a danger that the premises might be set on fire, but he thought tarry wires were seldom, if ever, attacked by rodents. It was a peculiar fact that a horse was more susceptible to an electric shock than a human being. A strong man felt the effects of a shock more than a weak person. This was debatable ground, he knew, but his investigations had led him to believe that the reason was this: a man who was fully developed had his muscles in a state of activity or strength, and the extra strain of the "shock" caused contraction to such an enormous extent as to prevent the muscles of the heart from working. It naturally followed that the person who was not fully developed would not experience the same severe contraction in respect to the muscular system. The same explanation would cover the question of accidents from lightning. When a man was electrocuted, it was necessary to flatten out the tongue; he had known a case in which a man received a shock, and although the coroner's verdict stated that death was due to the effects, in reality it was caused purely and simply by suffocation. Artificial respiration was tried, but the attendants neglected to examine the tongue, which had got rolled up by contraction.

Municipal Telephones.—The municipal telephone system which the Corporation of Grantham are about to establish in that borough and the neighbouring parishes seems likely to be one of the cheapest, if not the cheapest in the country. The inclusive rate it is proposed to charge a subscriber to the municipal exchange resident in Grantham, or within one mile of the town, is £3 per annum. Until a very short while ago the National Telephone Company were charging from £8 to £6 for the same service, but in order to meet the strong competition of the Corporation system, they are now offering a rate of 1d. per call,

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which with a guarantee of 1s. 2d. per week works out at £3. 0s. 8d. per year. A point in favour of the greater success of the municipal system, however, is that the Earl of Dysart has withdrawn his way-leaves, without which the company cannot get into Grantham. The Earl is said to be helping the Corporation all he can, and has guaranteed the half of any loss on the first year's working of the undertaking. It is not expected, however, that any loss will accrue, for in addition to the promised subscribers in the town, which include a large number of the present subscribers to the company's exchange, one of the features of the new system is to bring all the farmers and traders of the surrounding districts into contact with the auctioneers and salesmen in the market. For the trunk-line service the Corporation propose to charge £6 per annum, and if the party-line service system be adopted, this amount will be considerably reduced. To enable the municipality to provide a direct trunk-line service, negotiations have been entered into, and are nearing completion, with the Postmaster-General to provide a trunk line between the Corporation's exchange and the general trunk-line exchange at Nottingham, so avoiding the company's trunk-line accommodation, which is at Newark.

The Engineering Trade.—Several important engineering questions were discussed at the annual dinner of the Leeds Association of Engineers, held in that city last week. Mr. J. H. Wickstead first called attention to the fact that since electricity had come so much to the front Leeds had not been behind in taking up the manufacture of all kinds of electrical machinery, such as dynamos, motors, generators, etc. At the same time, he thought the English manufacturers should "wake up." If the manufacturer could find a stimulus to more initiative in the direction of keeping every detail up to its full working possibilities, he thought there was in this nation sufficient talent lying latent to enable it to keep the mechanical ascendancy of the whole world. Another speaker referred to the practice of German firms giving credit for two or three years, and accepting contracts at absurd figures. In one case just recently a German firm had taken a contract for electrical work at £35,000 below the lowest English tender. He did not think they need much regret that contract having gone to Germany, because at the price named they would not make their own by it. Mr. Reginald Wigram added a few sentences on electrical developments in this country. He had no doubt that for locomotion and for many other purposes electricity was the power of the future, and the real question for the engineering trades of Leeds was how they were to get their share out of the work that was done by electricity. It was quite probable that before many years were out they would see the main lines of some of the present steam railway systems, so far as their passenger traffic was concerned, largely worked by electricity. The difficulty of breaking up trains and handling them in goods yards was very great, but he believed that before long these difficulties would be overcome, and that they would also see the development of electricity for maintaining the goods traffic of the country.

Trolley Wire Safety Appliances.—This subject was taken up at the last meeting of the Students' Engineering Society of University College, Liverpool, by Mr. P. H. Powell, who read a paper describing some of the devices at present in use to protect the public from coming in contact with the live overhead conductors of electric tramways in cases of fracture. He first mentioned the use of long strips of cane for this purpose, but condemned the system as having too many objections. The method of placing guard wires over the conductors was being used at the present time on some of the largest systems of electric tramways. These wires were sometimes, though not always, insulated. The author could not see much good in insulating the guard wires, as if a telephone wire came in contact with the overhead conductor as well as the guard wires, it were better that the latter should be well earthed, when a short-circuit would result. He next described Cardew's contrivance of having the guard wires laid longitudinally over the wire to be protected, and lead weights attached to the telephone wires, causing them to come in contact with the guard wires if broken; also Quin's system of having a pilot wire lead from the far end of the section supplied by the switch pillar, and connected to the shunt coil on the switch, so that in the event of a stoppage of the current through the coil, the latter allows the armature to fall, knocking up a catch and releasing the switch lever, which is forced out by a spring, and thus cuts off the trolley wire from the feeder. The author also gave a description of the Ulbricht earthing method. He next turned his attention to the question of brakes, including the slipper, air, and electric types, an advantage of the last-named being that the frequency of stoppage did not matter, as it was the current from the motors used to drive the car itself, that furnished the brake. He concluded with an account of the various types of switches and fuses now in general use in this country. The paper, which was well received by the audience, was fully illustrated throughout.

New Electric Crane at Southampton.—A new electric travelling crane has just been placed on the Town Quay at Southampton, making the seventh of its kind that the Harbour Board have installed at this place for handling the very large and increasing traffic with which they have to deal. On Tuesday morning an inaugural trial of the new crane was made in the presence of several officials, with very successful results. It is intended for dealing with light loads up to 30cwt. at a very high rate of speed, the loads of 30cwt. being lifted at 225ft. per minute, and lighter loads at a still higher speed. The cranes previously supplied have been placed on high gantries to allow the traffic to pass through, but the present crane moves on an ordinary truck which is fitted with buffers and runs on 4ft. 8½in. gauge, so that it can be transferred to any part of the quay. The radius is 30ft. The current is brought to the crane by flexible cables connected to junction boxes placed at convenient positions. The crane has lifting and slewing gear worked by separate electric motors. The lifting motion is actuated by a patented arrangement on a plan devised by Mr. J. G. W. Aldridge, the electrical engineer to the Harbour Board, in conjunction with Messrs. Stothert and Pitt, Limited, the builders, by which the barrel is connected or disconnected from the lifting shaft by the same handle that works the lifting motor, the load being lowered under the control of a mechanical brake. This arrangement not only greatly adds to the speed of the crane, but also conduces to economy of current—two points of importance when discharging cargo. The crane is housed in with a complete crane-house, the working handles being placed close to a large window so that the driver can see his work. There are incandescent lights in the crane-house and on the jib of the crane. The revolving collector for taking the current from the centre pin of the crane is also a novel feature of the arrangements. The Southampton Harbour Board, it is interesting to note were pioneers in the adoption of electric cargo-handling cranes in England, and were the first who adopted the new departure in place of hydraulic power.

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Aluminium Alloys.—Prof. Ernest Wilson at the meeting of the Institution last week added a few interesting remarks to his paper on "The Physical Properties of Certain Aluminium Alloys, and some Notes on Aluminium Conductors," an abstract of which appeared in our issue of the 6th inst. At the close of the previous meeting, at which the paper was read, Mr. Gavey gave him some particulars with regard to the aluminium wires which were used in the Post Office experiments, and the author had used these particulars to make a few calculations. Mr. Gavey told him that the distance between the supports in the aluminium line referred to was 180ft., and that the wind pressure could not have been more than 20lb. to the square inch; also that the wires were stretched at the insulators to the extent of 30lb. on the total section, and that they broke in the strong wind without any fall of temperature. The author now produced a table of figures which he had prepared from calculations based on the above particulars. He showed, for instance, that from the point of view of elasticity there was practically nothing to choose between copper and aluminium wires. Taking it on a breaking load, however, there was a greater factor of safety in the case of copper. He thought that Mr. Gavey was probably right that it was due to the fact that pure commercial aluminium wires were used in the Post Office experiments that these broke. Since the time of those experiments aluminium wires had been very much improved in manufacture, and he considered that if alloys, with copper or nickel-copper, which could stand exposure to the weather, were used to the extent of about 1 per cent., there was no reason why aluminium should not be successfully employed for the purpose of telegraph and telephone wires overhead. The President remarked that Mr. Gavey was probably the only engineer who had had experience with aluminium wires in the open air, but, unfortunately, that gentleman was unable to be with them that evening. He had, however, promised to send a communication to the *Journal* on the subject. There was no discussion on the paper, and the President thereupon moved a vote of thanks to the author, which was warmly given.

Parallel Running of Alternators.—Mr. Ernest J. Berg recently contributed a very interesting paper to the American Institute of Electrical Engineers in an endeavour to show the principles governing parallel operation of alternators driven by steam-engines or turbines. The question of distribution of power between alternators is quite simple, if they are running at absolutely the same speed at all loads. In reality, however, engines cannot be made to govern so closely, but one will tend to hold up the speed somewhat better than the other. The author shows by equations that with the same armature reaction and induced E.M.F., if different power is given each machine, the armatures must be offset a certain and fixed degree, which means that by even the most minute difference in speed regulation the armatures are forced to change their relative positions, which obviously is a cause for hunting. From the author's discussion of the subject it is apparent that a definite tendency for hunting exists, and that this hunting is manifest in a mechanical pulsation in the speed of the armatures and a transfer of power from one unit to another. Investigation will show that this flow of power is much greater than that corresponding to the stored energy of the armature flywheel, etc., at the relatively small differences in speed, and that pulsating power actually has to be supplied by the engines. Therefore, and since power cannot be obtained from an engine without corresponding steam, the flow of steam must be periodic to sustain an accumulated hunting. The remedy is therefore to be found by preventing such periodic flow of steam, which can be accomplished by proper dash-pot arrangements at the governor. Other remedies also suggest themselves, the favourite being to make a short-circuited winding in and around the field of alternators. The object of such winding obviously is to establish a load acting against these oscillations, which tends to stop the acceleration and retardation of the armature. The disadvantages of this method are that losses of no small magnitude not only are introduced when the machines hunt, but also when they are running at steady speed, which losses are caused by induced currents in this short-circuited winding, due to pulsations of flux incidental to modern construction of iron-clad armatures.

Locating Metals by Electricity.—The *Western Electrician*, of Chicago, describes in a lengthy article a method of prospecting for metal deposits which has been worked up by Mr. F. H. Brown, whose patent rights are now owned by the Electric Metal Locating Company, of Chicago. It is not easy to understand quite what the claims will be in these patents. The method employed consists in measuring the resistance between two steel rods driven into the earth. The ground to be surveyed is divided off into parallel strips, and the resistance of each of these is determined in the same way with, we presume, the steel rods driven in the same distance. The distance apart of these rods is varied according to the depth to which the investigators wish to prospect, and the company has successfully used up to 3,000ft. of wire between the two earth terminals. The resistances between the various positions of the earth terminals along the parallel lines are written down, and it is found that these resistances drop considerably when the steel rods are located directly over the seam of ore. For instance, in one area, when prospecting for copper, the normal resistance of the earth between the two steel rods was 54,000 ohms, but when placed immediately over the rich copper vein, which was not far beneath the surface, but which was a narrow vein, the resistance dropped to 56 ohms. In another place, when prospecting for conglomerates, the normal reading was between 15,000 and 20,000 ohms, and when the veins were found the readings were respectively 1,000 and 1,100 ohms. For gold ore the diminution is not so strongly defined, but it is still clear. Of course, when prospecting for veins it is not sufficient to take one set of parallel lines unless it is known in which way the veins are sure to run if they exist. The interference which one would expect from the method due to moisture in the soil is stated to be absent, as practical experience by Mr. Brown has shown that the metallic streak in the earth has so much greater conductivity than the surroundings that it can be ascertained even when marked by other conditions, such as streams, moisture, etc., which tend to lower the resistance of the soil. Another point tending to distinguish between the two effects is that the fall of resistance, when immediately over the metallic vein, is exceedingly constant as the steel rods are moving along.

Automatic Fire-Alarms.—As we noted a few weeks ago, the committee of the London County Council dealing with the subject are at present pursuing a policy hostile to the introduction of any form of automatic fire-alarm in the metropolitan area. The latest instance of this is the case of the new fire station in Redcross-street, in the Cripplegate district of the City. Notwithstanding a very extensively signed petition from merchants and owners of property in the district mentioned, the committee have advised the County Council that the request of the petitioners in respect to the Pearson system should not be acceded to. The committee add in their report that the Council,

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having decided against any automatic fire-alarms being connected with the metropolitan fire stations, they do not think it necessary to discuss the effectiveness of any particular system, nor to institute comparisons between the various kinds of fire-alarms on the market. The committee, however, embody in their report to the Council a letter from Commander Wells, chief officer of the Metropolitan Fire Brigade, in which he observes that the great advantages claimed for Pearson's automatic alarm have by no means been proved, and also that as time goes on improvements in automatic alarms are rapidly coming to the front. It is not desirable, in his opinion, therefore, to advocate the admission of any particular system into the London fire stations. Above all, Commander Wells considers that the ideal automatic fire-alarm for London is one, no matter what pattern is preferred, that can be arranged within the premises, and will not only wake, if necessary, the people there, but will raise the alarm to the police. He also points out that the Pearson Alarm System, Limited, must be paying a high rent for one or two positions they have acquired opposite some of the metropolitan fire stations, and, of course, if they receive a reliable call by their system it is only necessary for the operator to run across the street and give information to the brigade. Although the Council are not likely for some time to come to authorise the installation of these automatic fire-alarms in connection with their fire stations, there is reason to believe from the chief officer's reference to improvements that it may ultimately be found desirable to adopt some device for automatically raising the alarm in cases of fire. We can quite see, however, that any system which is not to be absolutely relied on should not be allowed to add to the responsibility of the London fire brigades.

Ingenious Surface-Contact System.—Details of an ingenious type of surface-contact system of electric traction, which is the invention of Mr. L. M. Maxham, are published in the current number of the *Street Railway Journal*. The main principle of the new system seems to be to have a third rail between the two running rails, in lengths of about 10ft. each. This rail is normally disconnected from the feeder circuits, but whenever a car is over it the section immediately below becomes electrically connected, and thus supplies the current for the motors. The means by which this is accomplished is this: Attached to the bottom of the car by a spring suspension is a pair of strong electromagnets, which are energised by a small amount of energy. About 3ft. or 4ft. below the rail are placed some small circuit breakers, consisting of a deep cup made of copper or aluminium containing mercury, in which rests an aluminium or copper pin having an iron head. When the magnet is above one of the sections of the third rail, which is of iron, it magnetises the rail and causes it to attract the iron heads of the pins in the circuit closers, thus raising them up and connecting the bottom of the rail to the mercury in the cup. The cup is located in a porcelain receptacle, but is directly connected to the feeder system, and the third rail is therefore made alive. In order to ensure against the danger of the third rail remaining alive after a car has passed over it a piece of carbon is introduced, against which the plunger impinges, and no sticking of the plunger can occur either from residual magnetism or from the fusing of the iron head to the bottom of the rail. As an additional precaution against danger of leaving a section alive, a brush is provided at the end of the car, which is grounded to the axle, so that should a section be alive when it is reached by this brush, a short-circuit is produced between the third rail and the traction rails, and the circuit breaker on that division is opened immediately, cutting out the dangerous portion. A single cell of storage battery carried on the car serves to energise the first sections of rail when the car is starting, but afterwards a small amount of current is taken from the working current to operate the plungers. One of the advantages claimed for the new system is that there is no appreciable loss from leakage, no matter what the conditions of the pavement may be, as only that section of the rail under the car is alive. The essential features of this system are not novel, and we do not agree with the claim that the leakage will be small. Perhaps, however, the greatest objection is to the use of the mercury-cup connection, which seems so difficult to get away from in surface-contact systems. A mercury connection which has to be made and broken as frequently as this does cannot be considered, in our opinion, a commercial switch.

The Consulting Engineer.—Among the papers recently contributed to the Engine Builders' Association of America was one from a Mr. Neiler, entitled "From the Consulting Engineer's Standpoint." In it the author briefly defined the function of the consulting engineer in the States, and pointed out the excellent work that had been accomplished by the American Society of Mechanical Engineers and the American Institute of Electrical Engineers in perfecting standards of manufacture and standardising methods of testing. He argued that a consulting engineer should not attempt to design apparatus, but should specify machinery that could be furnished by manufacturers without undue hardship. He also pointed out that in order to obtain the best results manufacturers should supply with their bids to consulting engineers complete data regarding their engines, so that intelligent selection can be made. He criticised the practice many manufacturers follow of doing preliminary consulting engineering work for prospective purchasers without charge. Such work, he pointed out, very rarely pays, and usually has to be done over again by the manufacturer who succeeds in landing the order in such cases where an order is actually obtained by anyone. In the most of such cases, however, he said a large amount of engineering information was given to persons who had no idea of buying the machinery concerning which they asked for the information. Mr. Neiler mentioned the offer which had been made by the authorities of the coming exposition at St. Louis to have elaborate tests made of engines exhibited there, and expressed the opinion that engine builders should take advantage of this opportunity. We understand from the *Electrical World* that in the discussion which followed Mr. Dick referred to the fact that, although specious promises were made as to the tests that were going to be carried on at the Chicago Exhibition, no tests were made of which anybody had ever heard anything. He also referred to the specifications of consulting engineers, considering that it was unreasonable for an engineer to require that an engine bought for operation at 100lb. pressure should be made able to stand 150lb. pressure. The author, however, explained that it was not his practice to make any such stipulation, except in cases where it is the intention to ultimately raise the pressure in order to run the engine condensing. Another gentleman who joined in the discussion thought that the manufacturer took sufficient risk in building an engine and delivering it without any guarantee from the purchaser as to the settlement of the account. He therefore considered that the stipulation of a bond from engine builders was unfair. Mr. Neiler explained that he never exacted such bonds except where the engine was for some municipality or some State institution, in which case a bond was legally compulsory.

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CITY AND SOUTH LONDON RAILWAY.

(Concluded from page 765.)

At Islington the arrangement is somewhat different. In the first place, the sub-station is built in the form of a tunnel, the roof of which serves to support the island platform at which the trains pull up; and, secondly, the accumulators installed are run in conjunction with a Highfield reversible booster. So far as the arrangements for feeding the station from the main switchboard at Stockwell are concerned, these are practically the same as in the case of the London Bridge sub-station previously mentioned—a five-wire system being employed, with a motor-generator placed between the 'bus bar and the high-tension feeder, adding 500 volts to the latter. Referring back to Fig. 3, the motor-generators in the power-house at Stockwell will be seen in the foreground. There is a certain amount of interest attaching to these machines, due to their having formed part of the steam-driven generating plant originally installed in the old station, and being subsequently converted for service in their present capacity as motor-generators.

By the addition of the Highfield reversible booster to the equipment of the Islington sub-station, it is hoped to steady the load on the generating plant to a degree which it would be impossible to attain with the ordinary arrangement of accumulators and charging transformers. In fact, great things are expected of the introduction, and there is no reason to suppose that these hopes will be falsified. The governing factor in the design of the sub-station equipment, then, may be termed an endeavour to obtain an automatic and constant steadying influence on the output of the main generator at Stockwell. How this very desirable object is accomplished will be seen below.

The difficulties attending the regular working of a battery on a traction load are well known. It was in order to overcome these difficulties that Mr. J. S. Highfield designed the machine which bears his name. Briefly stated, the object of the design is to enable the generator output to be kept constant when the booster is working in conjunction with a battery on a traction or other variable load, while at the same time providing for fully charging during working hours, and discharging up to the momentary rate of the battery. To this end the booster armature is always in series with the battery, the machine being run throughout the time the generators are working, and sometimes when the battery alone is feeding the line. In Fig. 7 the essential connections to the machine are shown. The booster, B, has laminated field magnets, excited by a field winding proportioned so that the pressure given by the armature when run at constant speed shall be the same as the pressure across the ends of the field winding. The exciter, E, is a small generator giving a terminal pressure of 500 volts, and the necessary exciting current. This generator has a very small drop from no load to full load, a series winding being provided to correct for the drop. Its armature leads are coupled, one (the negative) to the negative terminal of the battery, and the other (the positive) to the opposite terminal of the battery, through the field winding of the booster, B. From this arrangement it follows that so long as the exciter and battery pressures are equal in value, no current will flow through the booster field windings, wherefore the booster will yield no pressure. But should the battery pressure rise, a current will flow through the booster field windings proportional to the difference of the pressures yielded respectively by the battery and the exciter, which latter will be motored. The booster armature will then yield a terminal pressure equal to the rise of pressure in the battery. Similarly, should the pressure at the battery terminals fall, the booster will give a pressure equal to the fall, but at the same time its poles will be reversed, while the exciter will run as a generator and give current to the battery. In other words, the booster follows the variations of the battery pressure from the line pressure, and corrects for the variations in such a way as to maintain the line pressure constant, whether the battery be charging or discharging A brief consideration suffices to make it clear that the exciter generally runs as a motor when charging, and as a generator when discharging; but since only 500 cells are used occasionally when the charge in the cells is low, the charging begins at a lower pressure than the 1,000 volts on the line, when the booster runs as a motor, and the motor in its turn as a generator returning energy to the line. Further, when the battery is fully charged, the pressure between its terminals is generally greater than the line pressure, and should the battery in this condition be called on to discharge, the booster opposes and is motored. The motor then runs as a generator, returning energy to the line, as in the previous case. The current variations in the motor amount to about 7 per cent. of the maximum line variation. In virtue of the fact that the booster field cores are laminated, the booster being, moreover, designed to work at a low induction, so that the field strength is as nearly as possible proportional to the magnetising force, the change of polarity is rapidly made, and the variation of pressure consequently is very closely in accord with the difference

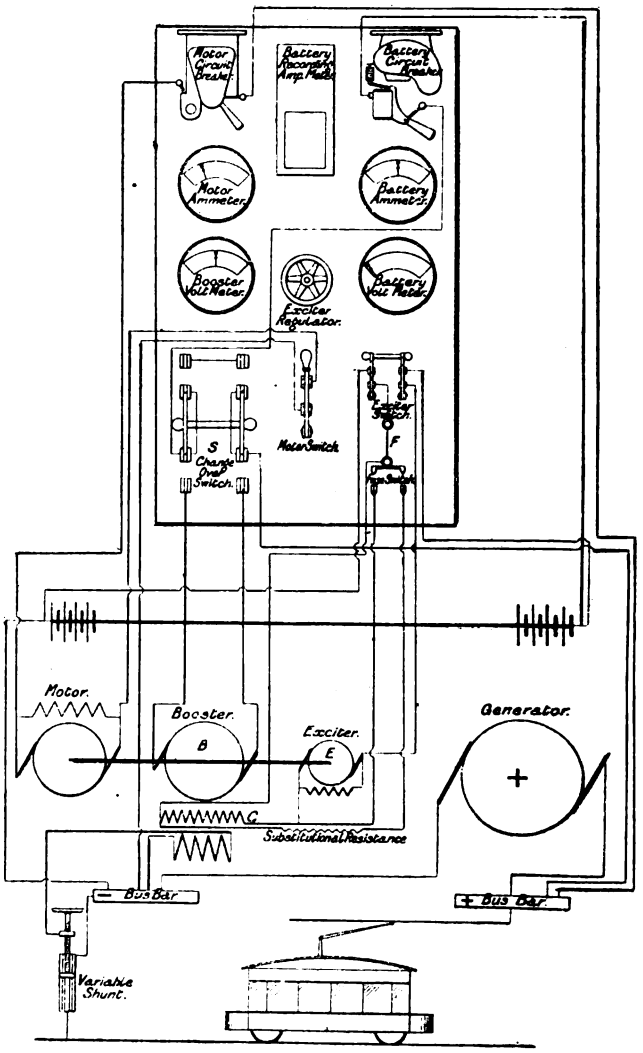

FIG. 7.—Essential Connections to Highfield Booster, City and South London Railway.

between the battery and exciter pressures. Such a booster connected in series with the battery will serve to maintain nearly constant, it is claimed, the load on the generator, and will nearly rectify all changes in the battery pressure. There will be times, however, when the current through the booster armature is large and the field very weak. It is then that the armature reaction will be an important factor in the working of such a machine. To overcome this, a coil connected in series with the armature is used, so that it opposes the reaction of the armature in whichever direction the current flows. This coil consists of a few turns only. In order to increase the pressure as the load on the line increases, a part of the feeder current is shunted round a coil on the booster field windings in such a direction as to help the discharge or to oppose the charge. As an alternative to this method a part of the feeder current may be taken round the exciter fields so as to raise the exciter pressure, or, again, a part of the feeder may be taken round the motor fields, so that

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the greater the load becomes the greater correspondingly is the speed of the motor, and hence also the pressure yielded by the exciter and booster in the discharging direction. In working with shunt-wound generators, there is a tendency for the motor to hunt, so that as the load on the line increases the battery does more than its share, causing the pressure to rise and the motor consequently to run faster. At the same time, the booster pressure and also that of the exciter increases, hence the tendency to take still more load. A similar tendency arises as the line load falls off. In order to counteract this, the motor is designed so that an increase in pressure at its terminals strengthens the field in a greater proportion than usual. In other words, the motor field is designed on the same lines as the booster field, whereby the tendency to hunt is entirely checked. With regard to the nature of the fluctuations of the current taken by the motor driving the booster, since the number of cells used is 500, the boost on the top charge amounts to 300 volts—that is to say, the pressure is about 1,300 volts on the cells when they are fully charged. The least pressure to which the battery falls on the heaviest discharges is 920 volts, the boost on charge being therefore greater than on discharge, hence with the same current the motor takes more driving on charge than on discharge, and consequently, with the steady load on the generator, the charging current is never as great as the discharging current The battery at Islington, it may be mentioned, was supplied by the Tudor Accumulator Company, Limited, and is composed of 500 cells, type No. 210 H.B. 13. It is capable of giving

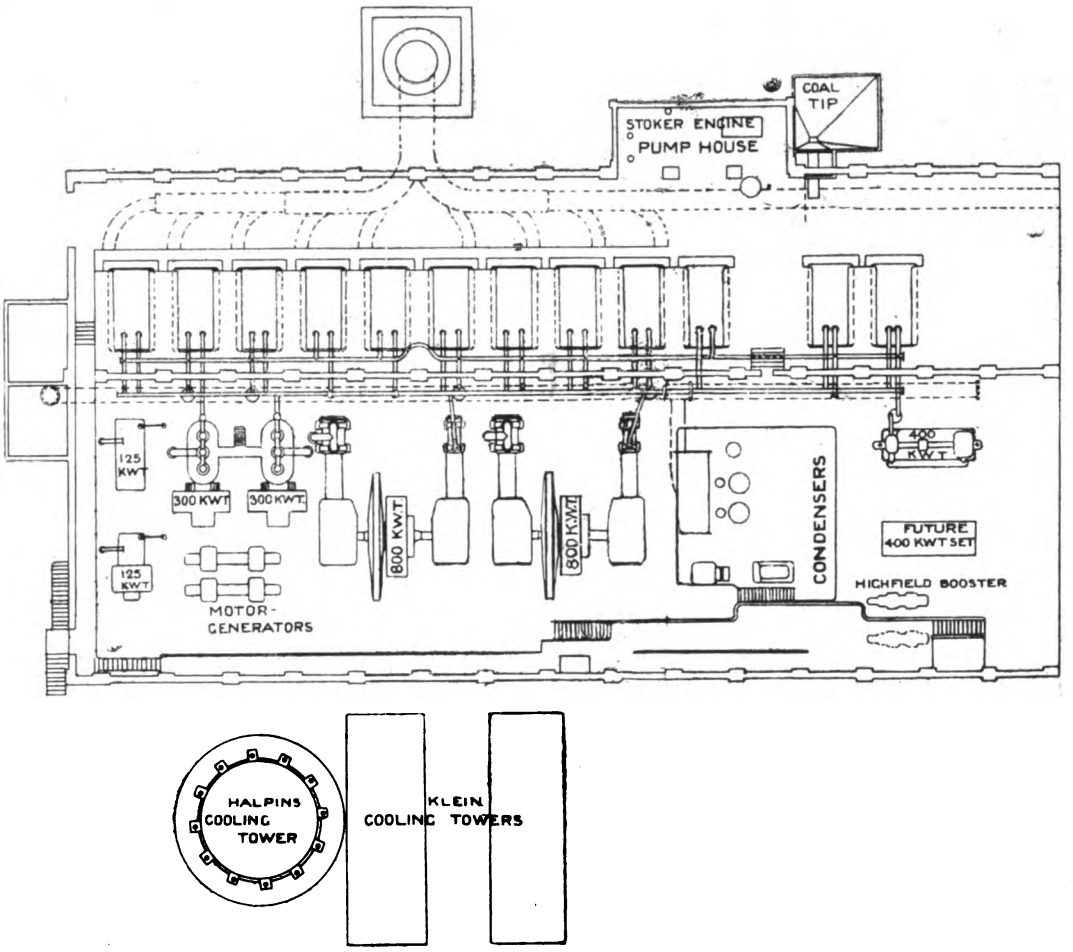

FIG. 8.—Plan of Generating Station, City and South London Railway.

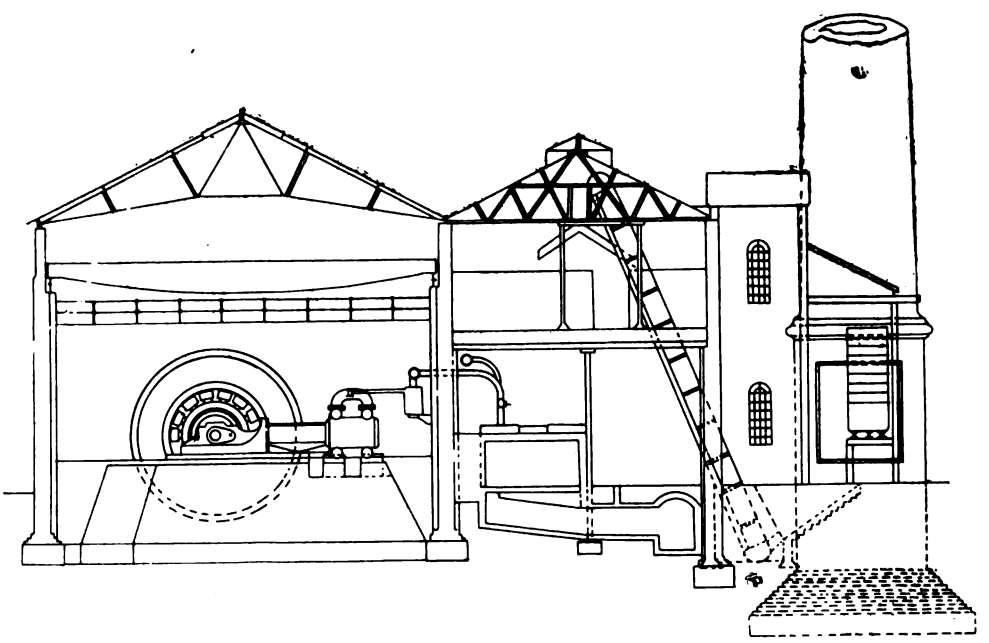

FIG. 9.—Section through Generating Station, City and South London Railway.

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180 amperes for three hours, or 420 amperes for one hour, and is further capable of yielding an output up to 600 amperes for short periods. The maximum constant rate of charge is 180 amperes, the maximum rate for short periods being 300 amperes.

Besides this battery and the Highfield booster already described, there are the continuous-current transformers for reducing the high-tension current from the generating station to 500 volts for supplying to either side of the three-wire system. These transformers are of the E.C.C. variable-ratio type. In order to be able to regulate the ratio of the transformation so as to compensate for large variations of load, causing a drop in the line pressure, these machines are provided with a small auxiliary field. The windings of only one of the two armature circuits of the converter are continued across the core opposite this auxiliary field. It follows, in consequence, that by varying the strength of this auxiliary field the transforming ratio is altered. The result is a much cheaper machine than a motor-generator, and also a further advantage is obtained in that the armature reactions between the two windings are practically balanced, so that they neutralise each other. The switchboard in this sub-station is of the E.C.C. standard type, interlocking gear being provided on the booster panel.

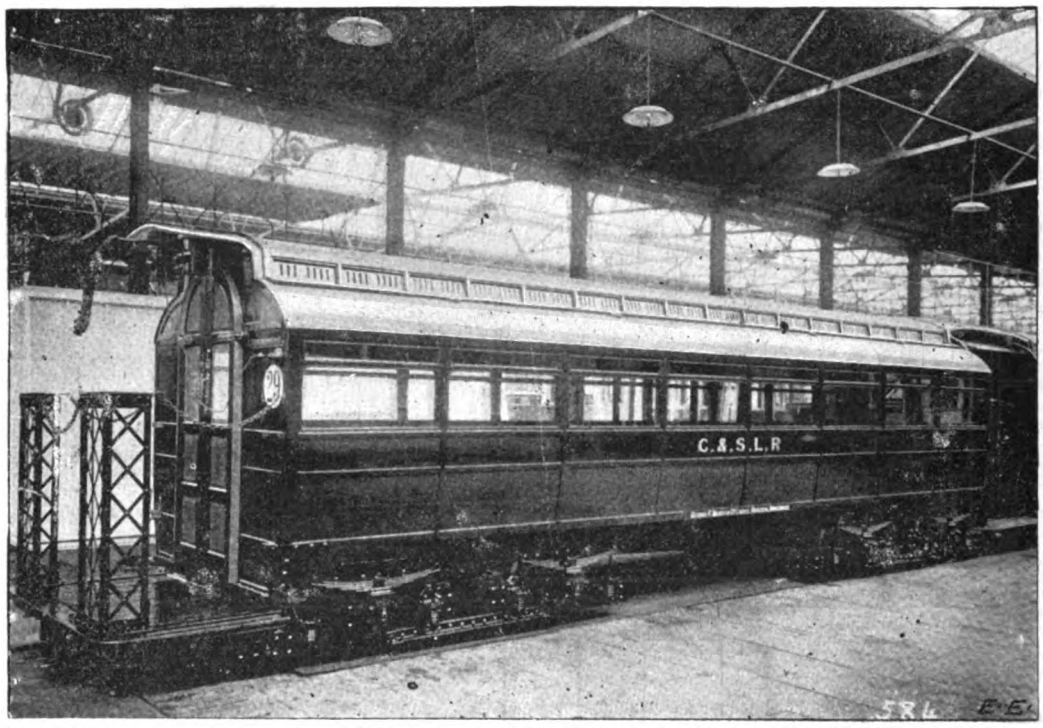

FIG. 10.—Exterior of New Coach, City and South London Railway.

When we visited the works recently the arrangements at Islington sub-station were not complete, although the Highfield booster had already been tested under working conditions. Its steadying effect on the line pressure was very apparent from the recorder curves, and there can be no doubt but that, apart from the object described above, the arrangement adopted, whereby the station lighting and current for working the electric lifts will be supplied from the batteries by independent cables, will ensure well-lighted stations, besides serving to maintain a constant supply of power for working the lifts.

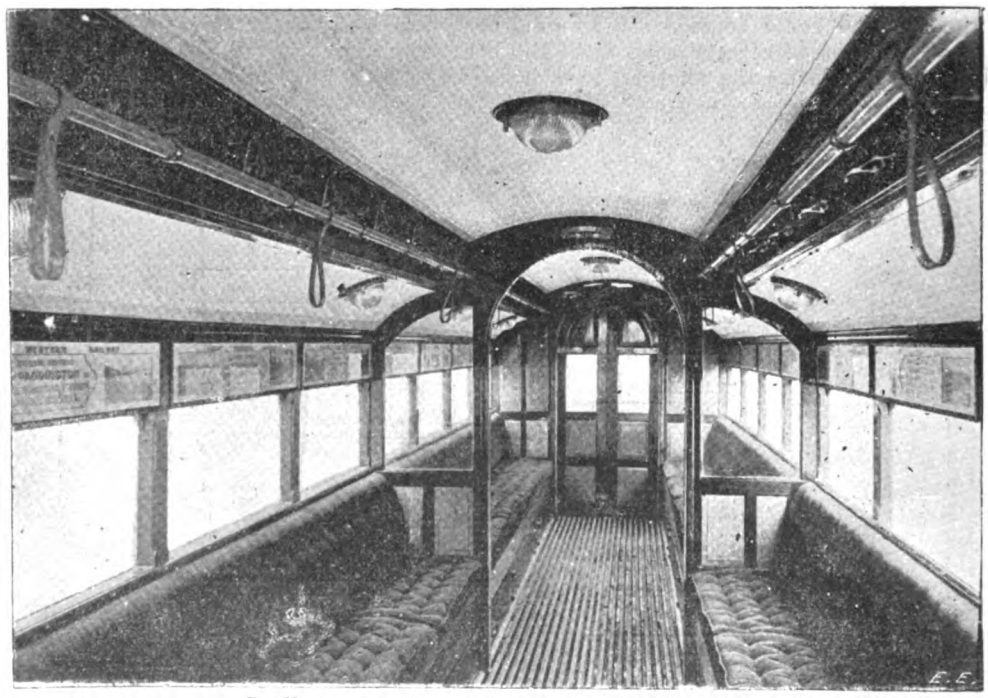

FIG. 11.—Interior of New Coach, City and South London Railway.

At the London Bridge sub-station the continuous-current transformers are of the same type as those already

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described, whereas the battery is in this case charged only at times of light load through a booster of ordinary design, and is held in reserve.

The third battery, to be installed at the generating station buildings, will be worked in conjunction with Highfield boosters, the proposed positions for which are shown on the plan (Fig. 8). On referring to this figure it will be seen that the extension generating set is of 400 kw. capacity, and not 300 kw., as stated in the first instalment of this article. Fig. 9, which we were also unable to prepare in time for inclusion with the previous article, is a cross-section through the generating station buildings.

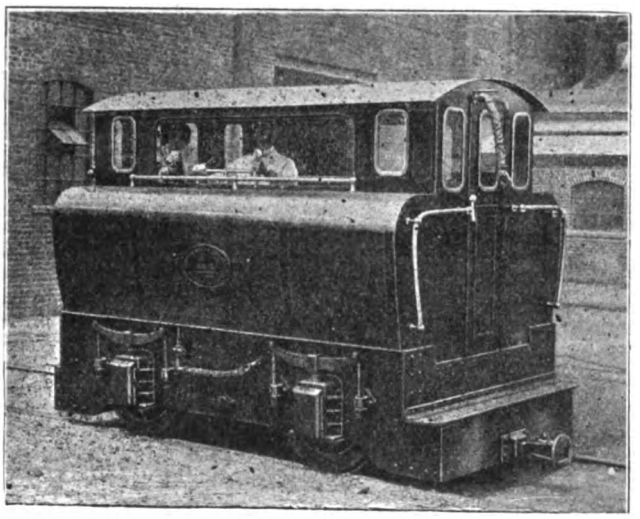

FIG. 12.—Locomotive, City and South London Railway.

It should be mentioned in connection with the electrical equipment of the line that at Moorgate-street, the Elephant and Castle, and Clapham Common Stations balancers are placed, each machine being capable of dealing with a load of 160 to 200 amperes concentrated on one side of the system, and that the plant already installed in the Islington sub-station is sufficient to work also the proposed extension of the company's system to Euston.

Now we come to rolling-stock, and in this connection it may be mentioned that the heaviest gradient which the locomotives are called upon to negotiate amounts to 1 in 114 over a distance of 500 yards. There are also gradients of 1 in 94 for about 300 yards, 1 in 65 for 100 yards, and 1 in 70 for 200 yards. The other gradients vary from 1 in 200 to 1 in 300. Since the line was first inaugurated a change had been made with regard to the collector rail, the weight of this having been increased from 14lb. to 40lb. per yard run.

Ten new four-coach trains are now being put into service,

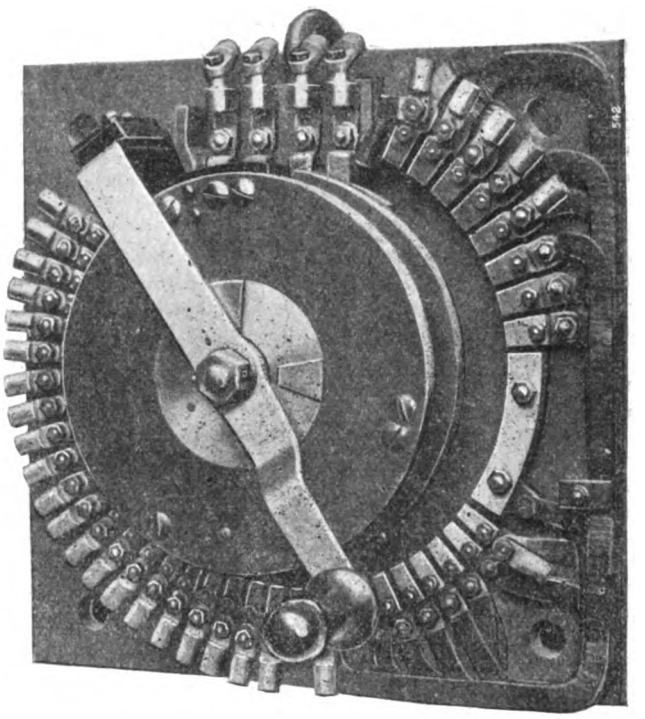

FIG. 14.—Series Parallel Controller, City and South London Railway.

while the older carriages are gradually being reconstructed on similar lines. In Figs. 10 and 11 exterior and interior views respectively of one of the new coaches are shown. These coaches were supplied by Messrs. George F. Milnes and Co., Limited. They are made up into trains of four, movable platforms being arranged between the coaches, and pivoted to allow of freedom in passing round curves. These platforms are fitted with patent collapsible gates, which are always kept closed when the train is in motion. The coaches are designed so as to secure the maximum amount of room consistent with a small diameter of the subway through which they have to run. The coaches are built almost exclusively of teak, handsomely fitted up and furnished, and, of course, lighted throughout with electricity, with the exception of the tail lights, which are

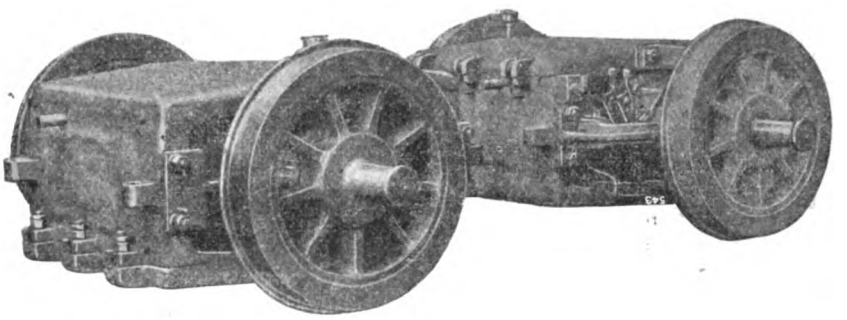

FIG. 13.—Locomotive Motor, City and South London Railway.

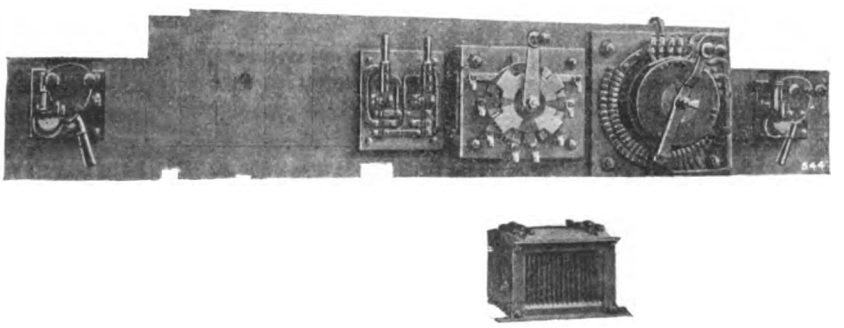

FIG. 15.—Locomotive Switch Gear, City and South London Railway.

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arranged to burn oil. Electric bells are also installed. The sides of the body are shaped to the form of the circular tube, and the steel frame is recessed in the centre, so as to get as near as possible to the rail level, and so gain headroom. The teak sole bars are plated with steel on both sides the whole length. The interiors of the coaches are elegantly panelled in figured wainscot oak, with ceiling of Lincrusta Walton. The seats and backs are arranged longitudinally. Both the seats and backs are highly finished and upholstered in figured rep. Each coach has seating accommodation for 34 passengers. The coaches are mounted on bogies of the most improved type, with springs arranged so as to ensure the coaches riding easily, and fitted with Westinghouse automatic air-brakes. They are also fitted with double sliding doors at each end, and in the centre a framed partition is arranged, dividing the coach into two parts. The over-all length of each coach is 26ft.

The rolling-stock in use comprises 52 locomotives and upwards of 124 coaches, as against 14 locomotives and 30 coaches in December, 1890.

So far as the locomotives at present in use are concerned, the design of these may be said to be the outcome of practical experience in working the line. They were constructed by Messrs. Crompton and Co., Limited. An exterior view of one of them is shown in Fig. 12. Their gauge is 4ft. 8½in., diameter of wheels 2ft. 7in., and the weight of each locomotive 13 tons. Two four-pole series-wound iron-clad motors are fitted to each locomotive, one coupled direct to each locomotive axle, as shown in Fig. 13. Series-parallel controllers, designed by Mr. P. V. McMahon, the company's engineer, are employed. The appearance of one of these controllers is shown in Fig. 14, while the combined switch-gear fitted to each locomotive is shown in Figs. 15 and 16. Mr. McMahon gave a very full and detailed description of the standard type of locomotive adopted by the company in his paper read before the Institution of Electrical Engineers on May 4, 1899, and reproduced at the time in these columns. We understand that the design has undergone no material change since that paper appeared, which also went fully into the results obtained.

In conclusion, we may add that the contract for the complete electrical equipment of the line described was let to the Electric Construction Company, Limited, who were represented on the work by Mr. N. H. White. The sub-contractors responsible for various sections of the work were as already mentioned. It is reassuring to know in these days of foreign competition that the whole of the plant, material, and labour in connection with the building and working of the line is British. Mr. P. V. McMahon was assisted in supervising the work by Mr. N. Rheam, the company's chief assistant engineer. We have to thank Mr. McMahon for his courtesy in allowing us to take photographs of the generating station, and in placing at our disposal most of the particulars given in the first and present instalments of this article.

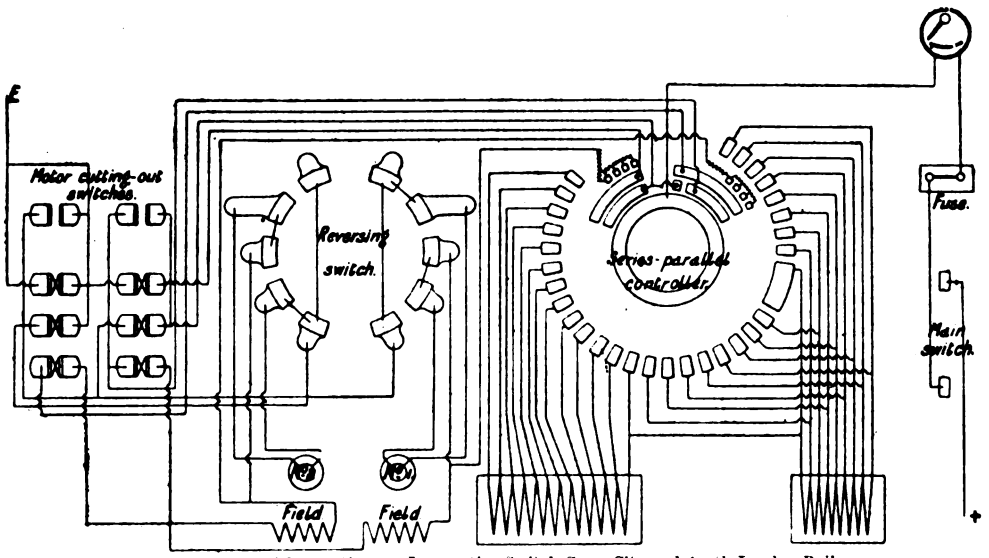

FIG. 16.—Diagram of Connections to Locomotive Switch Gear, City and South London Railway.

ALUMINIUM: NOTES ON ITS PRODUCTION, PROPERTIES, AND USE.*

BY W. MURRAY MORRISON, MEMBER.

The paper begins with a short description of the British Aluminium Company's water-power installation at Foyers, Inverness-shire. A description of this plant—the only one of its kind in the United Kingdom—appeared in our issues of April 24 and May 8, 1896. The power is derived from the River Foyers, the water being drawn from a point above the Falls. Passing first through a tunnel 8ft. 6in. diameter and half a mile long, it descends through separate cast-iron pipes to the turbines situated in the factory on the shore of Loch Ness. The turbines, seven in number, work under a head of 350ft. They are built by Escher, Wyss, and Co., of Zürich, and are of the Girard type with vertical shafts. These are direct-coupled to Oerlikon direct current generators of 700 e.h.p. each. Two small turbines of the Pelton wheel type drive direct-current generators for lighting and motive power.

Aluminium is now sold at about 1s. to 1s. 4d. per pound. The great lowering in its price dates from 1887, when Hall in America and Héroult in Europe took out patents for its electrolytic winning from alumina—the process now in use. Reduction in the presence of carbon in an arc furnace and electrolysis from aqueous solutions, are both impracticable. It is interesting to note that in 1894 Wilson (having in view the production of a metal with a higher affinity for oxygen than aluminium and the reduction of alumina by its agency) was attempting to obtain metallic calcium by the smelting of a mixture of lime and carbon in an arc furnace, when he discovered, practically accidentally, the commercial means of producing calcium carbide, now such a considerable industry.

All the processes for aluminium production now at work consist in the reduction of alumina (Al_2O_3). Other compounds of the metal offer great inducements, notably the chloride and the sulphide, their voltages of decomposition—2·3 and ·9 respectively—being lower than that of alumina, which is 2·8. Unfortunately, however, the two former compounds are, with our present knowledge, difficult and expensive to produce, and a cheap process for their production would be a most important advance. The electrolytic methods of Héroult and Hall (which are practically identical) are described. Alumina is dissolved in a bath of molten cryolite ($6NaF.Al_2F_6$), which latter material is found chiefly in Greenland; alumina being extracted by chemical means from the mineral bauxite, found in Ireland, France, and elsewhere, which contains 50 to 60 per cent. of alumina. Carbon anodes are used to convey the current, and the reaction takes place according to the formula $Al_2O_3 + 3C = 2Al + 3CO$, the carbon being derived from the anode. The aluminium sinks to the bottom of the bath, and is tapped or ladled out when sufficient

* Abstract of paper read before the Glasgow Section of the Institution of Electrical Engineers, Dec. 10, 1901.

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metal has accumulated. The process, though very simple theoretically, is difficult to work in practice, and requires considerable experience to make it successful.

The great amount of energy required for the reduction of the metal renders very cheap power absolutely necessary, the only practical form being water power, costing from 30s. to £4 per horse-power per year of 8,760 hours. Aluminium can be produced 99·9 per cent. pure, the commercial purity being about 99·5 per cent. The present world's output is estimated at something over 5,000 tons per annum, whereas the yearly output of the metals with which it chiefly competes—namely, copper and tin—is about 497,000 tons and 79,200 tons respec tively. It is thus seen what possibilities there are for the extension of the aluminium industry should even a small further percentage of these metals be replaced by aluminium.

The leading properties of the metal are gone into at some length, the chief one being, of course, its low specific gravity. A useful table is given comparing the specific gravities, prices, and costs for equal volume of eight common metals with those of aluminium. By this it is seen that for equal volume aluminium only weighs 37 per cent. of the next lightest metal in common use—namely, zinc—and that as regards cost for equal volume only three common metals are lower—viz., zinc, iron, and lead. Its tensile strength when cast is from five to eight tons per square inch, and rolled or drawn up to 17 tons per square inch. Its melting point is 625deg. C., and it can easily be worked, cast, extruded, rolled, forged, drawn, spun, etc., with attention to certain simple precautions now well understood and easily given effect to. It is third among metals as regards malleability and sixth as regards ductility. Sheets can be hammered down to ·000025in. thick, in consequence of which it has largely replaced silver leaf, and wire can be drawn down to ·004in. It is fourth among metals as regards thermal conductivity, which property, added to the fact that it is hardly affected by acids, and that all its salts are absolutely non-poisonous (unlike those of copper), makes it specially suitable for cooking utensils, for which it has already found extended use. It is less affected by dry or damp air than any of the ordinary metals, the film of oxide always on its surface being an efficient protection against further oxidisation. Its great affinity for oxygen has been taken advantage of in the well-known Goldschmidt process for attaining high temperatures, in which powdered aluminium is mixed with an oxide of a metal such as iron, and ignited with a piece of magnesium ribbon. The very high temperature obtained from the combination of the aluminium with the oxygen of the oxide present, enables the process to be used for the welding of pipes and rails, and for repairing broken castings. This process is of interest to electrical engineers from the facilities which it affords for welding rails, giving a good mechanical and electrical joint, and rendering bonding unnecessary. A valuable property is its power of combining with the occluded gases in castings. Two to five pounds of aluminium added to a ton of melted iron have the effect of making the casting free from blowholes, tougher, and of greater homogeneity, the metal being also rendered more fluid during casting. Foundries using aluminium in this way have their "waster" castings reduced by a large percentage.

Two classes of aluminium alloys are in common use, the light and the heavy alloys. The former contain not more than 10 per cent. of some other metal than aluminium, whereby the tensile strength is raised in some cases to 24 tons per square inch with hardly any increase in weight over that of the pure metal. The heavy alloys contain aluminium up to about 10 per cent. The aluminium bronzes are the principal alloys in this class, and have tensile strengths up to 45 tons per square inch. The use of aluminium for electrical conductors is treated very fully, and reference is made to the work done on this subject by Prof. E. Wilson, of King's College, London, who has recently read a paper thereon before the Institution in London. Acording to Prof. Wilson, aluminium 99·55 per cent. pure has a specific resistance of $2{\cdot}762 \times 10^{-6}$ legal ohms per cubic centimetre at 15deg. C., with a temperature coefficient of ·00393 per degree C. This makes the conductivity, as compared with copper (Matthiessen's standard), 61·4 per cent.

The following table is given comparing copper and aluminium wires:

Comparative Figures of Copper and Aluminium Wire.

	Copper wire.	Aluminium wire.
Specific gravity	8·93	2·65
Conductivity	100	61
Section for equal conductivity	1	1·64
Diameter for equal conductivity	1	1·28
Weight for equal conductivity	1	·485
Weight for equal section	1	·297
Tensile strength for equal section	1	·46
Tensile strength for equal conductivity	1	·75

Where tensile strength is of importance, as in aerial wires, pure aluminium, more especially in the case of small wires, is sometimes too weak, and an alloy becomes necessary. For this purpose alloys have been produced equalling the strength of copper for equal conductivity, with a reduction of from 1 to 2 per cent. of conductivity below that of pure metal. Figures are given showing that when the price per pound of aluminium is not more than double that of copper, it pays to use it rather than the latter. Copper wire being about 10d. per pound and aluminium wire about 1s. 6d., it is seen that for bare wires aluminium is cheaper than copper by about 13 per cent., and has the additional advantage of being about 50 per cent. lighter for the same conductivity. Jointing aluminium has been a difficulty in the past, as no other metal can be used in contact with it with safety. There are now, however, a large number of excellent joints for small and large wires and for strip, several specimens being exhibited by the author. A description is given of the various forms of aluminium conductors in use at Foyers. Many tons of flexible cable and strip carry current between the dynamos and furnaces. A telephone line of No. 12 S.W.G. runs a distance of six miles over exposed country. An overhead transmission line, ·38in. diameter and 5,500ft. long, is also installed. All the above have been in use for some years, and have given no trouble whatever, except the telephone line, which has broken on some occasions in high winds on account of its being of pure aluminium instead of an alloy, as wires of so small a diameter ought to be. The author admits having originally had the usual prejudice in favour of copper, but after experience of aluminium conductors his opinion is entirely altered, and he is fully convinced of their great advantages. Six important power transmission schemes in America are mentioned where aluminium is used for the overhead wires, the most important being that from Niagara to Buffalo, showing that American engineers are fully alive to the advantages of the new metal.

At present prices aluminium cannot compete with copper for low-tension insulated cables, but high-tension cables are on a different footing, and the matter is a subject of great importance in view of the numerous Power Bills lately passed by Parliament. The author makes use of the paper read by Mr. Mervyn O'Gorman before the Institution in March of this year, and shows that by reason of the absence of proportionality between the radial depth of insulation and its dielectric strength, the use of aluminium instead of copper will, under some conditions of voltage and current, enable a much cheaper cable to be obtained.

Many useful tables are given in the paper; lantern slides and photographs were shown, as well as a large assortment of specimens of conductors, joints, castings for brush-holders, and for overhead traction equipment, etc.

ELECTRICITY AS A MOTIVE POWER, AND ITS RELATION TO ECONOMY.

An instructive discourse upon the above subject was given by Mr. D. D. Marshall (an extensive manufacturer) before the members of the Yorkshire College Textile Society, Leeds, on Tuesday night of last week. He considered electricity as a distribution power applied as an intermediary between the steam-engine and the machine to be driven, and superseding wholly, or in part, ropes, belts, shafting, and toothed gearing. He supposed that they had to drive a 500-i.h.p. machine by electricity, and apply

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it to various classes of machinery used in the textile industry.

The driving of the machinery in the factory might be dealt with in two ways. They might fix a motor to each machine, by which plan they would be able to fix each machine where they thought fit without regard to shafting. Or they might group the machines in the usual way, and fix a motor of sufficient power to drive a line of shaft intended to carry a number of machines. To fix a motor to each machine in a woollen factory would be too expensive, not only in the initial cost, but in keeping the great number of motors in repair, and certainly not sufficient compensatory advantages gained thereby; consequently that could not be considered the most economical system. He would, therefore, base his calculations on the latter plan, and would outline the amount of indicated horse-power which each department in a well-arranged textile factory might be fairly estimated to take:

Blending-room	25 h.p.	at a cost of	£140
Rag or mango pulling	70 h.p.	,,	245
Cloth milling	90 h.p.	,,	315
Cloth finishing	40 h.p.	,,	180
Carding or combing	85 h.p.	,,	281
Weaving	80 h.p.	,,	265
Dye-house	30 h.p.	,,	160
	420 h.p.		£1,586

The dynamo to convey 420 h.p. to the motors should run, said Mr. Marshall, at about 350 revolutions per minute. The dynamo would cost £1,200, making the total sum £2,786. Coming next to compare costs, Mr. Marshall said that the above figures were as near an estimate as could be formed, both as to what the various departments would cost and the power required to drive the machinery requisite; also the cost of joining the motors to the various lines of shaft required for each room. Mr. Marshall then gave the subjoined estimate of the cost of a complete electric plant for 500 i.h.p. with a direct-driven high-speed dynamo:

High-speed engine (latest pattern)	£2,000
Dynamo	1,200
Motors	1,586
Shafting—various lines for transmission	500
Green's economiser	420
Foundation for engine (ashlar)	200
Steam-boiler	770
Total outlay	£6,676

The total initial cost of a steam driving plant, he proceeded, was £5,390. Thus there was a difference in capital outlay in favour of steam of £1,286—nearly 20 per cent. less than electricity. Every addition to the capital outlay of a business created an extra charge against the profits of that business for interest on the additional outlay; also in the case of outlay on plant or machinery, for depreciation, repairs, etc. These extra charges, therefore, must be allowed for in the calculations, and he thought that the following should cover them:

Extra annual cost of running and maintaining an electric plant: wages of skilled electrical engineer, £150; extra repairs (£1 per week), £50; extra depreciation on £1,286 additional outlay, £95; interest on the diminishing sum (reduced annually for depreciation, as appended) at 5 per cent. per annum, the calculations being arranged over the life of the dynamo (13 years), £35; making the gross extra charges, £330.

It was pointed out by the lecturer that, in calculating the extra depreciation, he had taken into account the fact that the whole of the electric plant, with the exception of the dynamo, depreciated at about the same rate as the steam plant, and the dynamo (costing £1,200) represented merely the amount of additional outlay; therefore the extra depreciation was upon the dynamo itself 7½ per cent. per annum, or, he would say, 13 years. He would deduct from this £330 the amount of saving in fuel in consequence of less friction and easier drive by electricity, which he estimated would reduce the fuel account about 20 per cent. less than steam power, and in the case of an engine of 500 i.h.p. would effect a saving of £135. That would leave a net increase in the annual cost against electricity of £195, or £3. 15s. per week. All of these figures, Mr. Marshall pointed out, had been carefully checked by Mr. Wilson Hartnell, the well-known electrician, of Leeds. It would be obvious from them that steam driving, under the most favourable circumstances, was the most economical of the two; but if a new factory were being built, and the supply of electricity for the motive power were got from some outside company, and the steam-engine, main gearing, and other lines of shafting used in transmission of power, as well as the boiler, were dispensed with, a very considerable amount of outlay of capital would be avoided, and in case of a further amount of power being wanted it would only be a matter of putting down another motor. That was a very important consideration in favour of electric driving; that would not, of course, make a total saving of the machinery which motor power would dispense with, as the motors themselves, and the necessary fixings, would cost over £2,000, but he thought that when all was duly taken into consideration, and the supply given at 1d. per unit, he should decidedly favour electric driving.

It would be well worth favourable consideration, thought Mr. Marshall, as the motor drive offered a few advantages which shafting and toothed gearing could not give. The working of the factory, for instance, would be much quieter; in working overtime they would only need to work such lines as were required; they could vary the speed of any line of shaft without changing the drums or pulleys; shafting much lighter in weight could be used, as each line was quite independent of other lines; and there would be less grease and dirt about, whilst the general appearance of the whole factory would assume a more pleasing and business-like aspect. A decided advantage, indeed, would be gained, as only those units would be paid for which had been actually used.

In a discussion which ensued, an engineer expressed the opinion that in 20 or 30 years' time people would wonder what "those ugly works and factory chimneys" were for: electricity as an industrial motive power would be general.

On the screen were shown views of splendidly compact motor drives of immense power, at present in use in one of the big engineering establishments of Leeds. These views were received with loud applause by the company, and many questions were asked concerning them.

ELECTRICITY WORKS LOAD FACTORS.*

BY J. GRAY SCOTT.

In dealing with the subject of load factors of electricity works, it is my desire to place before the members of the Technical College Scientific Society a few notes on the peculiar conditions which control the generation and distribution of electricity for the various purposes to which it is applied, the effect of these conditions on the cost of production, and the means whereby one may expect to make the said conditions more favourable. As the subject is an important one, and not always fully understood by some who have the control of such undertakings, I trust it will be of interest to the members of this society, and by the promotion of some discussion on the subject prove a mutual benefit. It is only by a careful study of economy and thorough organisation that electricity can compete with other commodities for the supply of light and power, and there is no doubt that the complete system of recording the various details regarding its generation and distribution, which are now universally adopted in most electricity works, has largely contributed to the success of undertakings of this kind, and, moreover, has set an example, now generally followed, in undertakings of all kinds.

The term "load factor" is due, I believe, to Colonel Crompton, and is used to express the ratio existing between the actual work done by a plant in a given time, and the possible work done by the same plant, if worked over the whole period, at the maximum load recorded. Thus, if we set off to any convenient scale horizontally a representation of any given period of time—for example, 24 hours—and likewise to a convenient scale vertically a representation of the capacity of the plant—say, 500 kw.—and at definite regular intervals of time take readings of the actual load on the plant, indicating these readings on their corresponding ordinates, we obtain a continuous curve showing, we will presume, a varying load on the plant over the period stipulated. If we now draw through the point representing the maximum load a horizontal line, we obtain a rectangle completed on the sides by the time limits and the base. The area of this rectangle represents the possible work done by the plant were the maximum load recorded maintained throughout the whole period, and the ratio borne to the area of this rectangle by the area of the figure enclosed by the load curve and time limits on the same base gives us the load factor of the load. Thus, if the maximum load recorded were maintained over the whole period, the load curve and the maximum load line would coincide, and the ratio borne to the area of the rectangle enclosed by the maximum load line by the figure enclosed by the load line would be 1 to 1, the areas being equal, and the load factor of the load would be 100 per cent.

* Paper read before the Glasgow Technical College Scientific Society.

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If, however, the load curve area were just half the maximum load area, the ratio would be ½ to 1, and the load factor of the load would be 50 per cent.

You will note that I refer specially to the load factor of the load as distinct from the load factor of the plant, because an increase of the load at its maximum point, nearer to the capacity of the plant, may increase the load factor of the plant without increasing the load factor of the load, and may possibly reduce the load factor of the load itself. To arrive, then, at the load factor of the load, the following formula is employed :

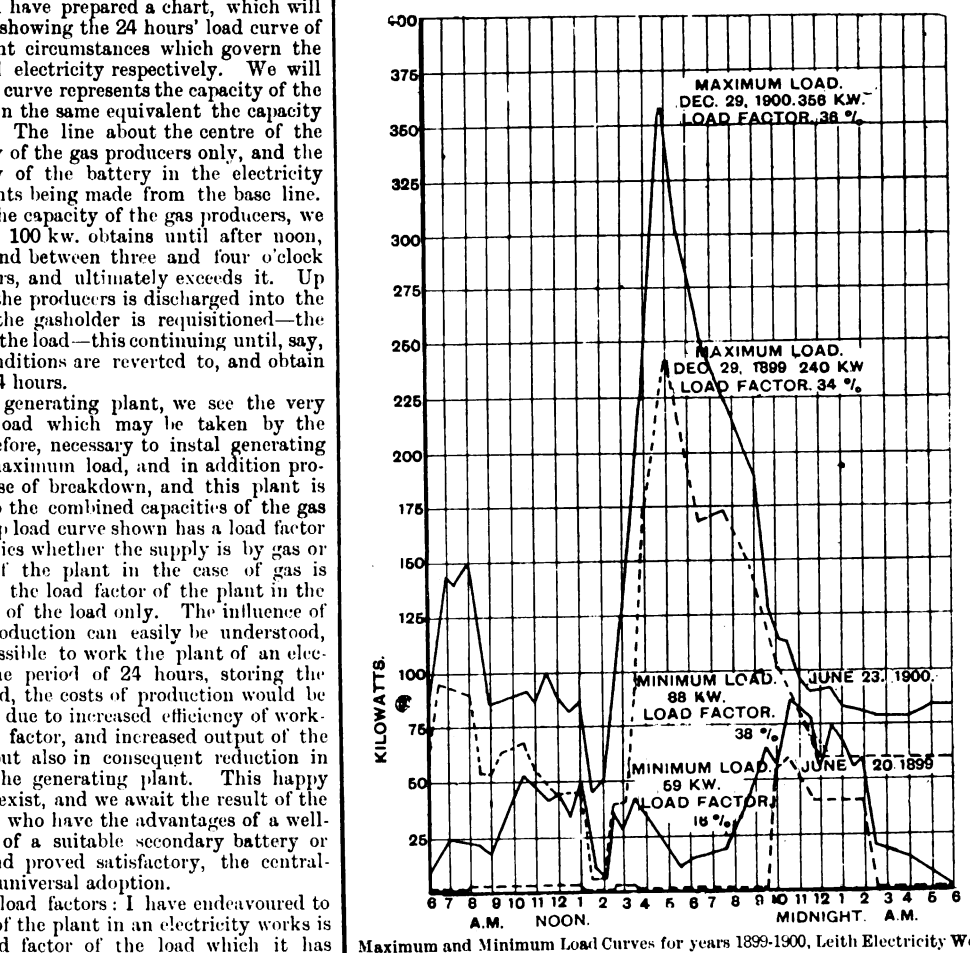
$$\frac{\text{Units generated}}{\text{Maximum kilowatts} \times 24}$$

To get the load factor of the plant under similar conditions, we substitute for the maximum kilowatts the capacity of the plant. Herein lies the great difference in the generation of electricity as compared to the manufacture of gas. In any certain town possessing both a gas and electricity supply, the nature of the load may be precisely the same in each respective case, but consider the vastly different conditions of working by comparing the load factors of the respective plants. Let us take a hypothetical load curve as met with in an ordinary town, amounting to, say, 300 kw. to 400 kw. at top load, constructed on the usual base line of 24 hours. Now, to supply this demand, a gasworks of very much less corresponding capacity, so far as the generating plant is concerned, will suffice, this plant being worked continuously throughout the 24 hours, supplying a gasholder of, perhaps, double the capacity of the works, which supply is available for the peak of the load. I have prepared a chart, which will convey my ideas more graphically, showing the 24 hours' load curve of an electricity works and the different circumstances which govern the supply for such a curve by gas and electricity respectively. We will suppose that the upper limit of the curve represents the capacity of the generating plant and battery, and in the same equivalent the capacity of gas producers and gasholders. The line about the centre of the chart, then, represents the capacity of the gas producers only, and the lower line represents the capacity of the battery in the electricity works, in each case the measurements being made from the base line. Referring to the line representing the capacity of the gas producers, we see that an average load of about 100 kw. obtains until after noon, when the load begins to increase, and between three and four o'clock reaches the capacity of the producers, and ultimately exceeds it. Up to this point the surplus gas from the producers is discharged into the gasholder, and beyond this point the gasholder is requisitioned—the stored gas being used to cope with the load—this continuing until, say, nine o'clock, when the previous conditions are reverted to, and obtain throughout the remainder of the 24 hours.

Considering, now, the electrical generating plant, we see the very small proportion of the actual load which may be taken by the secondary battery, and it is, therefore, necessary to instal generating plant sufficient to cope with the maximum load, and in addition provide for reasonable stand-by in case of breakdown, and this plant is here shown as equal in capacity to the combined capacities of the gas producers and the holders. The top load curve shown has a load factor of, say, 36 per cent. and this applies whether the supply is by gas or electricity, but the load factor of the plant in the case of gas is approximately 100 per cent., while the load factor of the plant in the case of electricity is less than that of the load only. The influence of such conditions on the costs of production can easily be understood, when we consider that were it possible to work the plant of an electricity works at full load over the period of 24 hours, storing the surplus for supplying the peak load, the costs of production would be very materially reduced—not only due to increased efficiency of working, in respect of the higher load factor, and increased output of the plant in actual units generated, but also in consequent reduction in the amount of capital sunk in the generating plant. This happy state of affairs, however, does not exist, and we await the result of the researches of you young engineers, who have the advantages of a well-equipped laboratory in the form of a suitable secondary battery or accumulator. Once produced, and proved satisfactory, the central-station engineer can vouch for its universal adoption.

But to return to the subject of load factors : I have endeavoured to show clearly that the load factor of the plant in an electricity works is practically equivalent to the load factor of the load which it has to supply. It is, of course, the desire of the station engineer to improve the load factor of his plant. How is he to do so? So far the method which has presented itself, and one which has been adopted in several towns, is that of so adjusting the charges for energy as to encourage consumers who will so influence the load for the improvement of its load factor. Dealing with the matter in a general way, consumers may be classified under two headings—viz., consumers of electricity for lighting ; consumers of electricity for motive power. The first class of consumer is charged a price per unit which will cover capital outlay, standing charges (such as rents, rates and taxes, and management, etc.), and also running costs. When it is borne in mind that the average lighting consumer only uses light for about 1½ to 2 hours per day throughout the year, it will be seen that the machinery would be left idle for no less than 22 hours per day, representing a large amount of capital giving no return during this period, and involving very large stand-by losses. If, therefore, it is possible to obtain a consumer during the day, it is profitable to supply such a consumer at practically works costs. Thus work is provided for the existing plant, and an opportunity presented to render it remunerative. The standing charges referred to remain the same, and the running costs are not perceptibly increased. More coal will, of course, be required, but this will not increase in the same ratio as the output of the plant. Oil, waste, and other stores are not greatly increased, and depreciation likewise. The price thus adjusted for motive power at, say, works costs will admit of the electric motor comparing most favourably with other forms of prime movers, and the result of the consequent increase in the output of the station is to immediately reduce the cost of production. Thus, while the lighting consumer may look with suspicion on the scale of charges applicable to his supply, as compared with that existing for the consumers of electricity for motive power, the ultimate advantage is his, because, as first pointed out, it is to the latter we must look for an appreciable reduction in working costs which will admit of a further reduction of the price per unit chargeable to the lighting consumer. A very prominent instance of this is to be found in the undertaking of the Leith Corporation. Supply was commenced in 1899 with prices at 6d. and 3d. per unit for lighting and power respectively. These were shortly reduced to 5d. and 1½d., and at May 15 last the tariff was again readjusted to the very low rates of 4d. per unit for lighting and 1½d. per unit for power, with discounts 2½ to 15 per cent. on amounts ranging from £25 to £300 respectively. It is interesting to note from returns recently issued that Leith stands fifth among undertakings throughout the whole country in respect of its very low average price received per unit sold, being forestalled in this respect only by Liverpool, Bolton, Bradford, and Edinburgh, and in the three first-mentioned towns the supply of current to tramways is included.

it will be seen from the chart shown how the load factor varies for various classes of consumers, and this is, of course, another circumstance that admits of a supply to motive power consumers at a very low rate. Probably the load with highest load factor met with in ordinary practice is that of a tramway system, on which cars are running more or less for, say, 16 hours daily, giving a load factor of about 66 per cent.



Maximum and Minimum Load Curves for years 1899-1900, Leith Electricity Works

Next in order comes public lighting, where lamps are burned on an average of 10 hours daily, giving a load factor of about 41 per cent. Then comes an ordinary motor load, say for workshop purposes, which is in use, say, 50 hours weekly, giving a load factor of about 30 per cent. Motors in intermittent use will not give a very high load factor possibly, but these will combine to favourably influence the load factor of the plant at the station. Considering, now, the lighting consumers, we find that probably the best ordinary consumer is the hotel or public-house, but the load factor of this class of consumer does not exceed about 12 per cent. And so on, by stages, through various classes of shopkeepers, with load factors depending on the lateness of their hour of closing, reaching finally the office, probably a small office, closing at 5 p.m. prompt, and with a load factor of, say, 1 per cent. Regarded from a financial point of view, this class of consumer is not a profit to the undertaking ; he is, indeed, a loss. It will thus be seen that in each respective class of consumer there is a considerable variation in the load factor, and reference to this naturally leads us to the important question of the method of charging for electricity. Considering that a consumer becomes a source of profit or loss in accordance with the load factor of his installation, a method of charging on this basis, which is no doubt known to many of you, was devised some years ago by Mr. Arthur Wright, chief engineer to the Brighton Corporation. Put shortly, this system is so arranged that each consumer is charged by the department for the capital outlay involved by his demand, and in addition, the current used, at a very low rate. To explain

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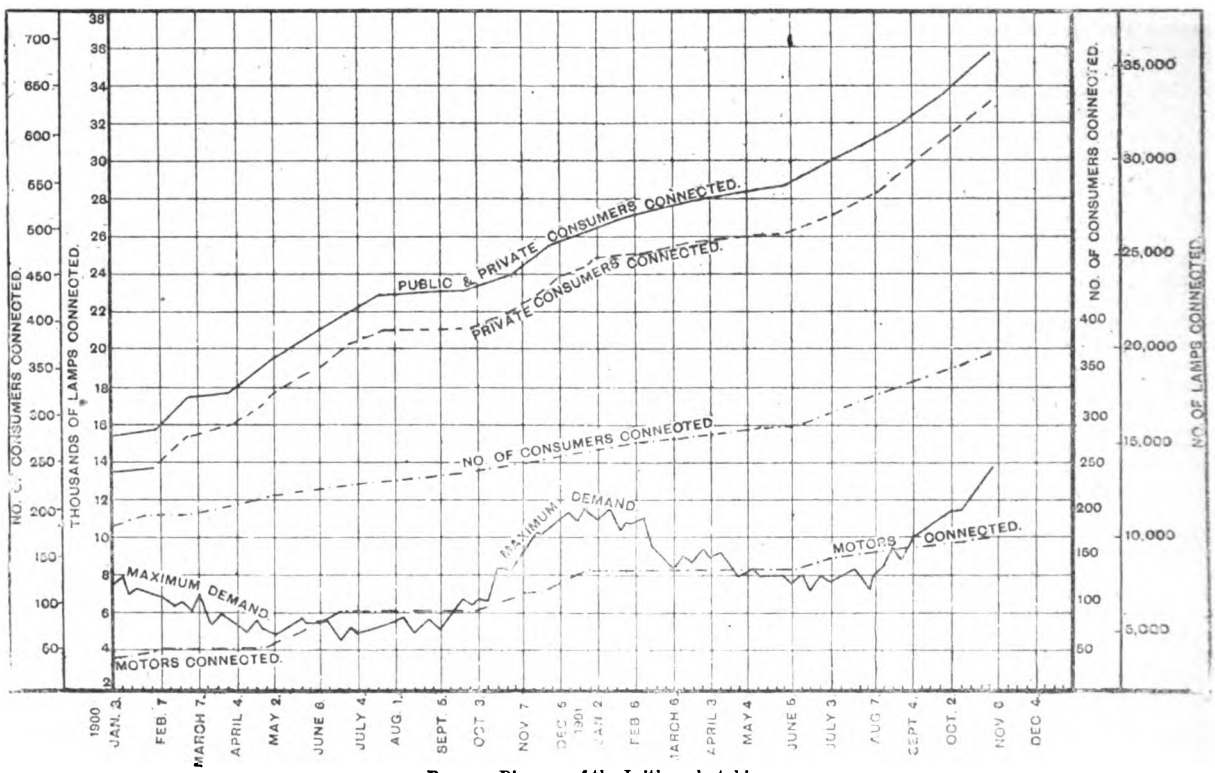
this system we may take a numerical example. One consumer has installed in his premises 100 lamps, which he uses for one hour daily; another has installed in his premises 10 lamps, which he uses 10 hours daily. It is obvious that the annual revenues from these consumers will be identical, but the capital cost to the department in providing machinery, mains, etc., to supply the former consumer will be 10 times that involved in supplying the latter. Thus, taking the price at 4d. per unit, the annual revenue from each consumer will be about £30, but the capital cost in the case of the consumer with the larger installation amounts to £480, while the capital cost in the case of the smaller consumer would probably amount to £48. Thus the so-called large consumer gives a return on his capital expenditure of about 7 per cent., which is not, of course, a profitable return, and being a short-hour consumer he is, notwithstanding his larger installation, actually a source of loss. The consumer with a smaller installation, however, shows a return on the capital outlay he involves of 62 per cent. Now, to prove a source of profit a consumer must show a return of at least 20 per cent. on the capital outlay involved by him. Obviously, where a fixed rate is in vogue—or what is termed the flat-rate system of charging—the profitable, or long-hour consumer, goes to redeem the unprofitable, or short-hour consumer; but from what has already been said it will be seen that if the conditions governing the generation of electricity are to be taken into account in arranging a scale of charges, then obviously the system referred to does not meet the case. The Wright system is on a more equitable basis, and is so arranged that each consumer is charged in proportion to his cost to the department in respect of generation. By means of an instrument known as the demand indicator placed in each consumer's premises, the maximum demand, or the equivalent of the greatest number of lights in use at one time, is recorded. For the number of units consumed during the first hour per day the consumer is charged a price to cover the cost of his proportion of the machinery and plant provided, so to speak, on his behalf, and for all subsequent daily consumption, as recorded by the ordinary meter, the price charged is a very low one, to cover only working cost. The effect of such a tariff is, of course, to cheapen the supply to long-hour consumers. The longer the period over which the current is used daily, the more nearly does the average price per unit charged to the consumer approximate the lower figure. In the numerical example given above it was seen that the revenue of the two consumers was the same, although the degree of profit to the undertaking very different. Let us now apply the Wright system of charging to the same case, and note the effect of the charges to the consumers. We had first the consumer with 100 lamps, all in use, say, for one hour daily. The consumption in this case would be, say, six units per hour, and taking 300 days the annual consumption would be 1,800 units. Now, the maximum demand indicator would show six units as maximum demand, and presuming the rate of charging to be 7d. per unit for the first hour, and 1d. per unit thereafter, the consumer would pay all his units at 7d. in virtue of the fact that his lamps are not in use for more than one hour daily on the average. The cost of light to this consumer would therefore be £52. 10s. per annum. As already pointed out, the capital outlay required to supply this consumer would be £480, and, therefore, the return from this consumer on capital would now be increased from 7 per cent. to about 10 per cent.

Referring, now, to the long-hour consumer, who has installed only 10 lamps, in use 10 hours daily, the maximum demand, or units consumed in one hour, will be about ·6 of one unit, and the total units as recorded by meter will be 1,800, as before. The adjustment of charges to this consumer would be as follows, taking 300 days per annum as before: ·6 × 300 = 180 units at 7d., £5. 5s.; balance – 1,620 units at 1d., £6. 15s.—or a total bill of £12 in place of £30, as formerly, and a return on capital of 25 per cent. in place of 62 per cent.; but in each case the consumer pays about 10 per cent. on the capital outlay he has involved, the balance being the payment for units actually consumed at a fixed rate, taken in this case at 1d. per unit. It will be seen that this system is on an absolutely equitable basis, so far as generation of electricity is concerned—that is to say, each consumer is charged according to his load factor. There are other systems of charging, and these have all arisen from the conditions controlling the generation of electricity. Thus, a system devised by Dr. Hopkinson is still in vogue, I believe, in Manchester and other towns, which charges the consumer a fixed charge per annum, depending on the number of lamps installed, and the number of lamps alight at one time, and, in addition, a small charge is made per unit for all current consumed in excess of this amount. This is on similar lines to the maximum demand system, and while it does not necessitate the permanent installation of a demand indicator, it is open to the disadvantage that it is only approximate, and the consumer, should he desire to do so, may increase his maximum demand without the knowledge of the engineer. It has also a tendency to discourage the installation of any more lamps than are absolutely necessary. The systems for charging for electricity are various, and the question is one which has been, and is still, very much discussed. There is no doubt about its being a very difficult question, and in his recent presidential address before the Incorporated Municipal Electrical Association, Mr. W. A. Chamen, chief engineer to the Glasgow Corporation, showed very clearly the difficulties connected with the adjustment of charges, particularly in a very large undertaking such as that of the Glasgow Corporation. A system of charging was devised, I believe, by Mr. Chamen, and provided an alternative scale to various consumers, and I believe this scale is still in vogue. Thus, the Glasgow Corporation charge those consumers whose load factor is a very poor one, such as offices, etc., a comparatively high rate of 6d. per unit, and those consumers whose load factor is a better one, such as domestic consumers, a lower price of 3½d. per unit. Presuming a business man has his residence in the same town, then in Glasgow he is charged a high rate in his office, in order to make him more nearly profitable, and a low rate in his home, where on account of his better load factor, he is more profitable. Now, in a town where the flat-rate system is in use, the consumer pays the same price per unit in his office as in his house, and he is thus a much greater source of profit in proportion as a domestic consumer, although, no doubt, he is a greater source of loss as an office consumer. The same remarks apply to a comparison between the maximum demand system and the flat-rate system. In the one case the unprofitable consumer is made to pay, in the other case the profitable consumer is made to pay. Neither system is perfect, but while granting that the flat-rate system is not a strictly equitable one, there are several advantages that may be put forth in its favour. In the first place, its simplicity appeals to the engineer and consumer alike, and such a system is in conformity with ordinary business principles, whereby a commodity is sold at a certain fixed rate. Further, I believe that within the next decade this system will have become almost universal, more particularly in large towns.

In the case of small towns, however, there is no doubt that the maximum demand system is invaluable, encouraging, as it does, the long-hour consumer, and discouraging the short-hour, or unprofitable consumer, and more particularly does this hold good in the case of a supply company, who look for dividends. But it has been said—and



Progress Diagram of the Leith undertaking.

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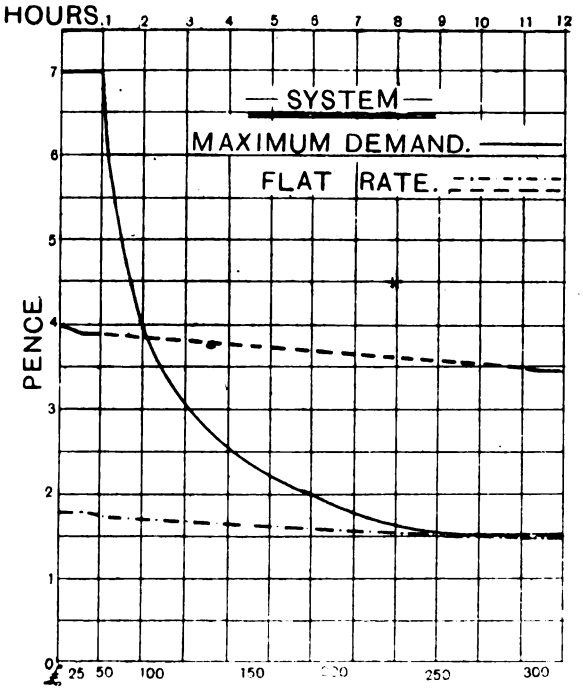
I think the sentiment is to be commended—that when a corporation undertake the supply of electricity to the public, they do so in order to provide an efficient system of street-lighting, and place at the disposal of the ratepayers a supply of electricity at minimum charge consistent with the cost of production. The making of profits is, in my opinion, to be deprecated by any municipal concern, as by so doing the ultimate limits of municipal trading are being overstepped, and it is generally found that the profit earned involves a considerable amount of discussion as to its allocation. Two points, in my opinion, should be borne in mind in connection with the maximum demand system. If it is decided to adopt the maximum demand system, then, first, the maximum demand system could be adhered to throughout for all purposes, and no alternative flat rate permitted; and, second, the maximum and minimum prices per unit should be adjusted in an equitable manner, and in accordance with the principle of the system. I have observed that in many towns the maximum demand system is in use, in which the maximum charge is placed at various figures, ranging from 7d. to 5d. for the first hour's consumption, whereas the minimum charge, or the price per unit for each hour after the first, varies from 2½d. or even 3d. down to 1d., and it is the custom in several towns to provide an alternative scale on the flat-rate system. This, I think, is to be deprecated, and, I believe, is the first step towards the abolition of the maximum demand system. If, as I say, it is decided to adopt the maximum demand system of charging, then it should be adhered to throughout, and it is highly improbable in any case that the capital expenditure is covered by any less charge than 7d., and, indeed, on going into the matter one can easily see that 7d. per unit is even too low. Take the case of the consumer already instanced, who has in his premises 100 lamps in use for one hour daily. It will be borne in mind that his account amounted to £52. 10s., showing a return of about 10 per cent. on the capital outlay. This, including as it does the cost of the electricity consumed, is certainly not sufficient to make this consumer a source of profit to the undertaking. When we come to consider the minimum charge on



Curves showing graphically a Comparison between the Flat Rate and Maximum Demand Systems of Charging.

the other hand, the reverse is the case. The better the load factor, the cheaper it is possible to supply, and this figure should be placed at, or even below, the actual cost of production for each unit of electricity. One defect of the maximum demand system of charging is that it does not take into account the hour of day at which any consumer's maximum demand is made. For example, a theatre is not lighted up at all till about 7 p.m., and the maximum may not occur till any time or times between 7.30 and 10.30. In such a case, I presume, a special arrangement would be come to. The same applies to halls requisitioned for evening concerts, dances, etc., and exists, in a modified degree, in several different cases. This is termed the diversity factor, and in this respect the system makes no distinction between its various consumers. I understand, however, that further developments have now been made in this respect, and it is now possible to control the demand indicator from the generating station, where they are cut out of circuit at ordinary times, and only switched in when the demand at the station is approaching its maximum, and again switched out an hour or two later.

Then there is the question of capital cost, both as regards the actual cost of the instrument and the fitting up of same, which in many cases is a considerable item. There may be a consumer, for instance, whose installation is very small—perhaps four or five lamps—whose load factor is fairly high, say 10 per cent., and yet whose revenue may not be sufficient to prove profitable on the capital involved in laying the service and making the connection, and it will thus be seen that there is a certain limit beyond which the question of load factor may receive undue prominence. It was shown how the prices charged were adjusted in order that the maximum charge might cover the capital outlay involved by each consumer, and while the cost to the supplier may be accurately gauged, so far as the demand on the machinery is made, and the consumer charged accordingly, still the system does not take into account the distance from the works the consumer may be situated. Here, again, we have a diversity factor, and while certain consumers may be connected to the mains at a cost of £6 or £7, others, in consequence of their greater distance from the mains, may involve a cost of £40 or £50. Of course, an agreement may be arranged whereby the consumer guarantees to pay annually an amount which will recoup the department for its outlay, and this may be arranged, of course, independently of the system of charging which may be in vogue. After the demand indicator is installed in the consumer's premises a certain amount of attention is required, occasional reading, and the item of repairs and maintenance will naturally tend to increase year by year. I understand, further, that in some towns where the maximum demand system is in use, it is customary when a consumer desires to increase his installation for a special purpose—say, a private consumer giving a dance or similar entertainment—the indicator is short-circuited for the occasion. This would, of course, involve a certain amount of labour—first short-circuiting, then removing the connection the following day—and would, in fact, only be possible in a comparatively small town; and this seems to indicate another defect in the system. I endeavoured to show how the system was an equitable one, founded, as it is, on the conditions governing the generation of electricity, but it will be clear, from subsequent remarks, that its equity is not perfect. Thus the diversity factor, both as regards maximum demand and length of cable, are taken advantage of, just as they are in a greater degree no doubt by the flat-rate system; and the equity of the system is further marred by the short-circuiting referred to, and also possible error and discrepancy in the instruments themselves.

One of the most difficult duties of the central-station engineer is to explain matters of a technical nature to a non-technical individual. The demand indicator is of a technical nature—the average consumer is a non-technical individual—and while the demand indicator may be said to improve the load factor of the station output, I venture to say that it is not required to enhance the load factor of the duties of the station engineer. Also, if the maximum demand system is in use, or even proposed, the members of the Electricity Committee are naturally anxious to grasp the details on which the system is founded, and the difficulty of making these clear again presents itself. Notwithstanding the conditions which govern the generation of electricity, we must do our best to cope with the conditions governing the demand—the one the laws of Nature, the other the sweet will of the consumer. So great are the advantages of electric light that those who appreciate them shall use the commodity regardless of the charge made, whether 8d. per unit, with a rebate (which, in consequence of the nature of the demand, is never procured), or by a flat rate of 5d. or 4d., rendered possible by the more profitable consumers; while, on the other hand, there are many—and I speak from experience—who may not have the opportunity to appreciate its advantages, and cannot, perhaps, afford the cost of the first installation, and others who have no desire to avail themselves of what they fully appreciate. As already mentioned, we have in Leith a flat-rate system. This is, of course, not on an equitable basis of cost of generation. Advocates of the maximum demand system will characterise it as iniquitous. I may say, further, that discounts are given on the amount of the bill in money. Advocates of the maximum demand system would describe this as even more iniquitous, but it is interesting to point out that those of our consumers who secure these discounts on the amount of money paid to the department are consumers with a good load factor, and, indeed, the load factor is in proportion in the majority of cases—that is to say, the consumers who pay a large sum and secure the discounts are, generally speaking, consumers with a good load factor.

In conclusion, I have to express my thanks to Mr. W. A. Bryson for kindly preparing for me the majority of the lantern slides shown, also to Mr. G. W. Grossett for his assistance in preparing the diagrams.

NEWCASTLE LOCAL SECTION.

At the meeting of this section of the Institution of Electrical Engineers held last Monday in the Durham College of Science, Newcastle-on-Tyne, a paper on "Electric Car Equipments and their Maintenance" was read by Mr. A. W. Wigram, associate, which we shall give in a future issue. Previous to the reading of the same, Mr. John F. C. Snell, chairman of the section, presented Mr. G. Ralph with a case of mathematical instruments, this being the extra premium which the Council of the Institution had awarded to Mr. Ralph for his paper on "Electrically-Driven Machine Tools in Workshops," read last session. Mr. Snell congratulated the recipient, and expressed the hope that this would be the first of many premiums which members of the Local Section would gain. At the close of Mr. Wigram's paper, Mr. Snell spoke of the advantages of a sanding device which would act with the brake. Many of the accidents which occurred on tramways were due to the wheels skidding, and the want of presence of mind on the part of the motorman in working his sand-box, while sometimes the latter choked. Speaking of lifeguards, he had made several experiments with these, and had found Tydeswell's the most satisfactory; dummies placed on the track were almost invariably picked up.

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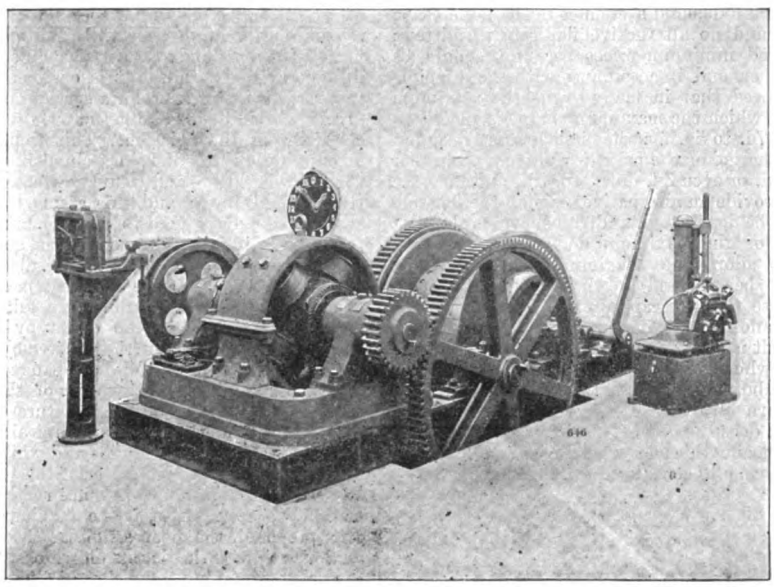
TRADE NOTICES AND NOVELTIES.

Electric Winding Gear.

The accompanying illustration represents an electric winding gear which has just been supplied by Messrs. Ernest Scott and Mountain, Limited, of Newcastle-on-Tyne, to the Heckmondwike Collieries for winding from a staple about 100 yards deep. The motor shown in



Electric Winding Gear.

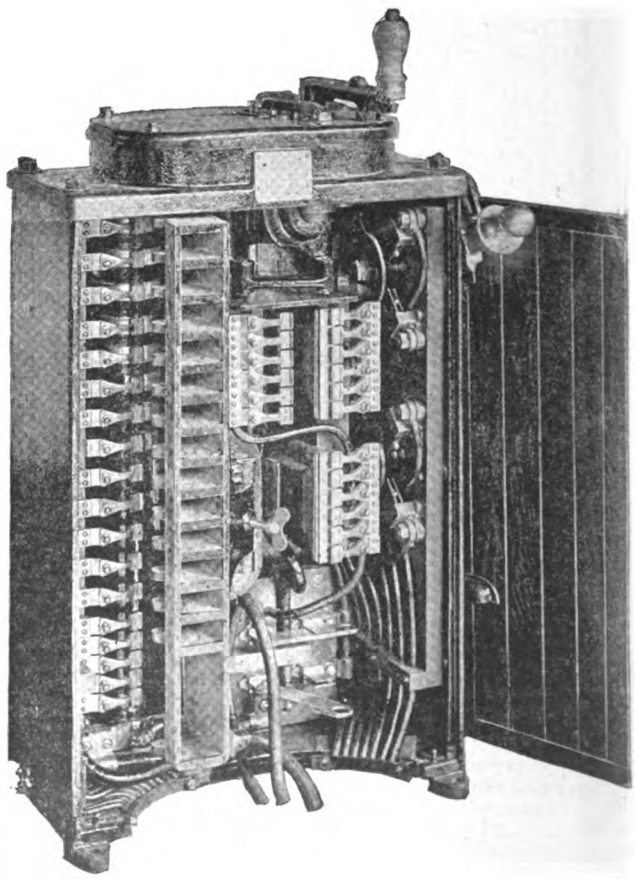
the illustration is of Messrs. Scott and Mountain's four-pole open type, capable of working up to 50 effective horse-power at a speed of about 600 revolutions per minute. At the end of the motor shaft an automatic electric brake is fitted, which sustains the load immediately the current is switched off, the coils of the electromagnet being in circuit with the armature of the motor. When the current is switched on to the motor, the armature is attracted by the electromagnet and releases the brake wheel. The motor drives through a train of gearing (the first-motion pinion being forged steel machine cut) into a machine-cut cast-iron spur wheel, which is supported by a counter-shaft on which a pinion is carried, gearing into a spur wheel on the drum shaft. The drum is 3ft. 6in. diameter by 2in. wide, lagged with elm, with strong cast-iron sides, a brake strap being fitted on one side, which is controlled by the attendant. An indicator is provided, which shows the position of the cages in the shaft, this being driven by machine-cut wheels from the shaft. The whole gearing is mounted upon a cast-iron bed-plate, made in sections for getting down the pit and into position by the staple. The electric motor on the winding gear is controlled by a special type of liquid reversing and regulating switch. The dynamo supplying current to the winding gear is also of Messrs. Scott and Mountain's multipolar type, giving a maximum output of 50 kw., and is driven by a horizontal engine, the current being taken through cables 1,030 yards in length down to the winding gear motor. We understand that winding gears of this type are made in all sizes by Messrs. Ernest Scott and Mountain, Limited.

The "Batten" Patent Rectifier.

A third circular which we have received from the General Electric Company, Limited, and which they call their "General Electrical Progress" sheet, deals with several of the firm's specialities, including the "Batten" patent rectifier. This piece of apparatus is designed for charging small accumulators, exciting spark coils, and driving small motors where direct current is required but only an alternating current available. It consists of a polarised relay whose torque moves synchronously with the alternation of the current, and sends uni-directed impulses into either of two paths, which it opens for itself, and is independent of alterations of frequency or voltage. It is claimed that the apparatus will work with a much lower percentage of wasted energy than would result from doing the same work on a direct-current circuit through charging lamps; will start at once at full load without speeding up, without expert attendance, and without delicate mechanical starting devices; and will provide 6 amperes at 25 volts for two charging circuits.

Series-Parallel Controllers.

We have received from the British Thomson-Houston Company, Limited, a copy of their pamphlet No. 114, which supersedes No. 42, issued at the beginning of the year. This pamphlet describes the firm's magnetic blow-out series-parallel controllers, types K and L. It may be stated in explanation that "K" refers to such of the controllers as include the feature of shunting or short-circuiting one or more of the motors when changing from series to parallel, while "L" serves to distinguish those which completely open the power circuit when making a similar change. The accompanying illustration shows the interior of a controller of the latter type. In the pamphlet the advantages of series-parallel control are dilated upon, but these advantages, directly connected as they are with the economical working of electric cars and locomotives, need no repetition here. In each of their controllers the British Thomson-Houston Company employ a magnetic blow-out to extinguish the arc formed at the finger contacts on interrupting the circuit, thus preventing undue wear and tear of the contacts. The resistance of the blow-out coil being very small, it is claimed that no wasteful consumption of energy occurs. The effect of the blow-out is to chill the arc by driving it over the surface of the breaking points, and it is claimed that the burning of the contacts protected in this manner is so slight that controllers which have operated for thousands of miles and broken circuits hundreds of thousands of times show no serious wear of contacts. A convenient method of securing an emergency stop or retardation of the car is also described. Provision may be made for this emergency stop by fixing a few additional contacts on the present reversing cylinder of the series-parallel controller, the stop being operated by the regular reversing handle. To make a



L Type Series Parallel Controller.

quick stop the reversing handle is simply set to a position one notch back of the usual reversing position. Further, the stop may be operated with the car running either backward or forward. The capacities and dimensions of the controllers are given in tabular form, while the pamphlet also includes several pages of useful diagrams of connections, etc.

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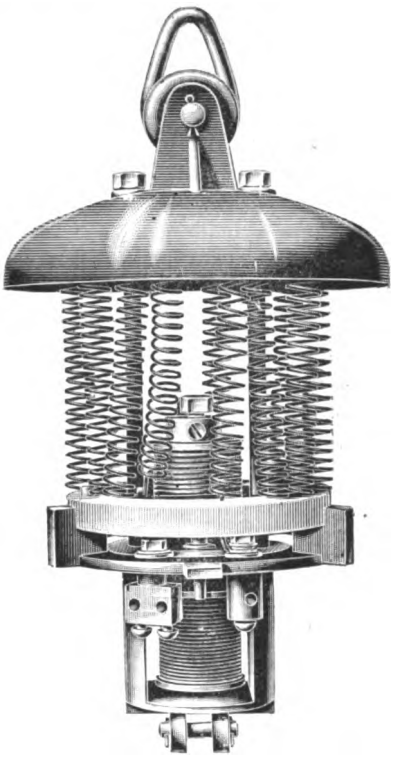
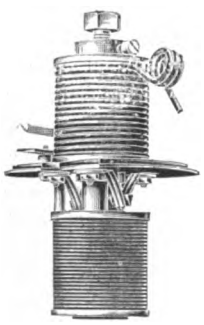
"Angold" Differential Cut-Out.

From the publishing department of the General Electrical Company, Limited, we have received a leaflet describing their "Angold" differential automatic cut-out and equivalent resistance for use with series arc lamps. This cut-out represents the latest outcome of the firm's great experience in connection with automatic devices of the kind, and important advantages are claimed for it. The necessity of

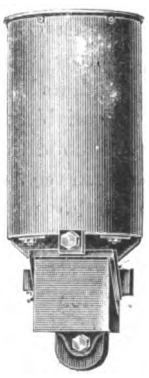


Automatic Cut-out and Equivalent Resistance for Suspension Above or Beside Arc Lamp.

protecting the shunt coils of arc lamps running in series on high-voltage continuous-current circuits is well known. The "Angold" cut-out is designed so that if there is sufficient headroom the arc lamp can be suspended from it, as shown in one of the accompanying illustrations, or for low ceilings it can be hung beside the lamp, or in any convenient position. A special form of this cut-out, also shown herewith, is made for inserting in the base of arc lamp-posts. Among the special advantages claimed for the cut-out are the following: equivalent resistance is left in parallel with the lamp when the latter is switched



Cut-out only.



Automatic Cut-out and Equivalent Resistance for insertion in Base of Lamp-post.

off, and thus a positive circuit is always provided; the shunt and series coils pull against each other, and are not wound on one bobbin—the pull is therefore differential; the series coil is in series with the carbons, not with the equivalent resistance, hence the equivalent resistance is only put out of circuit when everything is in order; the shunt coils of the lamps are never in circuit by themselves, therefore they cannot be subjected to the full line voltage, and the insulation is quite safe; no damage can befall the lamps if the cut-out is out of order; there is no sparking at the contacts; if the voltage drops abnormally the contacts are not burnt should the cut-out happen to be in action at the time, as they cannot make and break.

Diary.

We have received from Mr. L. M. Waterhouse, A.M.I.C.E. and A.M.I.E.E., engineer and general manager of the Simplex Steel Conduit Company, Limited, Mansion House-chambers, London, E.C., Walker's No. 7 diary for 1902, which contains some useful particulars of Simplex conduits. These diaries are published at Farringdon House, Warwick-lane, by Messrs. John Walker and Co., Limited, and are very handy for the vest coat pocket.

Electric Glow Radiators.

Another circular issued by the General Electric Company, Limited, describes their electric glow radiators. These radiators are made in several styles. The "Apollo" is made with four lamps, as shown in the accompanying illustration, with two switches, so that all four or only two may be on, as desired; also with three lamps, controlled by two switches in the same manner. The back is flat, so that it may be set against the wall, or two radiators back-to-back in the centre of a room. Moreover, the arrangement of the reflector is convex, so that the heat radiates in a wide area. A second type, the "Aurora," is made with four lamps and two switches only, the reflector being straight,

"Apollo" Radiator.

so that the heat rays are thrown further forward, and can be felt at a greater distance than in the case of the "Apollo." The lamps supplied with these radiators are of the "Robertson" make, each absorbing 300 watts.

ELECTRICAL EXHIBITION.

An electrical exhibition was opened on Monday at the Royal Aquarium, Westminster. The exhibition comprises a number of the latest improvements in electrical engineering and their application to manufactures coming within its scope. Mr. Langdon, president of the Institution of Electrical Engineers, was to have opened the exhibition, but owing to the serious interruption of the telegraphs throughout the country requiring his attendance at Derby in his official capacity as chief electrical engineer to the Midland Railway Company, he was unable to be present. In a letter of regret which he sent to the Aquarium management, he expressed his appreciation of the company's efforts to bring under the notice of the London public the progress and advantages of electrical appliances. He referred at length to the importance electricity was assuming in every one of our commercial and manufacturing pursuits, and said it behoved an industrial and commercial people, such as ourselves, to take the fullest advantage of it, to gain acquaintance with its properties, and in acknowledging its utility to lose no opportunity of fostering its advancement. Although there was scarcely any path in life in which electricity would not prove of service, it was probable that in none would it be of more advantage than in many fields of manufacture. Whether the electricity was generated by the manufacturer on his premises, or was obtained from one of the large supply companies now being established in various parts of the country, economy over the existing methods of applying power must ensue, for the reason that it could be applied directly at the point needed, and only for the time required. If England was to compete with other nations in the markets of the world it was necessary that we should not only foster all our resources, but should also endeavour to see that our merchants and manufacturers were placed in as favourable a position to do so as were those of other nations. Given a fair field, there was no reason to doubt the energy and success of British enterprise. He urged that Government should establish a Ministry of Commerce and Manufacture to watch over such matters. A detailed notice of the exhibits will appear in our next issue. The exhibition, which was inaugurated by a grand concert, will remain open until Jan. 25, and falling as it does into holiday time is sure to contribute much towards the dissemination of information with regard to the latest electrical appliances, while the visitors will find plenty to amuse themselves with.

FORTHCOMING EVENTS.

FRIDAY, DEC. 20.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper: "Transmission Dynamometers," by Mr. A. M. Morgan.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Paper: "The Microscopical Examination of the Alloys of Copper and Tin," by Mr. Wm. Campbell.

School of Practical Engineering (Crystal Palace).—At 12 noon, distribution of certificates.

SATURDAY, DEC. 28.

Royal Institution.—At 3 p.m., Prof. J. A. Fleming on "Waves and Ripples in Water, Air, and Æther" (Lecture I.).

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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WIRELESS TELEGRAPHY ACROSS THE ATLANTIC.

The great question before the electrical world this week is as to whether or no Signor Marconi has succeeded in receiving in Newfoundland signals dispatched from the Lizard by his system of wireless telegraphy. The only authorised version of what has been attempted and accomplished is the following, which we give in the inventor's own words to the newspapers: "Before leaving England I arranged for our long-distance station near the Lizard to signal me the letter 'S' repeatedly for three hours when I had advised them that I was ready to receive the same. On Monday last I cabled that all was in readiness, and I asked that the signal should be sent at short intervals between three o'clock and six o'clock Greenwich time, and to be continued each day until I ordered it to stop. This time would correspond approximately to half-past eleven and half-past two here. On Thursday I received indications of the signals at 12.30, and with certainty and remarkable clearness at 1.10, when quite a succession of 'S's' were received with distinctness. A further number was received at 2.20 p.m. The latter were not so good. On Friday at 12.8 signals were received, but not so distinctly as on Thursday. I am of opinion that the reasons I did not obtain continuous results were, first, the fluctuations in the height of the kite which carried the suspended aerial wire; and, secondly, the extreme delicacy of my receiving instruments, which were very sensitive, and had repeatedly to be adjusted during the course of the experiments. When the permanent station is installed here I shall not be dependent upon the fluctuations of the wind, and I am confident of making the signals strong and reliable—that is, not requiring such delicate and sensitive receiving instruments—by employing much greater power at the sending station. I must go immediately to England to make the arrangements for employing more power at the sending station, and I trust in a very short time to establish communication between the two continents in a thoroughly reliable and commercial manner." We regret that a more conclusive signal was not chosen for the test as it would have been equally easy to have repeated a word at regular intervals as the letter "S." In the Morse code for this letter is three dots, and, as Sir W. H. Preece has pointed out, does not form a reliable test. This is so because fluctuation in the electrical conditions of the atmosphere and earth is very apt to give records which resemble the letter "S." Naturally, we all hope that no such disturbance has been the cause of the faint signals recorded in Newfoundland, but it is to be regretted that the matter cannot be cleared up without further delay. The bad weather has, we believe, done considerable damage to the ordinary apparatus at the Lizard, but surely this could have been repaired and further power added without the personal presence of Signor Marconi. The other reason for the discontinuance of the experiments is flattering to wireless telegraphy. We refer to the interference of the Anglo-American Telegraph Company, who claim a monopoly of all telegraph work in Newfoundland. A lawyer's letter has accordingly passed, which is said to have stopped further work. This company may plead justification for its conduct, but it will not be absolved by any scientific or even by business men, as scientific experiments of the kind mentioned above cannot be considered as breaking the monopoly in question. Assuming that the signals were actually transmitted across the Atlantic, the most important question is as to whether the interruption was due to climatic disturbances in the air. If this is not the case, there is no reason to suppose that the working of this extremely delicate instrument cannot be made more certain, so that signals may be regularly dispatched from

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continent to continent by ætheric waves. The commercial value of this great scientific success would not be such as to do away with the need of submarine cables, which give a secrecy which is all important in telegraphy between business nations. At the present stage of the proceedings all that is necessary is to record the success which is said to have been achieved, and to reiterate what Dr. Gore once said to the writer: "Multiply experiments; obtain results; you never know what experiment or what result is going to become valuable." There is much truth in such words; but many of us prefer a definite object in front of experiments, and this we believe Signor Marconi has, although to the general run of scientific men it is almost inconceivable in the present state of our knowledge that a system of wireless telegraphy should give that secrecy so essential to business communities.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE ARMSTRONG-ORLING SYSTEM OF WIRELESS TELEGRAPHY.

SIR,—Permit me to observe, in reply to your editorial note, that abuse is not argument, and that your persistence in giving unwarranted expression to what you say you consider to be my opinions only shows how laboured is your criticism.

It is certainly surprising that you should not have discovered 'ere this that the Armstrong-Orling apparatus is not an electrometer at all, its effects being qualitative, and not quantitative. This being so, you will now, perhaps, perceive that a flow of current is not objectionable in an apparatus whose purpose is to detect (not measure) small currents by the difference of potential at two points of a circuit.

In the "cross-examination" to which you refer, your representative, who appeared to be unaware of the great sensitiveness of electro-capillary apparatus, was told, in reply to one of his questions, that an E.M.F. of $\frac{1}{300}$th of a volt was sufficient to actuate this class of apparatus, and that a current having a voltage so low as this is sufficient to actuate the Armstrong-Orling apparatus. It is therefore difficult to see how you can reconcile your version with what actually took place.

What you have, however, succeeded in pointing out is that the apparatus in question is capable of more than was at the time claimed for it—namely, that it can be operated even when there is no current at all so long as there is the necessary difference of potential.

As to the uses to which electro-capillary apparatus have been put, you are in error if it is your opinion that their application is restricted to the purpose mentioned by you. The fact that the passage of current in such a case is objectionable, does not apply when the object is not that of obtaining an accurate measurement.

If the above is not your opinion, I fail to see your object in citing this case as demonstrating the unsuitability of electro-capillary apparatus to deal with difference of potential when a current is allowed to pass. However, evidence to the contrary may be found in Prof. Silvanus Thompson's "Text-Book on Electricity and Magnetism" (1889), pp. 182-3.

Finally, the fact remains that currents whose E.M.F. is too low, and, owing to the resistance of the instrument, too weak to produce audible sound in a telephone, may yet be detected and caused to operate a relay by means of the Armstrong-Orling apparatus.—Yours, etc.,

Dec. 18, 1901. THE ONE REFERRED TO.

[Our correspondent should realise by this time that criticism is not abuse. In reading through this last letter it will be seen that our comments were not unjustified, as our correspondent admits that the apparatus will work even if a current is not passing. In spite of this, in the earlier paragraphs in the letter he says that "an E.M.F. of $\frac{1}{300}$th of a volt was sufficient to actuate this class of apparatus, and that a current having a voltage as low as this is sufficient to actuate the Armstrong-Orling apparatus." From this we gather that "The One Referred To" is still rather doubtful as to whether it is the current or the voltage. We have no wish whatever to be personal in this matter, and our remarks referred particularly to the Armstrong-Orling system of doing business. In the first place, when they conduct experiments in wireless telegraphy, they only ask the representatives of untechnical papers to witness the same, and the descriptions which afterwards appear are full, not of what these representatives have been shown, but what they have been told. In the same way we were asked to see the Armstrong-Orling receiver. This was not on view, but only an apparatus which can be found in any text-book, and we repeat that the answers received to our questions and the correspondence above shows that even this was not fully understood by those present.—ED. *E. E.*]

LIGHTNING CONDUCTORS.

SIR,—Mr. Whitehouse raises a new point as to the Nottingham accident, and if I had not reason for doubting the accuracy of the description he refers to, I should participate in his surprise. I do not wish to cast any reflection on the late Mr. Richard Anderson, for whose memory I have the greatest respect, as well as gratitude, for it was under him that I first studied the subject of protection. He was a most careful observer, and if the facts were stated from his own observation, I should have no doubts about them, but I think he obtained the account from some other source. When he died in 1889 he was, I think, about 40 to 42, and, therefore, only about 20 at the time of the incident. Then this case is not mentioned in the first edition of his work published in 1880, and we may therefore presume that he got his information between that year and 1885, when the third edition appeared. His statement is that the discharge passed through the masonry to the gas-pipe, "not effecting a clear breach through, as about 12in. of the masonry remained undisturbed in the centre of the wall." I cannot remember now whether he said, in discussing this case along with the others mentioned in his book, that the statement was to be taken literally or not, for at that time I considered a bad "earth" would account for anything however extraordinary, but most probably he said not.

It appears to me easy to account for the error. In the course of my probably unusual, but doubtless *not* unique experience, I have examined a number of cases of sparking through walls, and have found that the fractures were invariably more considerable on the surfaces than in the centre portions. In the latter part it is often confined to a few very fine cracks which might be easily overlooked. The repairs, therefore, generally consist of cutting away and making good the outer courses and leaving the centre untouched. If, therefore, the author obtained his description from a non-expert observer, it is probable that the word "undisturbed" meant only that the actual *destruction* was confined to the outer portions.

The only other description of this accident that I remember to have seen is that by (I presume) the architect in the Lightning Rod Conference report, and in that, this effect is not referred to. It should hardly be necessary for me to disclaim having stated that a bad "earth" need not be taken into consideration, but I may say that Mr. Whitehouse appears to have mixed my meaning as to the importance of the proximity to the gas-pipe. If there had been neither gas pipes nor other metals about the building I presume he admits that there would have been no side flash. The point is, is 4ft. 6in. of masonry sufficient insulation for the voltage of such a severe discharge of lightning as appears to have occurred at Nottingham? I think not.—Yours, etc., ALFRED HANDS.

TELEGRAPHIC DELAYS.

The secretary of the London Chamber of Commerce has forwarded the following letter to the secretary of the General Post Office on the subject of the recent serious

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interruption of telegraphic and telephonic communication between London and the provinces:

"Botolph House, Eastcheap, E.C., Dec. 18.

"Sir,—It has been my duty several times during the last few years to address your department on the delays occurring through the interruption of telegraphic and telephonic communication between London and the provinces owing to storms, gales, and other natural causes.

"Apparently a certain proportion of bad weather, gales, snowstorms, and other climatic disturbances, which are of a nature to interrupt telegraphic communications when these are conducted by overhead wires, are to be expected as more or less the normal condition within ascertained periods of each year.

"I should like, therefore, to know for the information of the commercial community of the City, which is much interested in these matters, and is detrimentally affected by interruptions (which appear to be taking place on an increasing rather than a decreasing scale), whether your department has the whole question under its consideration, and whether such delays as have just occurred are likely to be dealt with in such a manner as will in the near future ensure that the telegraphic and telephone business of the country shall not be again periodically suspended as it has been in the past.

"I am aware that your department has for some years past been spending considerable sums of money in completing underground telegraphic communications with some of the leading provincial cities, such as Birmingham, and apparently during last week the underground system remained intact and communications were uninterrupted; while, I understand, Manchester had to be communicated with *vid* Ireland, and Glasgow *vid* New York.

"I should also like to be informed whether your department has established any comparisons between the cost of erecting and maintaining respectively overhead and underground lines, and if these figures are available whether your department would kindly communicate them to me for the use of my committee.

"I am sure that I need not enlarge on these matters or their importance, which I have no doubt is fully in the minds of your department; but the commercial interests of the City are most anxious to know whether the matter is being efficiently dealt with by your department with a view to minimising these occurrences in the future.—I am, Sir, yours faithfully, "KENRIC B. MURRAY,

"Secretary, London Chamber of Commerce."

ELECTRIC TRACTION ON THE UNDERGROUND.

ARBITRATOR'S REPORT.

The following is the full text of the report of the Hon. Alfred Lyttleton to the President of the Board of Trade on the important question of the system to be used in the equipment of the Inner Circle for electric traction:

Sir,—The Metropolitan Railway Company are owners of nine miles and the District Railway Company are owners of four miles in length of that portion of the Underground Railway in London which is known as the Inner Circle, and are joint owners of the City Line and Extension Railways. Both companies have for some time concurred in the necessity of working these railways by electrical power, but have been unable to agree to adopt the same system, the Metropolitan Company advocating what may be described as the "alternating" current system, the District Company preferring the "continuous" current system of electrical traction. Under these circumstances, in the summer of 1901 all necessary steps were taken by the companies to procure the appointment of a special tribunal under the Metropolitan District Railway Act, 1901, Section 9, to hear evidence and to report to the Board of Trade with the object of deciding which of the two above-named systems should be adopted. A special tribunal was accordingly appointed, consisting of myself as arbitrator, Mr. Thomas Parker, engineer, of Wolverhampton, nominated by the Metropolitan Railway Company; and Mr. H. F. Parshall, engineer, of 8, Princes-street, London, E.C., nominated by the District Company, which heard the evidence of the two parties and the arguments and speeches of counsel on their behalf on Oct. 7 and 11 subsequent days.

The position under consideration is novel, for Parliament has for the first time thrown on the Board of Trade the task of imposing on a railway company a system of working to which that company is opposed. The system to be adopted on the Inner Circle will have to operate on a circular railroad, in tunnel, through which a dense traffic is carried by trains frequently stopping and rapidly succeeding each other, and where a large number of trains of foreign companies are at frequent intervals interjected. On such a road it is of vital moment that a service of precise and imperturbable regularity should be maintained. It is, further, requisite that the trains should be handy—*i.e.*, should, without discomfort to passengers, quickly start, accelerate, retard, and stop. It is, above all, essential that the system adopted should be safe to the public and the employés of the railway companies concerned. The "continuous" system, whereby an alternating current of high tension is first transformed and then converted into a direct current of 500 volts, and collected from a third rail into the train motors, is very well known, and it was not seriously questioned by the Metropolitan Company that it had been proved to satisfy the requisites above enumerated by long and well-tried experience on similar railroads, carrying similar traffic under similar conditions both in America and England.

The "alternating" system, as carried out by Ganz and Co., of Budapest, proposed by the Metropolitan Company, abolishes the rotary converters employed in the continuous system and introduces into the tunnels where the trains run a current of 3,000 volts carried on overhead conductors and collected thence into the train motors by trolleys.

It was admitted that no fully-equipped railway in actual working used a current in the traffic exceeding a pressure of 750 volts, nor have any experiments been made of Messrs. Ganz's proposed system on railways presenting the peculiar features of the Inner Circle. It is true that certain experiments of this method of traction have been made in the yards of Messrs. Ganz and Co. and on the Sondrio and Lecco Railway in Italy (not yet opened for traffic) of a very interesting and important character; but those experiments have not resulted in the proposal by the Metropolitan Company for the Inner Circle system of the plant there tested. The motors, the trolleys, the controlling gear, the conductors, the safety devices described by Messrs. Ganz before us as those proposed to be used on the Inner Circle differ materially from those tested as before mentioned, and the maximum of acceleration for the motors was changed from 1-8ft. to 2-6ft. per second; while the system, originally a 15-cycle system, was changed to a 25-cycle system.

It is therefore accurate to say that the system tested at Sondrio and at Messrs. Ganz's yards is still in the experimental stage, and that important departures from and amendments of that system were avowed as necessary before us for the Inner Circle.

It will thus be seen that the Metropolitan Company, who alleged in substance a superiority in economy only for the "alternating" system, seek against the will of their partner in ownership to displace a well-tried and widely successful system, and to make an experiment under perhaps the most expensive and complicated conditions which could be found in Europe. Such an experiment may very possibly be made on a railway of a scale where considerations of safety are less vital, where if any loss ensues it will not be heavy, and will be borne by those only who are responsible for making it; but it is impossible to recommend its trial against the will of the District Company on the Inner Circle.

Many controversial matters of great interest from the point of view of electrical science were discussed before us. Upon these questions it is not necessary—and would probably be premature—to express an opinion. It is for the broad reasons already set forth in this report that I advise the "continuous" system should be adopted on the Inner Circle and on the City Lines and Extension Railways. In this advice Mr. Parshall concurs; Mr. Parker does not dissent, and does not desire to send in any separate report.

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I think it right to add that the manner in which the District Company conducted the preliminary negotiations which took place between the two companies to determine the system of electrical traction was most embarrassing to the Metropolitan Company, and fully justified that company in clearing up the matter by arbitration.

(Signed) ALFRED LYTTELTON.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared.

QUESTIONS.

439. The switchboard of a large warehouse installation which has its different circuits controlled by two-way switches, is fed by the company's own dynamo and the corporation supply. The corporation supply is the three-wire continuous current, and all the three cables come to the board. The 'bus bars, which run horizontally at the back of the board, are four in number. The top one, No. 1, and No. 3 are fed by the dynamo, No. 2 by the corporation middle wire, and the bottom one, No. 4, is cut into two, and takes the two outer wires of the corporation supply. A smaller dynamo is about to be put down to take the day load, the corporation supply to be still kept connected to the board. What will be the simplest way of connecting the new dynamo to the existing board, so that all possible combinations of the two dynamos and corporation supply can be avoided?—H. H.

440. In connection with my installation is an overhead tank, water being drawn from the canal by a steam pump. I intend putting down a motor-driven pump, and should like to know if it is possible to keep the tank full by the automatic starting and stopping of the electric pump.—R. T.

ANSWERS.

Question No. 433.—A large current is required at about 30 volts. The corporation supply is at 220 volts. Taking into account prime cost, upkeep, attendance, etc., would it be more economical to drive the dynamo (producing the 30 volts) by a motor taking current from the 220-volt mains than to drive it direct by a gas or oil engine?

Answer to No. 433 (*awarded* 7*s.* 6*d.*).—In dealing with this question, the use of an oil-engine may be entirely ignored. If there is a corporation supply of electricity, it may be taken for granted that there is also an ample gas supply, and this being the case, it is unnecessary to adopt a prime mover which is more costly in the first instance, more complicated in its structure, more expensive in its maintenance and upkeep, which requires more floor space and more attention. The question then resolves itself into one of the relative economy of a gas-engine or motor under certain conditions, but what these conditions are we are not informed; we know neither the value of the current required, the price of gas (which price varies in England from 7s. 6d. per 1,000 cubic feet at Much Wenlock to 1s. 2d. per 1,000 cubic feet at Widnes), nor the charge made for electrical power per Board of Trade unit. In the absence of these all-important details, we are forced to assume, and the result arrived at will approximate the truth only if our assumptions are practically correct. We will, then, assume that 622 amperes are required—*i.e.*, 25 e.h.p. has to be given out by the dynamo; we will further assume that the price of gas is 2s. 6d. per 1,000 cubic feet, and that the charge for electricity for the purpose required is 2d. per Board of Trade unit. Now, a gas-engine which has to develop 25 h.p. will burn 20 cubic feet of gas per horse-power hour, or a total of 500 cubic feet will be consumed in one hour. If a motor is employed having an efficiency of 90 per cent, then 20·75 kw. will be required in order to get 25 b.h p. at the coupling to the dynamo. The relative running costs will then be, for the gas-engine, 1s 3d. per hour; for the motor, 3s. 4¾d. (In this example an additional assumption is made—viz., that the generator possesses perfect efficiency. This, of course, would not be the case, but does not materially affect the question, as the loss would be rather greater in the case of the gas-driven dynamo, owing to the loss in the belting, and hence the question of efficiency of the generator would not materially affect the result.) At first sight, then, it would appear that under the conditions named the gas-driven plant would be a long way the most economical, but this need not be the case. There are other considerations to be taken into account—viz., first cost, floor space required, attendance necessary.

First Cost.—The advantages in regard to this are all in favour of the motor. A motor to develop 25 h.p. will not cost anything like what a gas-engine to develop the same power would, and owing to the absence of all reciprocating and jarring motion, expensive foundations will not be required; the two machines can be directly connected, and hence there will be no cost for belts.

Floor Space.—Again, the advantage is on the side of the motor. With a gas-driven generator, not only will massive foundations be necessary, but the gas-engine will occupy considerably more room than will be required by the motor, and in order to get good driving the engine will have to be put some distance away from the generator. Room also will have to be found for the water-tanks, gas-bag, and other paraphernalia consequent with the use of a gas-engine. Now, with the motor the two machines may be coupled together, and occupy only a small percentage of the space required by the gas plant; or if the generator is not yet ordered, the two machines can be built as one—*i.e.*, be a rotary converter—and thus not only will the first cost be considerably reduced, but also the floor space necessary be brought to a minimum.

Attendance.—Once again the advantage lies with the motor. The motor-driven plant will only require cleaning once or twice a week; no special attendant will be necessary to start the machine; there will be no valves to take out and clean; there will be an entire absence of any noise or smell; in fact, there will be practically no charge for attendance.

Under the conditions assumed, we see that the gas-engine plant is the most economical in the cost of running pure and simple, but that the motor plant is most economical in first cost — *i.e.*, interest and depreciation; floor space required—*i.e.*, rent; attendance—*i.e.*, wages. These will probably far more than balance the one item which is against it, but unless fuller details are given it is impossible to fully demonstrate the case. We have assumed that the 25 h.p. is required continuously, but this need not be the case; the load may at times drop to 12·5 h.p., which would be to the advantage of the motor, owing to its greater efficiency at half-load to that of a gas-engine. The load may be intermittent, only required for a number of short periods during the day; then the motor plant would be the most economical, even in cost of running, owing to the fact that it would be stopped when not required; while owing to the starting difficulties, the gas-engine would be kept running the whole time.

The writer would have liked to have dealt with the case more fully, but this is impossible without fuller data. As it stands the question is similar to one which manufacturers sometimes ask, "Is it more economical to retain shafting and belt transmission of power, or to adopt electric transmission," when at the same time they entirely omit to give what may be called local details, such as the nature of the work, the area occupied, or the distance which the power has to be transmitted, and whether the exhaust steam is required for any part of the manufacturing process.—M.

Answer to No. 433 (*awarded* 7*s.* 6*d.*).—As no particulars are given of the actual output required at 30 volts, nor of the cost of gas and electricity in the particular town referred to, it will be impossible to decide definitely between the two schemes, though a general expression can be obtained showing the relative cost for any given values of these quantities.

Let W = capacity of 30-volt dynamo in kilowatts. We will assume that this is also the load at which the machine always works when running at all.

B = total Board of Trade units required per annum (at 30 volts).

P_e = price of the motor-generator in pounds.

P_g = price of the gas or oil engine and dynamo in pounds.

d_e = per cent. allowance for interest on capital and depreciation in the case of the motor generator,

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d_g = ditto in the case of the gas or oil engine and dynamo.

e = price of electricity in pence per Board of Trade unit.

g = price of gas per 1,000 cubic feet (or oil per gallon) in pence.

η_e = per cent. through efficiency of the motor generator set = $\frac{\text{output at 30 volts}}{\text{input at 220 volts}} \times 100$.

η_g = per cent. through efficiency of gas-engine and dynamo = $\frac{\text{E.H.P.}}{\text{I.H.P.}} \times 100$.

C_g = consumption of gas per indicated horse-power hour in thousands of cubic feet (or oil in gallons per indicated horse-power hour).

Then, neglecting the cost of attendance and floor space rental, both of which would be practically the same in both schemes, the annual cost when employing the motor-generator will be

$$\left(P_e \times \frac{d_e}{100}\right) + \left(B \times \frac{e}{240} \times \frac{100}{\eta_e}\right) \text{ in £,}$$

and with the gas or oil engine and dynamo it will be

$$\left(P_g \times \frac{d_g}{100}\right) + \left(B \times \frac{g}{240} \times \frac{100}{\eta_g} \times C_g \times \frac{1{,}000}{746}\right) \text{ in £.}$$

By inserting the correct values in these expressions, the question as to which scheme is most economical can be readily decided as far as actual expense is concerned. It must, however, not be forgotten that over and above this point there are the questions of convenience, cleanliness, freedom from vibration, and so on, all of which tend in favour of the motor-generator set, but none of which can be given definite money values, and must be decided on the merits of each individual case.

In order to show more clearly the nature of the figures dealt with in the above expressions, an actual case is worked out below. We will assume that the dynamo is to give an output of 50 kw. = W—viz., 30 volts and 1,670 amperes—at a speed of about 600 revolutions per minute, and that this output is to be given steadily for eight hours a day on 300 days in the year, thus giving a total annual number of Board of Trade units of $50 \times 8 \times 300 = 120{,}000 = B$. The price of such a dynamo with the 220-volt motor directly coupled to and driving it would be about £400 = P_e, and the price of the same dynamo and the gas-engine driving it by belt would be about £600 = P_g. Taking interest on capital expended as 5 per cent., and allowing 10 per cent. for depreciation of plant in either scheme, we get $d_e = d_g = 15$ per cent. The price of a Board of Trade unit of electricity will be taken at 2d. = e, and the price of coal gas at 2s. 6d. per 1,000 cubic feet, or $g = 30$. The through efficiency of the motor-generator set would be about 84 per cent. = η_e, whilst the combined efficiency of gas-engine and belt-driven dynamo would not exceed 80 per cent. = η_e. The consumption of gas per indicated horse-power hour may be taken as 16 cubic feet, or $C_g = \cdot016$. Then the annual cost with the electrically-driven arrangement will be

$$\left(400 \times \frac{15}{100}\right) + \left(120{,}000 \times \frac{2}{240} \times \frac{100}{84}\right) = £1{,}250,$$

and with the gas-engine driven arrangement:

$$\left(600 \times \frac{15}{100}\right) + \left(120{,}000 \times \frac{30}{240} \times \frac{100}{80} \times \cdot016 \times \frac{1{,}000}{746}\right) = £495$$

showing that for so large and steady a load as that chosen, and with the prices assumed, it would be far cheaper to generate the current by a separate plant than to use the corporation supply.—Q.

Answer to No. 433 (*awarded* 5*s.*).—As the amount of current required by the dynamo is not given, it is somewhat difficult to compare to a nicety the relative costs and efficiencies of the two methods. Assuming an output of about 400 amperes at 30 volts = (400 × 30) = 12,000 watts, allowing a dynamo efficiency of 80 to 85 per cent., this works out approximately to 20 b.h.p. required to drive the dynamo. The cost of a gas-engine of this size would probably be as follows: engine, £160; water vessel, £9; extra flywheel, £6; pipes and silencer, £8; foundations and bolts, £10—total, £193. The cost of the dynamo would approximately be as follows: dynamo, £130; slide rails, £3; belt, £5; foundations and bolts, £5; field resistance, £5—total, £148. Cost of engine and dynamo: engine complete, £193; dynamo complete, £148; contingencies, £4—total, £345.

Assuming the corporation supply to be continuous current at 220 volts, the cost of a motor to drive the dynamo would perhaps be slightly in excess of the dynamo cost; but if both machines were mounted on the same bed-plate and direct coupled, which would probably be the best method, a saving could be effected in the belt, slide rails, and foundations. As a set-off against this must be put the cost of starting resistance and wiring. The cost would probably be as follows: combined motor and dynamo, £250; field resistance, £10; starting resistance, £10; foundations, etc., £5; wiring and contingencies, £10—total, £285. Total for gas-engine and dynamo, £345; total for motor and dynamo, £285—balance in favour of motor, £60.

The relative cost of running can only be ascertained by a knowledge of the relative cost of gas and electricity, and on the nature and peculiarities of the load required. Assuming gas to cost 3s. per 1,000 cubic feet and electricity 2d. per unit, the running expenses would probably work out as follows, taking the machine to be running at full load: gas consumption per brake horse-power hour, 22 cubic feet; allowing for losses in belting and dynamo = 25 cubic feet per electrical horse-power hour. This works out to 0·9d. per electrical horse-power hour, or 1·2d. per unit delivered from dynamo. Allowing an over-all efficiency of 74 per cent. for the motor and dynamo combination, the cost per unit delivered works out to 2·6d., showing a gain of 1·4d. per unit for the gas-engine combination. This, however, refers only to the actual power cost. Taking into consideration the extra oil, waste, maintenance, and attention required by gas-engines, together with its more rapid deterioration, the figures become more even, and would probably be about 2·0d. per unit for the gas-engine and 2·8d. for the motor, showing a gain of ·8d. per unit by using a gas-engine. There are, however, many advantages to be obtained by using a motor, and these in many instances would outweigh the difference in the generating costs. A gas-engine is not, generally speaking, a very reliable machine. The difficulty in starting is often serious, and much time may thus be wasted; on the other hand, a motor is readily stopped and started, and where the current is not required continuously a great saving can be effected by stopping the motor when not required, where a gas-engine would probably be left running idle to avoid the trouble of restarting. In winter time great care has to be taken with a gas-engine to prevent the circulating water from freezing, as when this happens the engine is liable to explode. A motor runs quite as well in winter as in summer, and owing to the small number of working parts, compared with a gas-engine, the motor is by far the more reliable machine. Other advantages claimed for the motor are smaller floor space, freedom from vibration, dirt, and smell, and the unwholesome atmosphere generally surrounding a gas-engine. The combination of a motor and dynamo is also more flexible, as by having a regulating resistance in series with the shunt coils in both machines the voltage may be adjusted to suit the various conditions of the load, and will not fluctuate, as is usually the case when using a gas-engine. To sum up, the first cost would probably be slightly less for a motor installation than for a gas-engine, but where the load was likely to be constant and steady a gas-engine could, no doubt, be run cheaper than a motor, and, from an economical point of view, would in certain instances be better than a motor. Taking all things into consideration, it would be better and more economical in the majority of cases to instal a motor in preference to a gas-engine, but a knowledge of each particular case is essential before setting down any hard-and-fast rule.—C. I. S.

Answer to No. 433 (*awarded* 5*s.*).—The data given are insufficient for anything but an approximate answer; the price of gas and the cost of Board of Trade unit varies in different localities pretty considerably. Moreover, the amount of current required would greatly influence an engineer in deciding which system would be the most

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advantageous. Let us suppose current required be 200 amperes at 30 volts, that gas be 3s. per 1,000 cubic feet, oil 7d. per gallon, and 3d. per unit is the cost of electrical energy. Taking energy from the supply mains a good arrangement would be to have motor and dynamo on one bed-plate, both shunt-wound, the motor having two the dynamo four poles. With such a combination we should get an efficiency of, say, 70 per cent. Cost of energy would then be

$$\frac{200 \times 30 \times 100 \times 3}{70 \times 1{,}000} = 25{\cdot}7\text{d. per hour.}$$

Price of motor and dynamo would be, say, £150; with 10 per cent. for depreciation, allowing 2,700 working hours per annum, we must add on 1·3d. oil, and sundries ·1d. This gives us a total of 27·1d per hour. Motor and dynamo would be coupled together, thus no belt or slide rails would be required.

A suitable gas-engine and dynamo with belt, slide rails, etc., would cost, say, £220. The consumption of gas will be about 45 cubic feet per unit. Cost of gas per hour

$$= \frac{200 \times 30 \times 45 \times 36}{1{,}000 \times 1{,}000} = 9{\cdot}7\text{d.};$$

depreciation (as before) = 1·9d.;
oil and sundries = ·4d.;

giving a total of 12d. per hour.

First cost with an oil engine would be rather more, say £270. For each unit at dynamo we shall want 1·5 pints of oil. Cost of oil per hour

$$= \frac{200 \times 30 \times 3 \times 7}{1{,}000 \times 2 \times 8} = 7{\cdot}8\text{d.};$$

depreciation (as before) = 2·4d.;
oil and sundries = ·4d.;

giving a total of 10·6d. per hour.

In none of these cases has any allowance been made for labour; this in the case of engine plants would take up about one-half of a man's time. Both gas and oil engines repay well for skilled attention. Another point must also be considered with regard to gas and oil engines—viz., troubles that may crop up owing to noise and vibration. A motor and dynamo will want very little attention, take up but a small floor area, and may be easily started when required. If the current output were very large it might pay to put down a Dowson gas plant, when the economy over the use of ordinary illuminating gas would be from 40 to 60 per cent.—M.

Question No. 434.—How is the Hopkinson test for determining the efficiency of dynamos usually carried out, and how nearly do the test conditions represent service conditions?

Best Answer to No. 434 (*awarded* 10*s.*).—The Hopkinson test can be carried out in four distinct ways according to the source of power used for making up the losses in the two main generators under test. This source may be (1) a steam or gas engine, either direct coupled or belted to the dynamos; or (2) it may be an electric motor connected in the same way, or it may be an auxiliary dynamo or battery connected (3) in series, or (4) in parallel with the two test machines.

Of these, the first two methods are seldom employed, as the use of the first involves a knowledge of the engine efficiency, and also power measurements by indicator diagrams; and the second necessitates a separate determination of the efficiency of the auxiliary motor, not to mention the difficulty of correctly estimating the losses in belts if these are used.

The test is consequently almost always carried out by means of methods (3) or (4), and the decision between these two generally depends on the relative voltages of the machines to be tested and the machine available for use as the auxiliary dynamo. Fig. 1 shows the connections for method (3), and Fig. 2 those for method (4). The voltage of the auxiliary dynamo must for method (4) be equal to that of the tested machines, but for method (3) its voltage must be approximately equal to

$$\frac{\text{Total losses in the two machines under test}}{\text{Current in their armatures}},$$

and this figure will usually vary from about 15 or 20 per cent. of the main dynamo voltage when measuring the full load efficiency to 50 or 60 per cent. of it when measuring quarter-load efficiency. The maximum current required from the auxiliary dynamo will be from 15 to 20 per cent. of that of the main generators for method (4), and will, of course, be equal to that of the main generators for method (3) For greater ease in starting up, and also in order to make the whole system more stable when running, and more readily adjustable, it is usual to

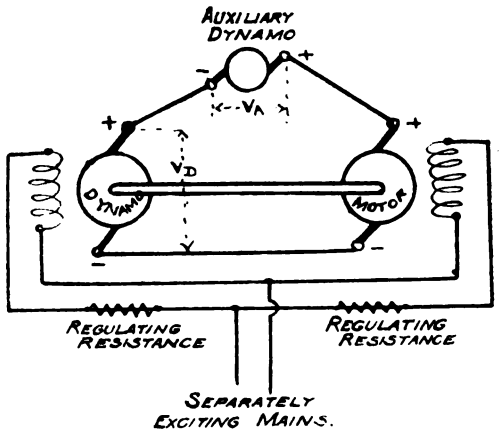

FIG. 1

separately excite both the main generators from some independent external source.

We will consider method (3) first. The two machines to be tested should preferably be directly coupled together, though if this is not possible they can be belted together, using pulleys of the same size as both machines. To start up, the two machines should be separately excited; one (the dynamo) being given a weaker field than the other (the motor). The auxiliary dynamo or battery is then

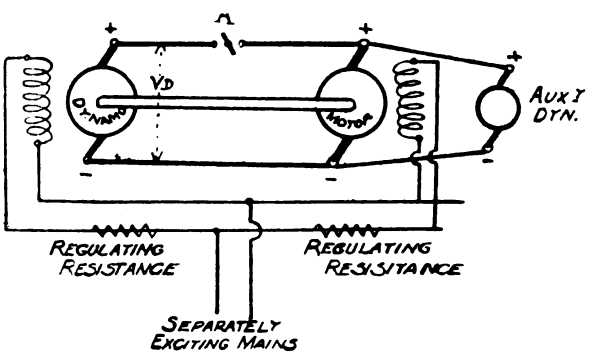

FIG. 2.

connected in series with the two main generator armatures and a resistance, and by gradually cutting out the latter the current through all three armatures is gradually raised until the two main machines start up. Then, partly by adjusting the volts of the auxiliary dynamo and partly by varying the relative strengths of the fields of the two main machines (one above and the other below the normal), both the correct speed and, at the same time, the correct armature current can be obtained. Readings are then taken of the auxiliary and the main dynamo voltages (V_A and V_D), the armature current, C, and the shunt C^2R watts of motor and dynamo (w_M and w_D).

The combined efficiency of the machines under test is then

$$\frac{\left(V_D + \frac{V_A}{2}\right) \times C}{\left(V_D + \frac{V_A}{2}\right) \times C + V_A \times C + w_M + w_D}$$

and the square root of this gives the commercial efficiency $\left(\frac{\text{E H.P.}}{\text{B H P.}}\right)$ of each machine at an output of $\left(V_D + \frac{V_A}{2}\right) \times C$ watts—which should be equal to the normal full load of the machine if the strengths of field have been properly adjusted.

The only point in which the conditions of this test differ from actual conditions is as regards strength of field. The fluxes through the two armatures have values proportional respectively to $V_D + v$ in the dynamo, and $V_D + V_A - v$ in the motor (v being the voltage lost in one armature due to

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its resistance), and these values differ by about 20 per cent. in the case of machines having an efficiency of 90 per cent., and by a greater proportion with lower-efficiency machines. By over-exciting the motor and under-exciting the dynamo the fluxes can, however, be made to differ equally from the normal—one above and one below—and the square root of the combined efficiency by test is then a very close approximation to the true efficiency of one machine at its normal load.

In the case of method (4) the test machines are again coupled together mechanically, either directly or by belt, but at starting up the electrical connection between the main dynamo and motor is broken at A (Fig. 2), and the motor is started as an ordinary motor directly from the auxiliary dynamo. The main dynamo field is then excited to the same amount as that of the motor, and switch A is closed. By slightly strengthening the dynamo field relatively to that of the motor (in approximately the ratio $V_D + 2e : V_D$), a current can be made to flow in the dynamo armature which is as much below the normal full-load current of the machines as the current flowing in the motor is above the normal. The actual difference between the dynamo and motor currents depends on the efficiency of the machines, and would be about 20 per cent. in the case of 90 per cent. efficiency machines. Measurements are then taken of the terminal volts, V_D (these will be practically the same at the terminals of all three machines if reasonably large and short leads are used to connect them together), of the dynamo current, C_D, and of the auxiliary dynamo current, C_A. Then the combined efficiency of the two machines under test is

$$\frac{V_D \times \left(C_D + \frac{C_A}{2}\right)}{V_D \times \left(C_D + \frac{C_A}{2}\right) + V_D \times C_A + w_D + w_M}$$

and the square root of this gives the commercial efficiency of one machine at an output of $V_D \times \left(C_D + \frac{C_A}{2}\right)$ watts.

With this method the two main machines are working with so nearly the normal field strengths that so far as this point is concerned actual running conditions practically exist, but, on the other hand, the two armatures carry currents differing decidedly from the normal value. Even when arranged so that one current is below and the other above the normal, a slight inaccuracy in the efficiency may be introduced by the fact that a change in armature current results in a change in field distortion and a consequent change in core loss, which change need not necessarily depend on armature current to the same extent above and below the normal. This source of error can, however, be of only very slight importance, except in the case of machines having a very low efficiency, in which case the current differences become excessive.—Q.

Answer to No. 434 (*awarded* 7*s.* 6*d.*).—In determining the efficiency of dynamos by the Hopkinson method it is necessary to have two identical machines, which should be bolted down in line with their shafts coupled together, so that one acts as a motor driving the other as a dynamo. The output from the latter, being returned to the motor, supplies the greater part of the power required to drive it; it is thus only necessary to supply to the motor from some external source an amount of power equal to the

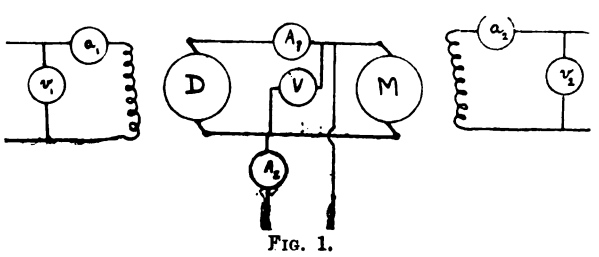

FIG. 1.

losses of the two machines. In Fig. 1 the two machines are represented by D, the dynamo, and M, the motor. From some external supply, having an E.M.F. equal to that of the machines under test, leads are connected to the terminals of the motor, which in turn are joined to the terminals of the dynamo. Ammeters are inserted to read the current in the dynamo, and also that from the external source of supply. Call the readings of these ammeters A_1 and A_2 respectively. A voltmeter is connected in to read the supply voltage; call its reading V. It is generally found most convenient to separately excite the fields, and each field should have a controlling rheostat, ammeter, and voltmeter. To start the machines, a starting box should be connected in series with the leads from the external supply. The fields of both D and M are then equally excited, and are so connected that the machines both tend to turn in the same direction, and in this way are brought up to speed just as any two motors running in parallel. Provided the flux in the armatures of the two machines are equal they will both be running light as motors, and the product, $A_2 V$, will be the power consumed by the two machines due to core loss and friction. All that is necessary to produce a load is to weaken the field of the machine that is to be made the motor. This will increase the speed, and therefore the volts of the other machine, which will run as a dynamo. The back E.M.F. of the motor will, however, remain about the same, as although the speed is increased it is working in a weakened field; the additional volts of the dynamo will therefore be free to drive a current, A_1, round the circuit consisting of the armatures of the two machines. By regulating the field of the motor any load may be obtained from no load to full load, and even an overload.

In taking an efficiency test for any load the two field rheostats are adjusted until the correct speed is obtained, and A_1 equals the amount of current corresponding to the required load. The voltage, V, being also correct, instantaneous readings are taken of A_1, A_2, and V; also the field amperes, a_1, a_2, and volts, v_1, v_2. From these readings the efficiencies for the load to which they correspond are deducted are as follows: neglecting for the moment the field losses, the power delivered from the dynamo is $A_1 V$; the power delivered to the motor is $A_1 V + A_2 V$; the difference between these powers is supplied from the internal circuit, and is $A_2 V_1$. The power, $A_2 V$, is required to supply the power lost in the two machines taken together. We will assume that this loss is equally divided between both machines. The efficiency of the dynamo is the ratio of the power given out by it to the power supplied to it. The power given out by the dynamo is $A_1 V$ watts; the power put into the dynamo is $(A_1 + \frac{1}{2} A_2) V + a_1 v_1$.

The dynamo efficiency is, therefore:

$$e_1 = \frac{A_1 V 100}{(A_1 + \frac{1}{2} A_2) V + a_1 v_1}.$$

The power put into the motor is $(A_1 + A_2) V + a_2 v_2$; the power given out by the motor is $(A_1 + \frac{1}{2} A_2) V$. The motor efficiency is, therefore:

$$e_2 = \frac{(A_1 + \frac{1}{2} A_2) V 100}{(A_1 + A_2) V + a_2 v_2}.$$

Instead of assuming that the power, $A_2 V$, supplied to both machines is equally divided, assume the efficiency of each machine to be the same; also assume in this case that the fields are self-excited, each from the terminals of the machine to which they correspond. Then, if P be the power supplied to the shaft common to both machines, the efficiency of the dynamo will be

$$e = \frac{(A_1 + a_1) V 100}{P},$$

and the motor $$e = \frac{P 100}{(A_1 + A_2 + a_2) V};$$

then $$e^2 = \frac{(A_1 + a_1) V 100}{P} \times \frac{P 100}{(A_1 + A_2 + a_2) V},$$

and $$e = \sqrt{\frac{(A_1 + a_1) 100 \times 100}{A_1 + A_2 + a_2}}.$$

In Fig. 2 are shown the connections for another Hopkinson method, with the armatures of the two machines in series with the external circuit supplying the losses. The fields are so connected that the machines oppose each other, each tending to turn in opposite directions. By strengthening the field of one, its armature exerts the greatest torque and starts to run as a motor,

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driving the other machine as a dynamo, which in its turn generates an E.M.F. producing a current which adds to that from the external supply. The load is produced, as before, by field adjustment Voltmeters are connected to register the dynamo volts, V_1, and the supply volts, V_2. An ammeter is connected in circuit, and measures the current flowing—call its reading A. The efficiencies on

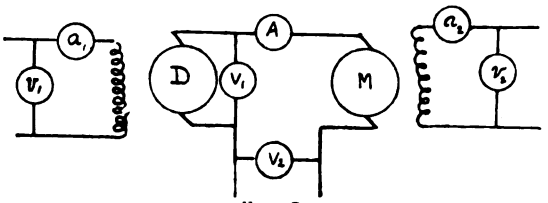

FIG. 2.

the assumption that the supplied loss, $A\ V_2$, is equally divided between both machines is calculated as follows: the output of the dynamo is $A\ V_1$; the input of the dynamo is $(V_1 + \frac{1}{2} V_2)\ A + a_1 v_1$. The efficiency of the dynamo is, therefore:

$$e_1 = \frac{A\ V_1\ 100}{(V_1 + \frac{1}{2} V_2)\ A + a_1 v_1}.$$

The input to the motor is $(V_1 + V_2)\ A + a_2 v_2$; the output of the motor is $(V + \frac{1}{2} V_2)\ A$. The efficiency of the motor is

$$e_2 = \frac{(V_1 + \frac{1}{2} V_2)\ A\ 100}{(V_1 + V_2)\ A + a_2 v_2}.$$

Or, on the assumption that instead of the loss, $A\ V_2$, being equally divided, the efficiencies are equal, and also assuming (as in the first method) that the fields are self-excited from their respective machines. Then if P be the power supplied to the shaft common to both machines, the efficiency of the dynamo will be

$$e = \frac{(A + a_1)\ V_1\ 100}{P},$$

and the motor $$e = \frac{P\ 100}{(V_1 + V_2)\ (A + a_2)};$$

then $$e^2 = \frac{(A + a_1)\ V_1\ 100}{P} \times \frac{P\ 100}{(V_1 + V_2)\ (A + a_2)},$$

and $$e = \sqrt{\frac{(A + a_1)\ V\ 100 \times 100}{(V_1 + V_2)\ (A + a_2)}}.$$

The efficiency figured by the Hopkinson methods, as above described, will never really be the same as that obtained under actual service conditions, as assumptions have to be made which are not altogether correct. For instance, in the first method (see Fig. 1), if the dynamo is fully loaded—*i.e.*, has its rated volts and amperes at its rated speed—then its losses are those due to normal full load; but in the motor, which is an identical machine, the current flowing is that of the dynamo plus that supplied from the external circuit, so the $C^2 R$ loss in the armature is greater than at normal full load, but, again, the internal voltage of the motor is lower than that of the dynamo by an amount sufficient to drive round full-load current, so that the core loss of the motor is less than that of the dynamo, and if in each machine the core loss and the loss due to $C^2 R$ are about in the same proportion, the efficiencies figured on the assumption that the losses were equally divided would be probably correct.

To arrive at more accurate results would be to supply the losses mechanically to the shaft common to both machines, but as this method involves the use of a transmission dynamometer to measure the power supplied, it is seldom used in practical shop testing.—B. H.

Answer to No. 434 (*awarded* 5*s.*).—Before giving a method of carrying out the Hopkinson test it might not be out of place to explain its theory. It consists of coupling together, electrically and mechanically, two similar machines, so that one machine when run as a dynamo supplies the other with energy to run as a motor, the motor in turn supplying energy mechanically to the dynamo. If there were no losses, due to heat, friction, etc, the motor and dynamo once started would continue to run each other without any help from the "loss supplier," which must either be an engine supplying power through a dynamometer or a battery or auxiliary dynamo supplying power electrically. In the following method a battery is used as the loss

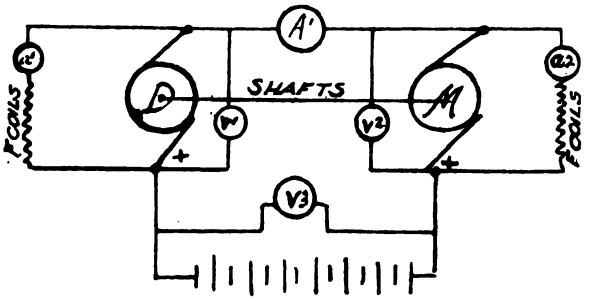

FIG. 1.

supplier, although in testing-rooms it is usual to use an engine belted to both machines.

Let two similar shunt-wound machines—*i.e.*, of the same output—be bolted down on the same bed-plate with their shafts coupled together in one line. Call one machine dynamo D and the other motor M. Run leads from terminals of D to terminals of M. Put in circuit of one of these leads a secondary battery so joined up that its E.M.F. aids that of the dynamo in rotating the motor in the proper direction to self-excite the coupled dynamo. Let each machine excite its own field, and put ammeters in the field circuits of each, also an ammeter in main circuit between each machine. Put a voltmeter across terminals of each machine, and also across the battery terminals. Resistances must be inserted in the field circuits of both machines for regulating the speed. Fig. 1 shows the connections for this test, leaving out the resistances in the fields and also the necessary switches. The test is started by varying the number of cells in the battery until the current which passes through the armature circuit—viz., A^1—is that corresponding to the full load of the dynamo. The resistances in the fields of both machines are then varied until they acquire their normal speed.

Suppose the current coming from dynamo = A^1 amperes, and its terminal P.D. = V^1 volts, then power = $A^1\ V^1$ watts.

If V^3 is P.D. at battery terminals, then power supplied by battery = $A^1\ V^3$ watts.

If V^2 is P.D. at motor terminals, then power supplied to motor = $A^1\ V^2$ watts.

Power delivered from dynamo = $A^1\ V^1$ watts; power delivered to motor = $A^1\ V^2$ watts; ∴ power supplied by battery = $A^1\ V^2 - A^1\ V^1 = A^1\ V^3$ watts; $A^1\ V^3 = A^1 (V^2 - V^1)$ = power required to supply the power lost in both machines taken together. Now, the efficiency of the dynamo = the ratio of the power coming out of it to that going into it. The power coming out of D = $A^1\ V^1$ watts (into external circuit), and $a^1\ V^1$ watts into its own field coils.

$$\therefore \text{ Power put into dynamo} = \frac{A^1\ V^3}{2} + A^1\ V^1 + a^1\ V^1 \text{ watts.}$$

$$\text{Then efficiency of dynamo} = \frac{A^1\ V^1}{\frac{A^1\ V^2 + A^1\ V^1}{2} + a^1\ V^1}.$$

Similarly, the power put into motor = $A^1\ V^2 + a^2\ V^2$ watts; also power given out by motor = $\frac{A^1\ V^2 + A^1\ V^1}{2} + a^2\ V^2$.

$$\therefore \text{ Efficiency of motor} = \frac{\frac{A^1\ V^2 + A^1\ V^1}{2}}{\frac{A^1\ V^2 + a^2\ V^2}{2}} + a^2\ V^2.$$

Taking the case where an engine is used in the place of the battery as the "loss supplier." Suppose the machines to be tested are rated at 100 kw. each (say, 200 volts at 500 amperes), and that when running at full load the power supplied by the engine = 14 h.p., then 14 × 746 = 10,444 watts. Assuming that in each machine the loss is the same, the loss in efficiency

$$= \frac{\frac{10,444}{2}}{100,000} = .052, \text{ or } 5.2 \text{ per cent.,}$$

that is to say, that the efficiency = 94·7 per cent.—J. W. R.

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COMPANIES' MEETINGS AND REPORTS.

GUTTA PERCHA AND TELEGRAPH WORKS.

The Hon. H. Marsham presided over the annual meeting of this Campany held at the Cannon-street Hotel on Tuesday.

The **Chairman**, in moving the adoption of the report, said the business of the year had been of a normal character. The profit had not been so large, although the Board felt that they had no reason to complain of the result. The ever-increasing competition in the different lines of manufacture in which they were engaged called for the adoption of the best existing machinery and conveniences, and the Company's works were continually undergoing alteration in plant and accommodation. The directors hoped by this means to keep abreast of the time, and to maintain the reputation they had enjoyed for the excellence of their manufactures.

Mr. A. Scott seconded the motion, which was carried, and a total dividend declared of 10 per cent. for the year.

NERNST ELECTRIC LIGHT.

The directors' report for the year ending Sept. 30, 1901, states that the expenditure during this period, after deducting interest on deposits, dividends, transfer fees, and receipts for the sale of lamps, is shown to have been £9,257. 17s. Of this sum £3,735. 18s. 11d. is represented by assets, the remainder—£5,521. 18s. 1d.—being working expenses, which sum, as in the last balance-sheet, has been carried to development suspense account. No account has been taken of any royalties to which the Company are entitled on lamps sold in Great Britain by the Allgemeine Elektricitäts-Gesellschaft of Berlin during the period under report, the accounts relating to these not being due to the end of the year. After the adjourned meeting in the early part of the year the directors, in accordance with the policy announced in their report, made arrangements for the manufacture in quantity of Nernst lamps in the form then exhibited, incorporating also certain further suggestions made to them at the time, and a considerable quantity were prepared for the market. Unfortunately the various reports received concerning the lamps issued experimentally in the Company's territories, and further tests made in the Company's laboratory, were not such as to justify the Board in continuing the manufacture on an extended scale until certain imperfect features had been corrected. Although urged to make lamps on similar lines to those adopted abroad, the directors decided, after careful tests, that such lamps were not in advance of those made by this Company, and the propriety of this decision has since been proved by the fact that the issue of the above foreign pattern has been suspended. Information as to the progress made by Nernst concessionaire companies in other countries showed that they had so far equally failed to produce commercially saleable lamps. Realising, therefore, that the heavy expenses of maintaining factories and a staff in readiness for the manufacture of the lamp would possibly absorb the remaining capital of the Company before it reached a profit-making stage, your directors decided to reduce expenses to the greatest extent possible consistent with the maintenance of a sufficient organisation to continue the development of the lamp, while being prepared to take immediate advantage of the production of commercially saleable lamps by their own staff or by any of the Nernst concessionaire companies abroad, whose facilities and resources exceed those of this Company. In view of existing circumstances the directors decided from that time to reduce their fees to one-quarter of the authorised sums, and they propose to continue to work on this reduced scale until such time as the production of the lamp in a commercially saleable form is an accomplished fact. Should they be unable to bring the Company to a self-supporting condition, it is not their intention to claim these arrears. They believe that the foregoing policy of reduced expenditure until success has been attained will meet with the cordial approval of the shareholders. The tests of the recent models of Nernst lamps produced by the staff appear to be in advance of anything hitherto achieved by this Company or others, and they are of opinion that many of the difficulties have been overcome, especially as regards the large lamps, to which their efforts, as also those of other licensees, have for some time been mainly directed. This is the more encouraging, as these later lamps are made under improved processes, for which supplementary patents have been applied for by this Company in Great Britain. The directors having been advised that they are entitled to obtain a compulsory license to manufacture for use in Great Britain, decided to make application to the Board of Trade for such license. In the event of a successful issue, the Company's field of operations will be increased by the inclusion of Great Britain. The directors, who with their friends have a large stake in the Company, desire, in conclusion, to assure shareholders that they have every faith in the ultimate success of the Nernst invention in spite of the many unexpected difficulties which have been encountered, and they believe that by prudent management the Company may yet enter upon a profitable career. The following letter from Mr. Swinburne, dated Nov. 25, 1901, as to the present position of the lamp will be of interest to the shareholders: "Gentlemen,—In reply to your enquiry, I consider that you have made good progress in the working out of the Nernst lamp. You have been seriously handicapped by the absence of co-operation of the other concerns who are developing the lamp. This has thrown more work on your staff and taxed your resources much more seriously than was to be expected, and has increased the time necessary. All the same I consider the progress satisfactory, and that your staff has done very excellent work. The commercialisation of the invention is taking no longer than is to be expected in such a case, and the advance has been real. Though I may have agreed with your policy at the time, owing to the progress in the small lamp, I now think it was a mistake to attempt to begin putting the small lamp on the market, and from a technical point of view I feel your present policy of return to the original lines of making large lamps is sound. The small lamp seemed to be practically completely developed, and there was justification in tackling the more difficult problem, having regard to the greater commercial value of its solution. The large lamp, to occupy the field above that of the incandescent, has almost nothing to compete with it, and has, as I stated at the formation of the Company, an enormous opening. Though longer experience is necessary before we can speak certainly, the present development of the large lamp looks entirely successful. I have seen nothing yet to alter my original opinion as to the Nernst invention.—Yours faithfully (signed), JAMES SWINBURNE."

The retiring directors are J. G. Dalzell and Hugo Hirst, who offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., retire, and, being eligible, offer themselves for re-election.

Mr. B. M. Drake (the chairman of the Company) presided over the ordinary general meeting of Nernst Electric Light, Limited, at Westminster Palace Hotel on Monday.

The **Chairman**, in moving the adoption of the above report, pointed out that it was not until the adjourned meeting in January last that a future course could be decided on for the Company, thus there had been only eight working months for the further development of the lamp. As any alteration required a period of about two months before it was possible to say whether it was an improvement or not, they would appreciate that with an invention of this class progress by leaps and bounds could not be expected, especially in view of the fact to which Mr. Swinburne had drawn attention, that they were compelled to rely mainly upon their own individual efforts. A large proportion of the expense shown in the balance-sheet was incurred in the early part of the year in the attempt to manufacture for the market in quantity, and the utmost economy had been exercised since it became evident that this action was premature, and that it would be necessary to revert for a time to an experimental basis. The directors had assured themselves by careful enquiries in all parts of the world that the same difficulties were being encountered by all the licensees; in fact, the Nernst lamp, although one of the most attractive electrical inventions, had proved a veritable "will o' the wisp"—no sooner was it grasped than it escaped once more, necessitating a further weary search in untrodden fields. During the past year, however, a vast amount of information had been acquired, and with Prof. Nernst's cordial co-operation they should soon turn the corner. Until the directors felt justified in issuing their own products, he was pleased to tell the shareholders that they had come to an amicable working arrangement with the Allgemeine-Gesellschaft of Berlin, whereby they could avail themselves on a profitable basis of their productions, as a result of which orders had been, or were being, executed for 4,000 lamps for use in the Company's district, representing a case value of some £3,000. The results obtained from the large lamp for street-lighting, which had been specially designed for the Company, were sufficiently encouraging to warrant a gradual issue, but he would ask the shareholders not to force the hands of the Board in this direction, as they might rely upon it that they were all more than anxious to see this concern with which their names had been publicly connected brought to a dividend-earning stage, and would leave no stone unturned to achieve this end as quickly as possible. With regard to the application for a compulsory license to make and sell lamps under their own patent in Great Britain, this step was only taken after the most careful deliberation and consultation with leading shareholders. If they succeeded, it would not only enable them to bring into operation a number of patents they had taken out in Great Britain which were now lying stagnant, but it would also enable them to manufacture in England for use in their countries such parts of the lamp as were covered by the original patent, thus avoiding the necessity for divided factories, which must be a source of additional expense and danger in a new enterprise. It was his personal opinion that a good deal of their trouble had been due to the attempt to get too high an efficiency in the first instance. Finding that lamps could be made to work at considerably below two watts per candle, they had struggled to keep their efficiency up to this standard, whereas they now found that if they were content with about two watts per candle, which was still half the energy required by the ordinary incandescent lamp in actual practice, a number of their difficulties became less acute. The recent development of an electrical furnace on entirely new lines, which was necessary before they could bake the large filaments, had also materially assisted them in the production of those of smaller size. He then formally moved the adoption of the report and balance-sheet.

Mr. Hugo Hirst, in seconding the motion, said that from the very first the Nernst lamp had had a peculiar fascination for him. He had joined the Board of this Company at the request of the other directors, and he hoped that at the next meeting they would have more cheerful news for the shareholders.

The motion was then carried unanimously without discussion.

Sir Henry Mance, in seconding the re-election of the retiring directors, which motion was also carried, expressed regret that want of health had compelled him to resign his position as chairman of the Company. At the request of the Board he remained an ordinary director. Until a more useful man could be found he would always be pleased to devote as much time and attention as he could to the business of the Company.

The meeting concluded with a vote of thanks to the chairman.

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS.

The annual general meeting of the shareholders in this Company was held in Manchester on Monday, Mr. Thomas J. Hutchinson (the chairman) presiding.

The directors' report stated that the Company's season had consisted of 130 days, against 121 last season, and the mileage had been 34,277,

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as against 34,033 last season. The daily service was most efficiently maintained, no accident to life or limb or rolling-stock having occurred. The gross earnings during the season yielded £5,026, as against £4,583 last season, or an increase of £443. From this must be deducted £837 tolls payable to the Douglas Head Marine Drive, Limited, leaving net passenger receipts £4,188. To this amount must be added £26 sundry receipts, making a total of £4,214, as against £3,844 last season. The net profit for the season was £2,042, as against £1,617 last season, and this, added to the £355 carried forward on Oct. 31, 1900, gave a disposable balance of £2,397, and the directors for the first time had the opportunity of recommending not only the full dividend of 7 per cent. per annum on the preference shares, but also that 2½ per cent. per annum be paid upon the ordinary shares. There would also be a balance of £220 to be carried forward. The permanent way, engines, boilers, electrical equipment, buildings, and rolling-stock had been thoroughly overhauled and maintained in a high state of efficiency out of revenue.

The **Chairman**, in moving the adoption of the report, said the Company was absolutely out of debt, and there were no debentures, mortgages, or other encumbrances on the property. The line was yearly increasing in popularity. Given anything like reasonably fine weather there was no reason why the line should not always pay the 7 per cent. preference dividend, even if it did no more; and he believed it would pay very handsomely indeed if they could get the line from the Head down to the bridge.

Mr. J. E. Winslow seconded the motion.

A **Shareholder** asked whether there was any probability of the line being brought down into the town.

The **Chairman** replied that the directors had not lost sight of the matter, and they realised the absolute necessity sooner or later of bringing the line as near to the town as possible.

The motion was adopted unanimously.

SOUTH STAFFORDSHIRE TRAMWAYS.

An extraordinary general meeting of the shareholders in this Company was held on Wednesday at the Cannon-street Hotel, with Mr. W. Somers L. Schuster (the chairman) presiding.

The object of the meeting was to consider a proposal to sell that portion of the Company's undertaking within the borough of West Bromwich to the Corporation for a sum of £32,000.

The **Chairman**, in putting the motion to the meeting, explained that the Company were originally offered only £20,000 for the 10 miles of single line in question, but by the united exertions of the directors they had now got a contract ready for the shareholders' approval, amounting to £32,000.

Mr. S. R. Blundstone seconded the motion, which was agreed to unanimously.

The ordinary general meeting of the Company was held immediately afterwards.

The **Chairman**, in moving the adoption of the Directors' report, said that the various negotiations which the Board were carrying on with local authorities as to the sale of the Company's lines had led to this meeting being delayed for some considerable period. Dealing with the Walsall lines, he stated that the purchase by the Corporation was concluded on Oct. 24 last for £18,500. With the exception of about £1,200, the whole of this sum had been devoted to paying off debentures. In regard to the Darlaston line, which was to the left of Bloxwich, and lower down on the system, and also a portion of Wednesbury, the Corporation had agreed to postpone their right of purchase for seven years. The length of these lines was about two miles. The main portions of the Wednesbury line were agreed to be sold to the Corporation, including the electrical equipment—£1,500—for a total of £17,420. There were 5½ miles of single line. The Corporation of Tipton at the present moment were not negotiating, but he believed they had a Bill in Parliament to enable them to purchase. With regard to Dudley, they had no news. He then formally put the motion for the adoption of the report and accounts for 1900.

Mr. Blundstone seconded, and the resolution was carried unanimously.

A dividend at the rate of 2s. 11½d. per share, free of income tax, upon the preference shares was then declared, and the proceedings closed.

AUTOMATIC TELEPHONE.

The annual meeting of the shareholders of this Company was held at Cannon-street Hotel on the 13th inst., Mr. Bernard Parker presiding.

The **Chairman**, in submitting the report for approval, said he was glad to be able to announce that Mr. Seligmann Lui had at last completed the working model of his automatic telephone invention. He did not wish to be over sanguine as to the future, but he would say that in the course of a very few months they ought to be in a position to prove to the telephone experts of the Post Office, the London County Council, and the National Telephone Company that by adopting the invention they could reduce the charge to subscribers very considerably, and yet make a much larger profit than the Post Office and the National Company would make under the system just started. He hoped that soon after Christmas Mr. Seligmann Lui, who was the Inspector-General of Telephones to the French Government, would bring the model to London in order that the public might have an opportunity of judging its value. Mr. Lui would not at present commit himself to figures in estimating the reduction in cost which would be brought about by the establishment of the system, but he had in his mind some such tariff as a 1d. call added to an actual rent of nothing. As regards the invention there were practically only two machines—one which was called the mechanical operator, and the other the connecting device or machine. The former was the more complicated and costly, but one machine would suffice for some 200 or 250 subscribers. The latter would serve about 10 subscribers, so that for 1,000 subscribers only about four mechanical operators and about 100 connecting devices would be required. The only other additional requirement was a small box for each subscriber. As to the future, they had the working model of the invention, which was protected practically over the whole world by some 40 patents. Although the shares were widely distributed, they were, in fact, a parent syndicate, with a capital of £100,000, of which some £6,000 was still held in reserve. In addition, they had some £2,400 available in cash. His own view was that, apart from the payment which would become due to Mr. Seligmann Lui when he delivered his model, very little, if any, further cash would be required. He anticipated that they would then be in a position to contract with a corporation or company to instal their system for a fixed sum, which would leave a profit, the Company guaranteeing the working for a specified period. Such an arrangement would require a very small outlay on their part, and when once the practicability of working and the saving in cost by adopting the invention were shown the future was assured.

The motion, having been seconded, was agreed to without discussion.

TYPEWRITING TELEGRAPH.

On the 13th inst. the second ordinary general meeting of this Company was held at Winchester House, Old Broad-street, E.C., at which the Right Hon. Sir James Fergusson, Bart. (the chairman), presided.

The **Chairman** said that since the first meeting, which was really the statutory one, the directors had had a great many difficulties, more or less unforeseen, to contend with. The first trouble arose in connection with the Post Office, who required certain alterations to be made in the structure of the instrument, with which they were not entirely satisfied. Some time elapsed before the Company could ascertain exactly what the requirements of the Government were, but eventually these were received and the improvements made. The result was that though the business of the Corporation was taken over on June 26, 1900, the agreement with the Post Office was not completed until June 6, 1901, and the consequent delay in deciding the class of instruments to be manufactured was most detrimental to the business of the Corporation, it being in the opinion of the directors most undesirable to proceed with the manufacture of machines until the Post Office pattern had been passed and approved. The next difficulty they had to contend with was in getting the contractors to keep up to the mark with the deliveries of the instrument. The specified number was never reached, and even at the present time there were no less than 140 instruments in arrear. The result of this non-fulfilment of contract interfered with the development of the business of the Company; indeed, their representative who went out to South Africa being unable to supply the instruments that the public required, the Company unfortunately lost considerable business. In the month of August, however, they were able to get a new firm of contractors, but that firm could not supply until two months later because of the necessity of the installation of the plant. Deliveries were now beginning, and the directors had no doubt that they would continue to be satisfactory. One feature, however, has since arisen, and that was that the instruments could be supplied at a lower rate and in a shorter time abroad, so that he had no doubt that in the future they would be able to obtain sufficient supplies to meet all requirements. In conclusion, the chairman moved the adoption of the report and accounts.

Mr. C. E. Spagnoletti seconded the motion.

In the discussion which ensued, several shareholders expressed dissatisfaction with the management, and eventually an amendment was carried appointing a committee to investigate the accounts.

The meeting was then adjourned for one month.

NEW COMPANIES REGISTERED.

British Automobile Training and Letting Company, Limited.—Capital, £1,000. Objects: to provide and carry on a training school for automobile drivers and a livery and hiring yard for automobiles, motor carriages, lorries, cycles, and self-propelled vehicles of all kinds.

C. H. Guest, Limited.—Capital, £2,000. Objects: to take over the business of an electrical and mechanical engineer, car builder, and cycle manufacturer, carried on by C. H. Guest at Draycott Mills, Draycott, Derby, and to carry on the same, and the business of electricians.

Automatic Letter Boxes, Limited.—Capital, £100,000. Objects: to acquire inventions, patents, licenses, concessions, and the like for or in relation to automatic letter boxes, phonoscopes, cinematographs, phonographs, photographic or other flash lamps, telephones, automatic stamping, etc.

William Rickard, Limited.—Capital, £50,000. Objects: to acquire and take over as a going concern the business of an electrical wire and cable manufacturer, and manufacturer of millinery wires and trimmings now carried on by Agnes Rickard (as executrix of the late Douglas Rickard) at Ashbourne-road Mills, Derby, under the style of William Rickard, etc.

Sidney Moorhouse and Co., Limited.—Capital, £10,000. Objects: to take over the business of a brass and ironfounder and brass finisher, carried on by Wright Boothroyd, at Stalybridge, as Sidney Moorhouse and Co., and to carry on the business of brass founders and finishers, ironfounders, metal workers, mechanical and electrical engineers, etc.

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Stockport Engineering Company, Limited.—Capital, £5,000. Objects: to adopt an agreement with H. Pearson and J. H. Nuttall for the acquisition of the business carried on at Manchester as Pearson and Nuttall, or Pearson and Co., and to carry on the business of iron-founders, mechanical engineers, electrical engineers, etc.

APPOINTMENTS VACANT.

Traveller. Full particulars in our advertisement columns.

Assistant Draughtsman, accustomed to electrical work. Full particulars in our advertisement columns.

Assistant Engineer, Oldham Corporation Electricity Department, salary £100, Dec. 31. Particulars in our advertisement columns.

Distributing Engineer.—The Hackney Borough Council will shortly advertise for a distributing engineer at a salary of £250 per annum.

Chief Assistant Engineer, Grimsby Corporation Electricity Department, £150 per annum, Dec. 23. Full particulars in our advertisement columns.

Engineer-in-Chief, South Lancashire Electric Traction and Power Company, Limited, £500 per annum, Jan. 15. Full particulars in our advertisement columns.

Cable Jointer, used to high-tension concentric and low-tension three-core and single cables preferred, £2 per week. Full particulars in our advertisement columns.

Draughtsman, Electricity Department of Brighton Corporation, good and capable of carrying out periodical tests of engines and boilers, Jan. 1. Full particulars in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Barking.—The Urban District Council invite tenders for additional generating plant by Jan. 24.

Bray.—The Urban District Council invite tenders for one 60-kw. to 75-kw. alternator by Dec. 27.

Barrow-in-Furness.—The Corporation invite tenders for the wiring of the new town hall. Specification etc., may be seen at the Electricity Works.

Bournemouth.—The Town Council invite tenders for feeder cables, pilots, arc lighting cables, conduits, etc. Tenders by Jan. 6. Details in our advertisement columns.

West Bromwich.—The Council invite tenders for the reconstruction and electrical equipment of about 12 miles of tramway in the borough. Tenders by Jan. 13. Details in our advertisement columns.

Brussels.—The administration of the Belgian Government Telegraphs will receive tenders for 7,300 telegraph posts by Jan. 8, 1902. Specification No. 12 may be obtained at the office of the department, Brussels.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of steam, exhaust, feed, and drain pipes, feed pumps, feed heater, feed tank, tools, etc. Tenders by Jan. 8. Details in our advertisement columns.

Hornsey.—The Urban District Council invite tenders for the supply and erection of steam, exhaust, water, and other pipes, valves, tanks, footplates, and accessories, and elevator and transporter, electric motor and switch gear. Tenders by Jan. 15. Details in our advertisement columns.

Louvain (Belgium).—The contract for the lighting of Louvain by gas will expire on Jan. 1, 1905. The Municipality are therefore prepared to receive, before Dec. 31, 1901, proposals for lighting the city, either by gas or electricity, or by the two systems combined, from gas or electric light companies. Address the Burgomaster, Louvain, Belgium.

Scarborough.—The Town Council invite tenders for the fitting up of an electric light, telephone, and bell installation to St. Nicholas House, St. Nicholas-street, Scarborough. Specifications, etc., may be obtained on application to Mr. Harry W. Smith, borough engineer, Town Hall. Tenders by Dec. 23.

West Ham.—The Council invite tenders for four sets of surface condensing plant, each to deal with 40,000lb. of steam per hour, complete with electrically-driven air and circulating pumps; and one travelling crane, to carry 30 tons, span 67ft. Tenders by Jan. 14. Details in our advertisement columns.

Madrid.—Tenders are invited for installing and working the electric light at a prison. After 15 years the installation is to become the property of the Government, who will contribute a maximum of 40,000 pesetas per annum. Particulars may be obtained from the Junta local de Prisiones, Madrid. Tenders by 3 p.m. on Dec. 26.

Nantwich.—The Urban District Council invite tenders for the supply and erection of boiler-house plant: one water-tube tube and one Lancashire boiler, fittings, steam and exhaust pipes, etc.; engine-house plant: continuous-current steam dynamos, pumps, etc.; switchboard, etc., underground mains, lamp posts, etc., accumulators, meters, crane, etc., dust destructor. Tenders by Jan. 6, 1902.

Barnstaple.—The Town Council invite tenders for the supply and erection of three straight water-tube or Economic boilers, fittings, steam and exhaust piping, condensers, three high-speed engines (220 i.h.p. each), three 125-kw. c.c. dynamos, switchboard, underground mains, lamp-posts, etc., meters, accumulators, crane, etc. artesian well. Tenders by Jan. 16. Details in our advertisement columns.

Madrid.—The Public Works Department invite tenders for an electric tramway from San Sebastion to Toloso, with power to work same for a maximum of 60 years, after which the undertaking becomes Government property without compensation. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m. Tenders by Jan. 27.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station of (a) main high-tension three-phase switchboards at generating station, (b) exciter and auxiliary switchboards at generating station, (c) high-tension three-phase switchboards at 10 sub-stations, (d) low-tension switchboards at 10 sub-stations. Tenders by Jan. 21. Details in our advertisement columns.

Middlesbrough.—The Electric Lighting Committee invite tenders for the supply and erection of—engine-house plant: one 300-kw. high-speed steam dynamo and accessories; switchboard panels: panels and instruments for dealing with the above plant, and three new feeders; condensing apparatus and pipework: ejector condenser for dealing with 8,100lb. of steam per hour, and steam, exhaust, and feed pipes; feed pump and economiser: one feed pump and extension to existing economiser. Tenders by Jan. 21. Details in our advertisement columns.

Reading.—The Corporation invite tenders for the supply and erection of the following plant, works, machinery, and rolling-stock for the purposes of the intended electrical tramways: (Section A) water-tube boilers, superheaters, and mechanical stokers; (B) fuel economiser; (C) piping, feed pumps, etc.; (D) compound condensing direct-coupled engines; (E) surface condensers, air-pumps, circulating pumps, piping, etc.; (F) electric generators; (G) switchboards and connections; (H) electric lighting; (I) overhead travelling crane; (K) motor trucks; (L) motors and electrical equipment for cars; (M) car bodies; (N) trolleys; (O) miscellaneous minor works and fittings. Specifications, etc., may be obtained from the Borough Engineer, Town Hall, Reading. Tenders by Dec. 28.

Rockhampton (Queensland).—The Municipality invite applications from companies desirous of undertaking the construction and working a system of electric tramways under the Queensland Tramways Act of 1882 and the Amendment Act of 1890, within the municipality of Rockhampton aforesaid. Rockhampton, with a population of 15,461, is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882 and the Amendment Act of 1890, copies of which may be seen at the office of this paper. Applications to be forwarded to Mr. H. W. Johnson, mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31.

RESULTS OF TENDERS.

Ilford.—The Urban District Council have accepted the tender of Mr. G. Sharpe for the erection of tramcar sheds at £5,937.

Rochdale.—The contract for generators for the above Corporation has been placed with D. Bruce Peebles and Co. at the sum of £850.

Canterbury.—In connection with the wiring of the electric works extension, the City Council have accepted the tender of Mr. Philpot at £78. 10s.

Stafford.—The Town Council have accepted the tender of the Electric Construction Company, at £240, for supply of an electric storage balancer.

Southend.—The Corporation have accepted the tender of the British Thomson-Houston Company for five motorcars and one trailer for the pier tramways, at £1,994.

Hull.—The Corporation Electric Lighting Committee have accepted the tender of Parker and Co., Wolverhampton, for six additional transformers, at £4,230; also the same firm's tender for switch gears, at £762.

Cape Town.—The Corporation have placed large orders as follows: Ferranti Limited, Hollinwood, Lancs., engines; Dick, Kerr, and Co., Preston, dynamos, the size of each unit being 1,200 h.p.

Birkdale and Southport Light Railways.—The generating plant for this, comprising three 150-b.h.p. direct-coupled sets, have been placed with D. Bruce Peebles and Co.; engines by Browett, Lindley, and Co.

Bournemouth.—The Corporation have accepted the following tenders: Jenkins and Sons, engine-house, etc., £11,719; Alphons Custodis Chimney Construction Company, chimney shaft, £1,215; Jones and Seward, Bournemouth, car-sheds, £7,640.

Doncaster.—The Tramways Committee have accepted the tender of H. Arnold and Son, at £2,407, for the construction of a car-shed in Grey Friar-road, near the baths, and the tender of Mullins and Richardson, at £534, for the erection of a small car-shed on Marsh-gate.

Electrolytic Alkali Company.—The contract for the supply of eight 250-h.p. double-commutator 2,500-ampere generators for the above company has been placed with D. Bruce Peebles and Co. This plant when completed will form one of the largest electrolytic plants in the country.

Stoke Newington.—The Borough Council have accepted the offer of the Hackney Borough Council to supply nine pillars and arc lamps with switch gear and resistances and one spare lamp and gear com-

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complete, at £290; also of Johnson and Phillips to erect the said posts, at £4. 17s. 6d. each.

Hammersmith.—The following tenders have been accepted: British Westinghouse Electric Company, 175 5-ampere electricity meters, at £577. 10s.; Chamberlain and Hookham, 80 10-ampere £280, 40 15-ampere £150, 50 25 ampere £187. 10s., 20 50-ampere £80, five 75-ampere £21. 5s., five 100-ampere £21. 5s.

Tunbridge Wells.—The Town Council have received the following tenders for wiring and part of the electrical fittings required at the new technical institute:

Powell	£188	5	0
Sykes and Co.	160	0	0
Haward and Co. (accepted)	146	11	0

Huddersfield.—The Town Council have accepted the tender of Ferranti Limited, for supplying and fixing of a combined set of 600-kw. plant, at £5,200. The Council have also decided to accept tenders (all from British firms) to the amount of £47,987. 2s. for the conversion of the steam tramway lines for electric traction, the laying of lines and wires to Honley, and for engines, boilers, and other plant for the power generating station.

Willesden.—The following tenders have been accepted for the equipment of the electricity works: (Section A, boiler-house plant), Babcock and Wilcox, Limited, £5,502; (Sections B and D, steam dynamos, rotatory converters, and balancers, British Westinghouse Electric Company, £10,363; (Section C, transformers, British Electric Transformer Company, £900: (Section E, switch gear, high and low pressure, Ferranti Limited, £4,527; Section F. overhead travelling cranes, Chatteris Engineering Company 8-ton hand traveller), £148. 10s.; Broadbent and Sons, Limited (12-ton electric traveller), £545; (Section G accumulators), Tudor Accumulator Company (two batteries), £3,302; (Section H, mains. high and low pressure), British Insulated Wire Company, Limited, £22,917; (Section I, public lamps), not yet adjudicated; (Section J, steam pipes), Babcock and Wilcox, Limited, £425; (Section K, condenser and cooling plant), Ashton, Frost, and Co., Limited, £1,011; Korting Bros. £516. There were 320 tenders received, a full list of which will appear in our next issue.

London.—The London County Council have received the following fresh tenders for wiring and fittings for electric lighting installations at the Manchester-square, Bishopsgate, and Brompton fire stations:

Manchester-square station.

Ellis, Potten, and Co.*	£170	0	0
Jackson Bros.	177	8	6
G. W. Clarke	197	9	4
National Electric Wiring Company, Limited	221	9	0
J. H. Rake	226	10	0
Graham and Biddle	240	0	0
G. Weston and Co.	247	14	4
Barlow Bros. and Co.	257	0	0
C. Peacock and Co.	280	0	0
F. J. Coleby and Co.	295	10	0
J. Sperati	378	0	0
C. Esson (informal)	259	0	0

Bishopsgate station.

Ellis, Potten, and Co.*	150	0	0
Jackson Bros.	159	7	0
G. W. Clarke	168	7	6
National Electric Wiring Company, Limited	193	12	0
G. Weston and Co	221	18	3
Barlow Bros. and Co.	247	0	0
C. Peacock and Co.	247	0	0
J. H. Rake	256	10	0
F. J. Coleby and Co.	273	0	0
J. Sperati	313	0	0
C. Esson (informal)	215	0	0

Brompton station.

Jackson Bros.*	98	2	6
Ellis, Potten, and Co.	104	0	0
National Electric Wiring Company, Limited	115	8	0
Graham and Biddle	120	0	0
J. H. Rake	136	10	0
C. Peacock and Co	145	11	0
G. Weston and Co	148	14	0
F. J. Coleby and Co.	165	0	0
Barlow Bros. and Co	170	0	0
J. Sperati	186	0	0
C. Esson (informal)	125	10	0

* Recommended for acceptance.

BUSINESS NOTES.

TRACTION.

Cardiff.—The Corporation take over the working of the tramways on Jan. 1.

Stretford.—The Urban District Council have decided to borrow £50,000 for electric traction purposes.

Portsmouth.—The Town Council have adopted a new scale of wages for their tramway employés to come into force on Jan. 1.

Cheltenham.—The electric tramways are proving so successful at this place that fresh extensions are promised in town and country.

Swindon.—The Town Council have appointed a sub-committee to confer with the electrical engineers (Messrs. Lacey and Co.) as to the construction of the tramways.

Burton.—A memorial asking that a town's meeting might be held to discuss the electric tramways scheme has been referred to the Highways Committee of the Town Council.

Yarmouth.—The borough surveyor reports that the works of tramway construction are proceeding at a pace which will ensure their completion in May or June next, as promised.

Bute.—The County Council have agreed to dissent to the proposed electric tramways to Ettrick Bay, and the matter has been remitted to the Bute District Committee, with full powers.

Benwell.—The District Council have agreed to the proposed extension of the tramways to this place, one condition of their consent being that the line shall be completed within two years.

British Electric Traction Co.—The directors recommend an interim dividend at the rate of 6 per cent. per annum on the ordinary share capital for the half-year ended Sept. 30 last.

Arnold.—The Urban District Council have appointed a committee to confer with the promoters of the light railway schemes with a view of obtaining the greatest advantages for this district.

Manchester-Liverpool Electric.—The engineers of the Manchester and Liverpool Electric Express Railway Company have deposited the plans for the proposed line with the Board of Trade.

Taunton.—Alderman Potter has been appointed chairman of the Tramways Committee for the ensuing year. The Town Council have approved the new by-laws proposed by the company.

Govan.—A somewhat serious collision took place in New Govan-road between an electric car going west and a lorry in a fog last week. The force of the impact threw the horse to the ground.

Upper Norwood.—A meeting of the ratepayers' association has passed a resolution against the proposed electric tramway from Croydon to the Crystal Palace *via* South Norwood-hill and Church-road.

Haywards Heath.—In the event of the promoters of the London and Brighton electric railway refusing to provide a station at this place, the Urban District Council have decided to oppose the scheme.

Gillingham (Kent).—The District Council have decided to ask the tramway company to lay down Jarrah wood blocks in the High-streets of Old and New Brompton, the Council to pay the difference in the cost.

Bournemouth.—Considerable opposition is being raised to the proposed scheme to construct an electric tramway through the picturesque village of Parkstone, situate between Bournemouth and Poole.

Smethwick.—The Town Council have decided to oppose the Bill being promoted in Parliament by the Birmingham and Midland Tramway Company to obtain powers to extend their tramways in this district.

Romford.—By 91 votes to 109 the ratepayers of Romford, at a meeting held last week, decided against the tramway scheme which the Urban District Council have decided to promote. A poll was demanded.

Wolverhampton.—A special meeting of the Town Council has agreed to apply for a provisional order to authorise the construction of a new tramway along Snow-hill and down to the junction of Piper's-row.

Halifax.—A statement prepared by the borough accountant has been submitted to the Tramways Committee, showing that on the summer traffic, from April to September, the tramways had yielded a profit of £2,000.

Solent Tunnel Scheme.—The shareholders of the Freshwater, Yarmouth, and Newport (Isle of Wight) Railway at an extraordinary meeting have agreed to sell their undertaking to the promoters of the above scheme for £85,000.

York.—A petition from owners and occupiers of property in Davygate has been presented to the City Council disapproving of the proposal to introduce electric tramways in Davygate, and asking the Council to amend the scheme.

Ripley.—Mr. C. W. Thompson, surveyor to the Urban District Council, has been asked to report on two light railway schemes it is proposed to bring through the district—viz., the Mansfield and district light railway and the Erewash Valley light railway.

Provincial Tramways Co.—The directors recommend a further dividend of 6s. per share, making a total distribution of 9s. per share for the year, setting aside £2,500 for the local company at Plymouth and £2,500 to Grimsby, and carrying £2,480 forward.

Wallsend.—The Town Council having already approved the scheme of the Tyneside Tramways Company for providing tramway connection with Newcastle, a request from the Newcastle Corporation for an interview on the question of tramways has been refused.

Woolwich.—After a lengthy discussion the Borough Council at their last meeting rejected a proposal to rescind their previous resolution not to contribute towards the cost of street widenings in connection with the London County Council's tramway scheme.

Gosport.—The Urban District Council have received a letter from an official of the Provincial Tramways Company saying that he thought he could induce his directors to accept £15,000 for the undertaking, to include the lines, the depôts, the cars, and plant as it stands.

Sunderland.—The tramway traffic returns for the fortnight ending Dec. 4 amount to £1,916, as against £2,036 for the previous fortnight. This shows a decrease of £120 in two weeks. A new scale of increased payment in all departments of the tramway service has been adopted.

Paisley.—Having agreed to supply the tramways company with the electrical energy required for the working of the system, the Corporation are about to apply for sanction to a loan of £30,000 for the extension of the electricity works and the provision of additional plant.

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Hammersmith.—The Public Health Committee of the Borough Council recommend that further summonses be taken out against the Central London Railway Company "for permitting black smoke to issue from the shafts of their premises in Wood-lane in such quantities as to be a nuisance."

Beckenham.—The British Electric Traction Company, who are proposing to apply for powers to construct electric tramways in the districts of Beckenham, Bromley, and Penge, have suggested that a joint conference of the local authorities concerned should be held to discuss the question.

Southend.—One of the electric tramcars collided on Saturday evening with a heavy cart laden with bricks. The front part of the car was knocked into the body of the vehicle, injuring the driver and causing great consternation amongst the passengers, one of whom was seriously injured about the head.

Handsworth.—The Highways Committee of the District Council are in communication with the City of Birmingham Tramways Company with a view to getting the company to take effective means for putting an end to the "serious nuisance arising from noise connected with the working of the tramways."

Hampton.—The District Council have called a special meeting to consider a notice of an intended application to the Light Railway Commissioners by the London United Tramways Company for an order authorising the construction of light railways in the district, together with the draft order, plans, and sections.

Manchester.—A crowded meeting of owners and ratepayers has unanimously consented to the promotion by the Council in the next session of Parliament of a Bill to authorise the construction and working by the Corporation of certain new lines of tramways in the city. The names of the proposed extensions appeared in our issue of the 6th inst.

Ardsley.—The District Council have received information to the effect that the promoters of the light railway extension scheme will proceed with the same next May. The promised extension ought to have been promoted last November, and the Council have passed a resolution expressing dissatisfaction at the promoters failing to carry out their agreement.

Ossett.—A committee of the Town Council has been appointed to look after the interests of the Corporation in relation to the light railway schemes. The general opinion in the town seems to be that they would be a great improvement to the borough. It is felt that a system of light railways would enhance the value of building sites and increase the ratable value.

Ashton-under-Lyne.—The tramways scheme is reported to be proceeding satisfactorily, and plans submitted by the borough surveyor of an alteration of the lines at the junction of Mossley-road and Queen-street have been approved. The Town Council are now about to make application to the Board of Trade for sanction to borrow £23,500 for the purposes of the scheme.

Chorley.—The Rural District Council have received a letter from the promoters of the proposed Preston and Horwich light railway, stating that the route will be practically the same as that in respect to which application was recently made, with the exception that railway No. 6, from the Bolton-road to Boar's Head, will be omitted, and a railway from Chorley to Standish substituted.

Edinburgh.—The directors of the tramways company have made certain proposals in regard to the litigation now in progress between the Corporation and themselves with reference to the Sunday running of the cars, arrears of rent, etc. The nature of these proposals has not been allowed to transpire, but it is confidently expected that they will lead to an amicable settlement of the difficulties.

Hove.—On the recommendation of the General Purposes Committee the Town Council have decided to take all such steps as may be necessary to oppose the proposed application to Parliament by the Brighton and Shoreham Tramways Company, and also that the consideration of whether any tramway in addition to the one already being worked is required within the borough be referred to a joint committee.

Llandudno.—At the last meeting of the Urban District Council a discussion arose on the question of opposing the Light Railway Bill. A consultation with the promoters of the Bill was finally resolved upon. Lord Mostyn has withheld consent to the construction of the proposed electric tramway round the Great Orme pending an arrangement to ascertain public opinion in Llandudno on the proposal.

Normanton.—At the present time two companies—the Wakefield and District Light Railways Company and the West Riding Tramways Company—are proposing to construct a line from Wakefield to this place. The Urban District Council have decided to oppose the scheme of the former company, but a committee has been appointed to negotiate with the company for a withdrawal of the opposition if thought expedient.

Dudley.—The heavy fall of snow experienced at this place last week had a most serious effect on the overhead equipment of the electric tramways. According to a local paper, telegraph and telephone wires were brought to the ground, and through the inadequacy of the system of guard wires they got in connection with the trolley lines. As a result, three horses which came in contact with the broken wires were instantly killed.

Camberwell.—On the recommendation of the Highways Committee the Borough Council have agreed to consent to the construction of a tramway by the London County Council from Camberwell-green, *viâ* Denmark-hill, Champion-park, Grove-lane, Dog Kennel-hill, and Lordship-lane, to a point near Crystal Palace-road, and to contribute one-third of the cost of the necessary street widenings in the borough, such contribution not to exceed the sum of £34,000.

Sunbury.—With reference to the proposal of the London United Tramways Company for light railways to be constructed through the district, the District Council have included the following two points in their objections: (1) that the proposed order does not make provision for the surface-water drainage of the roads where interfered with by the company's works; (2) that the scheme does not include an extension of the railway to Lower Sunbury.

Batley.—The British Electric Traction Company having become the owners of the Dewsbury, Batley, and Birstall tramways, efforts are being made to arrive at an amicable agreement with the Corporation of Batley, who are anxious to acquire that portion of the undertaking within their area. The traction company, on the other hand, suggest that it would be more advantageous to the ratepayers if the lines were leased to them upon terms. Negotiations are said to be proceeding smoothly.

Newcastle.—The new electric tramways here were opened by the Mayoress on Monday. The system has cost up to the present £600,000, and is expected eventually to cost £800,000. Cars were successfully run on four routes, and the lines in the other districts are being rapidly completed. The Tramways Committee hope that, should the weather prove favourable, the Scotswood-road, the Westmoreland-road the Westgate-road, and the Elswick-road sections of the new system will be opened by Jan. 15.

Oldbury.—Notices have been issued by the Birmingham and Midland Tramway Company to property owners in Birchfield-lane and Halesowen-street of their intention to introduce a Bill in Parliament during the ensuing session to lay down tramways in these roads. Further extensions through Langley are contemplated, which will complete the network of tramways in the Black Country between Wolverhampton and Birmingham which the British Electric Traction Company intend laying down.

Rochford.—It is announced that the company formed to promote light railways from Southend to Bradwell have withdrawn their Bill in its existing form, and intend to substitute one containing proposals to commence the line from Prittlewell instead of Southend, to run through Bradwell to Colchester instead of stopping at the former place, and to run also from Southchurch Church by way of North Shoebury to the Cambridge Hotel at Shoeburyness. A committee of the local authority has been appointed to go into the matter.

Clacton.—The Urban District Council have decided to oppose the scheme for the light railway from Clacton to St. Osyth upon the grounds, among others, that provision should be made for the roads to be of not less width in any part than 30ft. The Council, however, do not oppose the principle of the scheme. The Reno Elevator Construction Syndicate have applied to the authority for a concession to construct one of their electric stairways up the face of the cliff. Subject to a satisfactory agreement, the Council have decided to accept the proposals of the company.

Birmingham.—On Monday the Tramways Committee of the Town Council had under consideration a draft agreement with the Birmingham and Midland Tramways Company relating to such part of the new tramways proposed by the company as will be within the city boundaries. The company are prepared to give an undertaking to provide the most approved system entirely at their own cost, the Corporation to have the option of purchase at the expiration of the lease for which the company ask. The matter is still under consideration, no decision having yet been arrived at by the Tramways Committee.

Leeds.—On Wednesday the City Council considered the question of passing a resolution to apply to the Board of Trade for a provisional order authorising the construction of the following tramways: from the present terminus at Thwaite-gate to the city boundary at Rothwell *viâ* Low-road and Wakefield-road; from the junction of Whitehall and Geldard-road to the city boundary at Drighlington, *via* Geldard-road and Whitehall-road; from Oldfield-lane through New Blackpool to Whitehall-road, *via* Oldfield-lane, Lower Wortley-road, and Branch-road; from the present terminus in Elland-road to the city boundary at Churwell, *via* Elland-road.

London County Council.—The Highways Committee of the London County Council have arranged that the Council's electrical engineer, who is preparing the plans, drawings, and specifications for, among other things, the main feeder cables which will be required in connection with the reconstruction of certain parts of the Council's tramways, shall do the same for the lines, the reconstruction of which is to be carried out under the supervision of Dr. A. B. W. Kennedy, consulting electrical engineer to the Council. The lines in question are those between Westminster and Tooting, Kennington and Blackfriars, and St. George's-circus and Waterloo-road.

Sowerby Bridge.—A deputation from the District Council have had an interview with the Tramways Committee of the Halifax Corporation to urge the desirability of the tramways being extended to Sowerby Bridge by way of King Cross, Pyenest Wood, and Bolton Brow. The committee have already obtained powers to construct a tramway along a route yet to be made from Skircoat Green by way of Birdcage Wood to Sowerby Bridge, but, as the deputation pointed out, there is no present probability of that scheme being carried out. The committee promised that the views of the deputation should receive due consideration, and they would instruct their engineer to report as to the most feasible route.

Bradford.—On Feb. 1 next the Corporation will formally take over the whole of the lines now leased to the tramways company. The conversion of these lines to electric traction is already in progress so far as the Leeds-road, Manningham-lane and Saltaire, Manchester-road, Low Moor, Wyke, and Shelf routes are concerned. The track in all cases has to be doubled, and it is now doubtful whether the Corporation will be able on taking over the trams on Feb. 1 to at once adopt electric traction. The whole question of fares was considered at the last meeting of the Tramways Committee, and in nearly all cases it was decided to give a longer ride for a smaller sum on the lines which will be taken over early next year.

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Burnley.—Major Druitt and Mr. A. P. Trotter, of the Board of Trade, this week inspected that portion of the new electric tramway for the district which is already completed. Up to the present about 5½ miles out of a total of eight miles of main line have been relaid, and the overhead electrical equipment has been so far completed as to enable the cars to run from the centre of Burnley to within a mile of Padiham, the latter town being 3½ miles away. A public service of cars is now being maintained along this portion of the line. The approximate cost of the entire reconstruction is about £150,000, and in addition to this a sum of £53,000 has been paid to the old tramway company on the taking over of the old line and plant.

Locomotion in London.—Mr. J. W. Benn delivered a lecture at the National Liberal Club on this subject. Referring to what he called the "underground invasion" of London, the lecturer said that the County Council was in favour of all means of locomotion, but he maintained it was necessary for somebody to interfere and see that the persons conducting these new tube enterprises should work on a well-considered plan, and in the interests of London as well as their own. Unless something was done to systematise the tube companies, the County Council would be compelled to make a declaration in favour of some central authority taking control of them. Otherwise they would be financed, as telephones were, to such an extent that 2d. fares would of necessity take the place of 1d. fares.

Electric Traction for Steam Lines.—Enquiries at Crewe railway works on the subject of the possible adoption of electricity as a train motor instead of steam on the London and North-Western Railway, show that the engineers of the company have for several years had the subject under consideration, and Mr. F. W. Webb, the chief mechanical engineer, has more than once publicly declared that as soon as the directors asked for an electric train the Crewe workmen were ready to turn it out. There is no immediate probability of this however, though it is recognised that it is, sooner or later, inevitable. The laying down of the electric plant will be enormously costly, though the charge would be spread over several years. The North-Western Company are applying electricity to their signalling, and have many electric signals now at work.—*Leeds Mercury.*

Broadstairs.—The Urban District Council have received a communication from Mr. Murphy with reference to the noise from the running of the electric cars on the Isle of Thanet Light Railways. It is interesting to see some of the reasons given by this gentleman for the nuisance complained of. He says, for instance, that "the sound caused by electric cars is increased by wood paving, and there appears to be a peculiar resonance in the chalky soil of the district," and that "owing to this peculiarity and to the silence of the streets in the absence of other vehicular traffic, all street noises are more noticeable in Thanet towns than most other places." He concludes: "As you know, I have done, and am doing, everything in my power to minimise the noise, which is inherent in the working of every kind of traffic, the reports of which in Thanet are, I cannot help thinking, a great deal exaggerated."

Middlesex Light Railways.—It will be remembered that only a week or two ago the Middlesex County Council concluded an agreement under which they handed over to the London United Tramways Company the whole of the southern half of the county for tramway purposes. Following close on this, we see it announced that a proposal is now before the County Council to lease the whole of the proposed lines which still remain in the Council's hands in the northern half of Middlesex to the Metropolitan Tramways and Omnibus Company. The length of the projected lines in question is 37 miles, and they embrace those from Acton to Stanmore, from Willesden to Friern Barnet, and from Golder's Hill to Kingsbury. The result of the action of the Middlesex County Council in this matter will be to surrender the whole of the proposed tramways in the county into the hands of companies. We understand that the proposal came up for consideration at the meeting of the Council yesterday.

Liverpool.—Mr. Bellamy's returns of the tramway traffic for the fortnight ended Nov. 30 show a great increase over the figures for the corresponding period of last year. Thus the total mileage was 435,111, an increase of 54,038 compared with the corresponding fortnight last year, and the passengers carried were 3,744,755, an increase of 396,707. The receipts were £17,295. 3s. 8d., an increase over the corresponding fortnight in 1900 of £1,286. There are now 351 cars in constant service in the city, of which only six are horse cars. A long discussion took place at the last meeting of the City Council on a recommendation to confirm a clause in the omnibus Bill which the Corporation are promoting, conferring power to charge the whole or portion of the cost of street improvements so far as in the opinion of the Council they have been or may be in the future necessary or desirable for the tramways service against the tramways capital or account. The clause was eventually carried with the following two amendments: "(1) That the operation of the clause should not be retrospective; and (2) that the payments should come out of revenue tramway profits."

Electric Traction on the Underground.—The directors of the Metropolitan Railway Company on Thursday week had under consideration the Board of Trade decision as to the system of electrical working to be applied to the Underground Railway, and also the report of the Hon. Alfred Lyttelton, who presided over the recent arbitration. The directors announce that, so far as the Metropolitan Railway is concerned, no time will be lost in proceeding with the installation of electric traction in accordance with the decision of the Board of Trade. The announcement made in these columns some three weeks ago that the Metropolitan District Company had awarded the contract for the electrical equipment of their own lines and power station to the Westinghouse Electric and Manufacturing Company is confirmed by a Laffan's telegram from New York, which further states that the manufacture of the machinery and plant, or the greater part of it, will be undertaken at the company's new works at Manchester. A portion of the installation will, however, be put in hand at once at the company's Pittsburg works in order to hasten the construction of the plant. The electrical generators will be larger than those of the Manhattan Elevated Railway of New York, which up to the present are the largest in the world. The Westinghouse Company's generators at Niagara Falls are of 5,000 h.p. each. Those of the Manhattan Elevated Railway are of 6,500 h.p., while those manufactured for the Metropolitan Railway will be of over 7,000 h.p. They will be driven by turbine engines. The generating machines of the Manhattan Elevated Railway weigh 370,000lb. apiece, and are each 42ft. high. One of them will give energy equal to that of 500,000 men. The Metropolitan electric generating station will have a minimum capacity of 70,000 h.p. and a maximum of 100,000 h.p. It is announced that a special meeting of the stockholders of the Metropolitan District Railway is convened for Monday to approve Parliamentary Bills in connection with the electrification of the Underground. Among the more interesting objects for which the company seek power are: to abstract water from the River Thames and return same; to work by electrical power (*a*) portions of the London and South-Western Railway between Turnham Green and Richmond, and between Putney Bridge and Wimbledon, (*b*) East London Railway, (*c*) Hounslow and Metropolitan Railway; and to raise additional capital. Also to constitute the deep-level railway authorised by the Metropolitan District Railway Act, 1897, or any part thereof, into a separate undertaking; to extend the time for the construction of the deep-level railway and the purchase of lands therefor; to run over the portion of the London, Tilbury, and Southend Railway Company's railway between Campbell-road and Barking; and to amend an agreement with the Metropolitan District Electric Traction Company, Limited. There is also a Bill suggesting a friendly agreement with the new Brompton and Piccadily-circus Railway Company.

LIGHTING AND GENERAL.

Blackpool.—Alderman Grime has resigned his position as chairman of the Electric Lighting Committee.

Ashton-under-Lyne.—The Town Council propose to borrow £30,000 for works of electric lighting.

Tunbridge Wells.—The salary of Mr. H. Bates, one of the assistant engineers, has been increased.

Southend.—The Town Council have decided to purchase an electric crane for the loading pier to cost £410.

Kettering.—The Council propose to expend £43,450 on electricity works and £4,200 on a refuse destructor.

Broughty Ferry.—The Town Council are debating the question of introducing the electric light in the burgh.

Dumbarton.—The Council have formally agreed to apply to the Board of Trade for an electric lighting order.

Margate.—The Town Council are taking steps to light the front of the town with electricity before next summer.

Brighton.—The surveyor is preparing an estimate for installing electric light in the slipper baths at North-road.

Maidstone.—The Corporation's electric light works at Fair Meadow were officially opened by the Mayor yesterday afternoon.

Chester-le-Street.—The Council have sealed a memorial to the Board of Trade for an electrical lighting provisional order.

Govan.—The salaries of the electrical engineer and of his assistant have been increased by £50 and £10 per annum respectively.

Telephone Conference.—A conference on telephone charges will be opened by the Lord Mayor at the Guildhall on Dec. 23 at 3 p.m.

Ferranti Limited.—We are informed that S. Z. de Ferranti, Limited, having been reconstructed, the title is now Ferranti Limited.

Pemberton.—The following appointments have been made: engineer, Mr. T. Partington, Pemberton; assistant engineer, Mr. J. B. Robb, Pemberton.

Greenock.—It is proposed that a committee of the Parish Council be appointed to enquire into the advisability of lighting Smithston Asylum with electricity.

Erratum.—In the note referring to York lighting which appeared in our last issue, the number of lamps connected should read 26,000, and not 16,000 as stated.

Heywood.—The Electric Lighting Committee have decided to lay additional mains outside the present system wherever the demand warranted such extension.

Carlisle.—An additional feeder cable is to be laid at an estimated cost of £350. Twenty new applications for lights, equal to 699 8-c.p. lamps, have been received.

Hull.—The Telephone Committee propose to transform the Trippett Baths into a station for the proposed municipal telephones. The baths will be closed at the earliest possible date.

Ediswan Co.—We have received from the Ediswan Company a gorgeously-coloured glass letter-weight representing a blue, white, and gold incandescent lamp, with a red and green inscription.

Gillingham.—The District Council have finally decided to apply to the Board of Trade for a provisional order authorising the Council to supply electricity for public or private purposes in the district.

Ilford.—"Chelmsford" lamps, made by Messrs. Crompton and Co. are to be substituted for the present arc lamps. The penny-in-the-slot system for supplying electric light to private consumers has also been agreed to.

Eastern Extension, Australasia, and China Telegraph Co.—The directors declare an interim dividend for the quarter ended Sept. 30 of 2s. 6d. per share, free of income tax, payable on the 15th prox.

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Finchley.—Mr. Calvert, the Urban District Council's electrical engineer, has been authorised to purchase office furniture, materials, and drawing materials as he may consider necessary, at a cost not exceeding £60.

Tiverton.—At last week's meeting of the Town Council a discussion took place upon a proposal that postcards be sent to all the burgesses in the town asking whether they desired electric light or not. No action was taken.

Norwich.—The Town Council have approved of the expediency of promoting in the next session of Parliament a Bill to empower the Corporation to acquire the undertaking of the Norwich Electricity Company, Limited.

Beverley.—The Town Council on Monday decided to borrow £15,000 for the installation of electric light within the borough. The field adjoining the railway station is to be acquired as a site for a generating station.

Trowbridge.—The Urban District Council have deferred the discussion of the question of electricity supply, which includes lighting, dust destructor, and pumping of sewage, until the Electric Light Committee have made their report.

Newcastle.—At the last meeting of the City Lighting Committee of the Corporation it was announced by Mr. Gillespie that the electric lighting of the streets of the city will be in the hands of the Tramways Committee in all probability next winter.

West Ham.—Mr. J. J. Steinitz has been re-engaged as consulting electrical engineer for one year. The failure of the electric light in the east end of Barking-road on Nov. 30 is attributed to a defective Brush transformer, which has since been replaced.

Warminster.—The Urban District Council desire to sell their electric lighting plant, which was purchased for £178 in 1896, and has never been used; and the surveyor has been instructed to advertise the plant in an electric engineering paper, and ask for offers.

Surbiton.—The ratepayers have asked the Council that the whole electric lighting scheme should be laid before them and publicly discussed. Mr. Shaw, chairman of the Electric Lighting Committee, has resigned, and Mr. H. H. Judd has been appointed chairman *pro tem.*

New Branch.—We are informed that Messrs. E. Bremner-Smith and Bremner, civil and electrical engineers, Oswestry, have arranged for offices at 10, Warwick-court, Holborn, London, W.C., where they will practise as consulting electrical engineers as of that address and Oswestry.

Aberdeen.—At Monday's meeting of the Town Council the Public Health Committee recommended that gas be introduced at the Corporation lodging-house in place of electric light, which, it was stated, was too costly. The matter was, however, referred back to the committee.

Bognor.—At the next meeting of the Urban District Council, estimates, plans, and specifications for providing electric light in the town will be considered, and a resolution will be moved in favour of making application for sanction to borrow the sum of £12,000 for the installation.

Wellingborough.—Application is to be made for sanction to borrow £1,500 for plant and works required as follows: engine-house, £250; fittings to 227 street lamps at 69s., £990. To these must be added: legal expenses and contingencies, £80; costs of Board of Trade order, £180.

Middlesbrough.—An electric hoist, the first of its kind in the North of England, is being erected at the Normanby Ironworks, Middlesbrough. It will be used to convey materials from the base level to the top of the new furnaces, which are producing about 1,000 tons of iron per week.

Greenock.—During the five weeks ended Nov. 29 44,093 units of electricity were generated, as against 33,383 for the same period last year, being an increase of 10,710. The units sold numbered 38,455, an increase of 15,316. The connections made number 240, which is equivalent to 22,511 8-c.p. lamps.

Chard.—The Town Council have resolved to oppose the application by the Chard Gas Company for an Act of Parliament giving them additional powers. The opposition to the Bill is chiefly on the ground that it would prevent the Council at some future date entering upon an electric lighting system for the borough.

Aylesbury.—The Council are prepared to enter into a contract with the North Metropolitan Electrical Power Distribution Company for the execution and maintenance of the electricity works, subject to the details being arranged between the parties and to proper security being given for the due performance of the contract.

Glasgow University Engineering Society.—At the last meeting of this society—Mr. Arch. Denny occupying the chair—a paper by Mr. James Rowan on "Workshop Management" was read and discussed. On Saturday a visit was paid to the North Johnstone and Dalry Railway. The annual dinner was held on Friday.

Taunton.—Sanction has been received to the raising of £18,000, part of the electric lighting loan of £21,000 authorised by the Council in February last, and subsequently reduced to £20,000. The Local Government Board have intimated that the balance of the loan—namely, £2,000 for motors—is still under consideration.

Burton.—There is a substantial increase in the supply of both gas and electric light in the town. The question of street-lighting was mentioned at the last meeting of the Town Council, also the employment of an expert to make an exhaustive inspection of the plant at the gasworks, which is a subject still under consideration.

Manchester.—The Electricity Committee of the City Council have appointed a special committee, with the Lord Mayor as chairman, to enquire into certain statements which have been made to the effect that a member of the Electricity Committee has used the services of certain officials of the department in connection with his own private business.

Fire.—A serious fire occurred at Leicester on Wednesday morning on the premises of Messrs. Gent and Co., electrical engineers. The outbreak occurred in the insulated wire department of the works, which extend over an acre of ground, and was not subdued until the whole building had been destroyed. The damage is estimated at about £15,000.

Coatbridge.—The Lighting Committee are considering a letter from Mr. M'Indoe, local manager of the electricity company, in connection with the electric lighting of Coathill Hospital, stating that the company purposed extending their mains so as to include Whifflet, and asking if the Town Council wished to co-operate with them in getting this done with a view to street-lighting.

Whitehaven.—At the last meeting of the Council a letter was read from the Local Government Board stating that it was after careful consideration of all the circumstances, including the fact that a debt was outstanding upon the mains to be superseded, that they decided to allow a term of 10 years only for the repayment of the loan of £9,000, and that they were not prepared to reconsider their decision.

St. Pancras.—We understand that a special committee is to be appointed, consisting of the Mayor and two members selected from each of the following committees—namely, Finance, Parliamentary, Works, and Electricity—who shall consider the requirements of the electricity department in relation to a site or sites in or outside the borough for the future development of the installation, and report to the Council.

London County Council.—On Tuesday it was decided to lend the St. Pancras Borough Council £6,310 for electric light installations. In reply to a question on the Highway Committee's report, it was stated that in view of Lord Londonderry's statement, that the agreement between the Post Office and the Telephone Company had gone too far to be revoked, it had been decided by the Highways Committee to take counsel's opinion as to whether that agreement was not in contravention of the Telegraphs Act.

Southwark.—The Borough Council last week passed a resolution expressing their great disappointment of the tariff laid down by the General Post Office as to the telephone service, and urging the Government to establish, as promised by their representative in Parliament, a moderate and effective competition to the National Telephone Company at reduced charges. Failing this, the motion suggested that the London system should be placed in the hands of the London County Council and conducted, as in Glasgow, as a municipal institution.

Hammersmith.—Extensions of the mains are projected in the northern part of the borough, at a total cost of £9,540. 5s. 4d. Four meters are required at the station estimated to cost £165. The tariff for electricity supplied for power purposes is to be reduced to 1½d. per unit for large consumers, provided the consumer does not use current after 6.30 p.m. In order to check the consumption after 6.30 p.m. it will be necessary to fix a time switch, for which a rental will be charged, to operate an indicator to register the amount of current demanded by the consumer between that hour and 12 p.m., and an additional charge will be made on the reading of this instrument to cover the cost of running the plant during the hours of heavy load.

London Telephones.—At the request of the London Reform Union Mr. Thomas Lough, M.P., has consented, when Parliament meets, to move the following amendment to the address with reference to the telephone agreement: "But we humbly express our regret to your Majesty that having regard to the promises made to this House during the recent Parliament by your Majesty's Government, and to the report of the committee that enquired into the question, your Majesty's Government should have entered into an agreement with the National Telephone Company with regard to the telephonic service in the Metropolis without giving either to Parliament or to the local authorities in London an opportunity of considering the terms of the said agreement."

Stock Exchange.—The Stock Exchange Committee have appointed Dec. 28 a special settling day in British Insulated Wire Company's £250,000 4½ per cent. first mortgage debenture stock; Edmundson's Electricity Corporation's further issue of 9,000 6 per cent. cumulative preference shares of £5 each (issued at 5s. premium), £3. 5s. paid (of which £3 is capital and 5s. premium), Nos. 20,001 to 29,000 and 10,000 ordinary shares of £5 each (issued at 5s. premium), £3. 5s. paid (of which £3 is capital and 5s. premium), Nos. 40,001 to 50,000, and have ordered the undermentioned securities to be quoted in the official list: British Insulated Wire Company's £250,000 4½ per cent. first mortgage debenture stock. Application has been made to the committee to appoint a special settling day in the Calcutta Electric Supply Corporation's further issue of 10,000 shares of £5 each.

The Storm.—The breakdown in telegraphic communication, as a result of the recent storm, has been extensive and serious. The head office was practically cut off from its superintendents north of Birmingham. At Birmingham there are underground wires, hence the non-disturbance of communication with it. Comment is needless. The storm would appear to have travelled by the south of Ireland, and up our south-western counties, right to the north. London and the southern counties have seen little of it. The trouble was that the snow, being damp as it fell, clung to the telegraph wires. In that way they became greatly weighted, and necessarily there were extensive breakdowns. Had the snow been dry, it would not have clung in the same manner to the wires. Every resource was used to get through, by roundabout routes, telegrams for northern places. Similarly, every expedition was used to repair the broken telegraph lines, only that was a work needing a little time. By Monday the stress was well overcome, as shown by the amount of matter which passed over the wires on account of the Chesterfield meeting.

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Oban.—Proposals have been submitted for the lighting of Dingwall by electricity, and the latest scheme is to use the tidal flow at Dingwall Canal and the water of the Peffrey for the motive power. Mr. Adam estimates the total capital outlay at approximately £4,000, and calculates that by charging 10d. per unit for lighting with a system capable of supplying 1,000 8-c.p. lamps, the community would be put in possession of a scheme which at the end of 30 years would be their own without having cost the community anything for erecting it.

Sunderland.—At the last meeting of the Lighting Committee of the Corporation an application from the Tramways Committee for a reduction from 2d. to 1½d. for current supplied to them was considered. After considering a report from Mr. Snell, the borough electrical engineer, with respect to the charges in other towns, the committee came to the conclusion that it was impossible to reduce the price of electricity, as the actual cost per unit during the past year had been 4·11d., and for next year it was estimated at 1·784d., without allowing for depreciation, etc.

Wireless Telegraphy.—Mr. Marconi claims to have transmitted the letter "S" across the Atlantic by means of wireless telegraphy. A number of interviews appear in the daily Press, but nobody appears to have taken the trouble to interview the transmitting station on this side. If so, perhaps the people there have been successful in avoiding opportunities to talk. Anyhow, the Anglo-American Cable Company have protested as licensees of the telegraphs on the island, and Mr. Marconi has folded his balloon and left, with the intention of erecting a station at Halifax, N.S.

Bath.—We have now received the opinion of the city electrical engineer, Mr. F. Teague, on the best means of bringing the Corporation's electric lighting undertaking up to date. Mr. Teague has not given a full report upon the matter, as independent expert advice is being obtained by the Council. He recommends, however, that in the centre of the town a low-tension continuous-current system of distribution be used on the three-wire system. The present high-tension, single-phase, alternate-current plant would then, after being modernised, be used to supply the outlying districts.

Hastings.—The Town Council have adopted a report by the sub-committee appointed some time ago to consider the advisability of inaugurating a municipal telephone service, and on their report, which was of a favourable character, it was decided that it was desirable that the telephones should be municipalised. It was further resolved, before going any further, to call in the assistance of an expert. The matter was then referred back to committee, for further consideration and report. The statement of the expert will be awaited with interest by those concerned in this important question.

Brierfield.—The Tramways, Electricity, and Sewage Committee have accepted an offer of the Lancashire and Yorkshire Railway Company to remove the telegraph wires necessary on account of tramway reconstruction, subject to the cost not exceeding £35. The sub-committee appointed to consider the question of lighting back courts have come to the conclusion that any argument which might be used in favour of lighting one back court could be used for the others, and therefore, for the present at all events, they did not think it advisable to go in for lighting back courts in the township.

Twickenham.—The Highways Committee have received a letter from the Edmundson's Electricity Corporation, Limited, enclosing statutory notice of intention to lay mains in various roads in the district for private lighting purposes. The letter also contained a suggestion with reference to the company submitting a scheme for the lighting of the whole or part of the public streets of the district by electricity. The surveyor is to confer with the company's engineer with reference to the matter, and to report as to the advantages and probable cost compared with the present system of street-lighting.

Hendon.—Colonel Hepper has held an enquiry into the application of the Urban District Council to borrow the sum of £36,400 to build an electric light generating station and distribute electric light in a prescribed area within the district. The scheme was opposed by the North Metropolitan Electric Power Company (represented by Mr. Atherley Jones), North Middlesex Gas Company, the Midland Railway Company, the Mill Hill School trustees, 359 ratepayers outside "compulsory area," 265 ratepayers within compulsory area, 63 tenants on Schweppes's Estate, and a number of poor inhabitants, who were each and severally represented.

Eccles Telephones.—A public meeting was held on Tuesday for the purpose of consenting or otherwise to the promotion by the Council in the next session of Parliament of a Bill authorising the Corporation, along with other local authorities in the Manchester telephone area, to form a joint telephone board, consisting of 19 representatives, 10 of whom will be elected by Manchester, 5 by Salford, 2 by Stockport, and 1 each by Eccles and Stretford. After discussion it was agreed to adjourn to Jan. 15, in order that fuller information might be given on the proposals of the Council and the probable cost of promoting the Bill.

Swindon.—At the last meeting of the Town Council it was reported that the sanction of the Local Government Board had been received to a loan of £31,000 for initial expenses in connection with the scheme of electric lighting for the town. The contracts for the erection of the generating station has already been placed, and out of a large number of applicants Mr. J. Fitter, of Tottenham, London, has been appointed clerk of works, at a salary of £3. 3s. per week. With regard to the question of the construction of the tramways, a sub-committee was appointed to report on the matter, after consultation with the engineers, Messrs. Lacey, Clirehugh, and Sillar.

Stepney.—The Electrical Committee reported to the last meeting of the Borough Council that they had received from the New Century Arc Light Company, Limited, the contractors for the arc lamps and columns to be erected in Mile End-road, a quotation for a cheaper and lighter form of lamp and column which they propose to erect in Brick-lane, Osborn-street, Vallance-road, and New-road. This work was sanctioned by the Council on Nov. 27 last. The company offer to supply and erect complete 20 lamps for the sum of £493. 10s. The committee recommended that, subject to the terms of the resolutions passed by the Council on Nov. 27 last, the estimate of the New Century Arc Light Company, Limited, be accepted. This was referred back.

Yarmouth.—The last report of the borough surveyor gives the income from the Corporation electric lighting undertaking for the quarter ended Sept. 30 as £2,301. 12s. 9½d. The sum of £1,014. 6s. 4½d. was earned beyond cost of production. Taking off interest, sinking fund, etc., there remained a net profit of £237. 6s. 4½d. for the quarter. Mr. Gordon Bryant, resident electrical engineer, has presented the following figures, showing by comparison the progress of the works: Michaelmas quarter, 1900, units generated, 102,050; sold, 79,629; lost on mains, 22,421; generating cost per unit, 3·24d.; total revenue, £1,845. 16s. 4d. Michaelmas quarter, 1901, units generated, 121,240; sold, 100,967; lost, 20,273; generating expenses, 3·04d.; total revenue, £2,301. 12s. 9d.

Town Clocks.—The new clock just erected in the north tower of the Newcastle Town Hall is to be electrically controlled by Messrs. Reid and Son, at whose works in Grey-street it has been made, and it is probably unique in being produced entirely by electrically-driven machinery of the most modern type, with which these works are equipped. Clocks electrically controlled in Newcastle are now in use by the North-Eastern Railway Company, who have had the clock over the doorway inside the Central Station electrically controlled, and now take it for their standard of time for the whole station. Other public clocks under Messrs. Reid and Son's electric control are St. John's Church clock, the *Chronicle* Office clock, and clocks in the Literary and Philosophical Society's Library, the Durham College of Science, Coal Trades Offices, and Wood Memorial Hall, Newcastle, and in the Willson Tower and St. Mary's Church Tower, Gateshead.

Smoker.—The employés of the Incandescent Electric Lamp Company, Limited, last Saturday held their annual smoker at the Brook Green Works, Hammersmith, W., under the genial presidency of Mr. C. Wilson, joint manager. The enormous hall which usually serves as a dining and recreation room to the employés had been transformed into a concert hall, well decorated with flags, and profusely illuminated with Robertson lamps. The attendance was enormous, probably 800 or 1,000, and the bars did a lively business, especially as there was no charge. The president's table was adorned with the large and handsome silver trophy recently conquered by the firm's employés at "footer" from the Ediswan Club. Robertson's are evidently as handy with their feet on the green as they are on the platform, and the excellence of a large programme of songs and dances performed on Saturday fully justified the enthusiatic applause of the audience.

Abercarn.—A poll of ratepayers of the Abercarn district is taking place this week upon the question of the public lighting of the district. The Council have obtained expert advice both as to gas and electricity, and the electrical experts engaged by the Council, Messrs. Medhurst and Lloyd, estimated the cost of laying down an electric plant for the Abercarn district at £15,172, which was exclusive of the cost of obtaining parliamentary powers to carry it into effect, while the length of mains contained in the estimate would only cover a portion of the district at present lit by gas. Taking the probable number of private consumers at 1,000, which they thought was a very high estimate, the engineers concluded it would involve an annual loss to the district of £558. 5s They, therefore, gave it as their opinion that the district was not favourable to an electric lighting scheme, and could not recommend the ratepayers to face the heavy addition to the rates which the scheme would necessarily involve.

Lecture Tour.—For the benefit of teachers, the West Riding Technical Instruction Committee are arranging for a series of four illustrated lectures on "Alternating Electric Currents," to be given on Saturday afternoons in March next at some convenient centre in the West Riding. Dr. J. A. Fleming, F.R.S., professor of electrical engineering in University College, London, will be the lecturer, and a syllabus has already been issued indicating the course of study, and giving suggestions as to previous reading. The meeting place will be determined by the majority of those who are desirous of attending, but it will be either Leeds or Bradford. Applications for exhibitions to cover free admission and the expense of attendance are to be considered, but teachers non-resident in the administrative area of the council will be charged fees varying probably from 5s. to 7s. 6d. for the course. The matters to be dealt with by the lecturer will range from the resistance, inductance, and capacity of a circuit to wireless telegraphy.

Stoke Newington.—At a meeting of the Council on Tuesday the Electric Lighting and Sites Committee reported the sealing of an agreement by the Hackney Borough Council for the supply of electricity in the form already sealed by the Council. The committee have appointed Messrs. Hopkinson and Talbot, consulting engineers, to prepare specifications, obtain tenders, and superintend the work of laying the electric cable along the Stoke Newington-road, High-street, and Stamford-hill, and for generally advising the Council and committee thereon. The committee approve of the principle of the draft Bill to empower London local authorities to combine for the purchase and conduct of electric undertakings where the area of supply extends into the district of more than one local authority, and to empower the London County Council to purchase and conduct such undertakings. A petition to the Local Government Board for a provisional order empowering the Council to purchase land otherwise than by agreement for the purpose of the erection thereon of a destructor was submitted for approval and sealing.

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Islington.—At to-night's meeting the Lighting Committee will recommend the Council to consent to the proposed application by the Stoke Newington Borough Council for power to enable Islington to supply them with electricity in bulk on condition that the provision is permissive and not compulsory so far as Islington is concerned, and that a copy of this resolution be transmitted to the Stoke Newington Borough Council, with a request that they will forward a copy of the draft provisional order containing the suggested provision. The Newington Council have thus safeguarded their interests well by having another string to the bow should Hackney fail them at any time. The Finance Committee will submit the following estimates: provision and laying of lengths of low-tension distributing mains in Penn-road-villas and Huddleston-road, £320; in Holloway-road, New North-road, and Essex-road, £592; in Shepperton-road, £330; in Caledonian-road, Upper-street, Carleton-road, and Tufnell Park-road, £492.

Walsall.—The total number of consumers supplied on Nov. 31 last was 210. During the past month the total units generated at the station was 60,440. The total output from the main generators was 58,377 units. The total units from the transformers was 45,168 (estimated). The machinery was run for 537 hours. The wages paid amount to £86. The Electric Lighting Committee have agreed with the South Staffordshire Tramways (Lessee) Company, Limited, the price to be paid by them for current for working the whole of the Bloxwich section of the tramways, including the proposed extension to Bell-lane, until the expiration of their lease for three years, and have authorised the common seal to be affixed to the necessary agreement. With a view to the works being completed by the month of May next, instructions have been given for tenders to be obtained. The question of a site for a tramway transformer station, required in connection with the supply of electric current to the Bloxwich section of the tramways, is being settled. The salary of Mr. A. Wyllie, the electrical engineer, has been increased to £400 per annum as from Nov. 1 last, with further increases of £50 per annum at the expiration of the first and second years.

Elton Fold Electrical Works.—Satisfactory progress, we understand, is being made with the equipment of the works at Elton Fold, which are about to be opened by the European Maguire Electrical Manufacturing Company, Limited, and it is anticipated that work will be commenced in earnest early in the New Year, as the firm have to commence the delivery of goods by March. The first order which will be dealt with at Bury will probably be the contract for trucks for the Great Northern Railway Company, which has been secured by this firm. The amount of the contract is £25,000, and it will take some eight months to complete. We are informed that negotiations are nearly completed for the making at Bury of the new Crawford-Voelker electric incandescent lamp for the North of England, the European Maguire Company having practically obtained the rights to make the lamp. The filament of this lamp, instead of being pure carbon, is a new compound of carbon with titanium, one of the rare earths which have been used so successfully in incandescent gas lighting, and that at one end of the globe is bifurcated. It is claimed that this latter improvement prevents a further waste of energy; also that lamps of equal and even higher efficiency can be manufactured for use on 200-volt and higher circuits.

Barnsley.—The Electricity and Lighting Committee reported to the Town Council on Tuesday that, consequent upon the decision of the Guardians not to take a supply of electricity for the workhouse from the Council, they had written to the Local Government Board, stating that they had reason to believe that the Guardians would ask the Board's sanction to a loan for the cost of an installation of electric lighting at the workhouse, and the committee were convinced that the Guardians could not possibly obtain a supply of electric energy as cheaply or as conveniently as they could from the Corporation. In conclusion, they asked the Board to refuse consent to any application by the Guardians to obtain a supply elsewhere, as it would be a wilful waste of public funds. The same committee reported that they had applied to the Postmaster-General for a license to establish municipal telephones in the borough, and, having received a reply, had adjourned the consideration of the subject. Further, the committee making provision for the supply of electricity to the proposed Barnsley and district light railways, recommended that one of the 75-kw. generators be sold, and a 150-kw. generator be substituted therefor; and that the requisite traction switchboards be installed in accordance with the agreement with the company, at a total cost of £2,000.

Tunbridge Wells.—The Town Council on Tuesday adopted a report of a committee to expend a further sum of £15,000 on the recently established municipal telephone. It was explained that no charge would be involved upon the rates by this step, which has become necessary by the rapid growth of the undertaking. The committee state in their report that the works comprised in the original estimate and the extensions which have been from time to time approved by the Council (including the additional underground cables, improved poles, and alteration of routes) are approaching completion, and the total estimated cost thereof amounts to £19,320, as against the sanctioned loan of £10,000. In the estimate upon which this loan was based 316 miles of metallic circuit (comprising 4½ miles of underground cables), 349 completed lines, and 312 partially completed lines were provided for. The success of the undertaking has necessitated the laying of no fewer than 679 miles of metallic circuit, as against 316 (comprising 9½ miles of underground cable, as against 4½), while 516 working lines are actually in operation, as against 349, and there are 385 partially completed lines, as against 312. The committee have also had applications from 200 persons desirous of being connected to the exchange, many of them in districts where their requirements cannot be met by the already partially completed lines, while at least 50 of them cannot be connected for want of underground cable, the whole of the wires in the cables which would otherwise serve them being already in use.

Sutton Coldfield.—On Saturday afternoon the electricity supply works, which have been erected at Sutton Coldfield at a cost of £26,000, were opened. The Mayor presided, and called upon Mrs. W. J. Seal (the wife of Alderman W. J. Seal, chairman of the Electric Lighting Committee of the Corporation) to open the works. Mrs. Seal, with a gold key, bearing a suitable inscription, and presented to her by Mr. W. A. H. Clarry, the borough surveyor and the designer of the works, unlocked the door leading from the offices into the machine-rooms, and declared the works open. Alderman Seal then briefly traced the history of the undertaking, and Mr. W. C. C. Hawtayne, the consulting engineer, described the works, which are situated upon the site of the old gasworks at the corner at Riland-road and Coleshill-road, and occupy an area of 1,000 square yards. In their structure there is no unnecessary ornamentation, but they are convenient and compact, and as pleasing in external appearance as the situation of the site warranted. The buildings, which are of ordinary red bricks with Bath stone heads and sills to windows, have two Tudor roses carved upon each of the stone window and door heads, and the borough arms over the main entrance. Three engines and dynamos are at present in the building, and a space is provided for a fourth set when required. The chimney stack is octagonal, and is 150ft. high. The generating plant, etc., are of the best to be obtained, and will meet the requirements of the district for some time to come. The Mayor afterwards opened an electrical exhibition at the town hall. Mr. W. C. C. Hawtayne presented a silver lamp, suitably inscribed, to the Mayoress, who, after some further speeches, amidst applause, switched on the electric light to the lamp, and also to the 12 arc lamps in the main streets of the town.

City Lighting.—A surprise was sprung upon the Court of Common Council last week, when it was announced that the negotiations with the City of London Electric Company, which had been looked upon as established upon a common fixed basis, had been suddenly broken off. Mr. Alderman Smallman, chairman of the committee, said that their sole desire was peace with the company, and to come to some understanding with them. After long negotiations they came to an understanding which he believed would have been unanimously approved by the Corporation. They met that morning to sign the report, but there was a communication from the company's solicitors which completely altered the aspect of affairs. This showed that alterations had been made which they could not agree to, and they had no other course but to recommend that negotiations with the company be broken off. Since he had been in the chamber he had received a letter from the chairman of the company stating that he was sorry that there had been misunderstandings, but he did not agree to the cancellation of all the contracts, and the shorthand notes of the conference would show that to be so. The alderman denied that this was so, and said the action of the company amounted to a distinct breach of faith. The report was carried, and the whole question was referred once more to the Streets Committee. A letter was read from the Charing Cross and Strand Electricity Supply Corporation offering to supply electricity to the Corporation's buildings at 3½d. per Board of Trade unit, and asking that they might be allowed to tender for the lighting of the streets, both main and side thoroughfares. The letter was referred to the Streets Committee for report and to all other committees concerned in the use of electricity. Since then a correspondence has been appearing in the daily Press, in which Mr. Alderman Smallman maintains the statement made at the Council meeting, while Mr. Bull, the secretary of the company, states that the basis of all negotiations between the company and the special committee of the Corporation had been that all litigation now pending between the company and the Corporation should be dropped, and each side should pay its own costs.

PHYSICAL SOCIETY.

At the ordinary meeting held Dec. 13, 1901, Prof. S. P. Thompson, president, in the chair, the following papers were read by the Secretary: **"On Circular Filaments or Circular Magnetic Shells Equivalent to Circular Coils, and on the Equivalent Radius of a Coil,"** by **Prof. T. R. Lyle.** It is shown that we can represent the magnetic action of any coil by replacing it by one or more filamentary circuits in which currents circulate bearing a simple relation to the actual current in the coil. If the axial and radial dimensions of the coil in question are the same, then the external magnetic action can be represented by that of one filamentary circuit. If the axial breadth is greater than the radial depth, we must employ two filaments of equal radii separated by an axial distance, and if the opposite condition holds, two circular filaments of different radii lying in the same plane perpendicular to the axis of figure of the coil. In the case of coils in which the axial and radial dimensions are equal, a modification of Bosscha's method is described which yields the equivalent radii directly as the result of length measurements. If the axial and radial dimensions are not equal, it is shown that the method is still applicable, provided that the ratio of the resistances of the Bosscha comparison be altered in a ratio depending on these dimensions. Apparatus for carrying out the experiment is described, and applications to some classical cases are given. It is also pointed out that the correction for finite length of magnet in Bosscha's (or the present) method of comparison is in general far from negligible. The formulæ used are based on the expansion of the potential of a coil for points on its axis, and terms up to the fourth have been included, but the effect of neglecting higher terms is not investigated.

The Secretary read a letter from **Lord Rayleigh**, in which he stated that the length of the magnet used in determining the constant of the current balance used in the determination of the electrochemical equivalent of silver was $\frac{1}{10}$in., and the error due to neglecting this was less than one part in 10,000.

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Mr. W. Watson expressed his interest in the method, because it reduced the ordinary arithmetical calculations, and drew attention to some advantages of the practical applications.

The **Chairman** said it was a useful step to reduce the action of a rectangular coil to that of two filaments. In the case of a tangent galvanometer with one coil, if the channel is so cut to take nine turns axially and 11 radially, then the equivalent radius is equal to the mean radius.

"On a New Hygrometric Method," by **Mr. E. B. H. Wade.** In this method a thermometer is wetted, not with water, but with sulphuric acid of such a strength that the temperature of the acid bulb is close to that of the dry bulb. The maximum tension of the acid at any temperature is known from Regnault's work, and two or more determinations with this instrument and with a wet and dry bulb hygrometer at the same time enable the constants of both instruments to be determined. If the difference between the acid bulb and the dry bulb is less than 2deg., the constant remains fixed over a large range. Experiments show that the readings of the instrument are not affected by ventilation, and since the difference between the temperatures of the bulbs is small, errors in the determination of the constant are unimportant.

Prof. J. D. Everett criticised the paper at length, and said he could not commend the method described.

Prof. A. S. Herschel said that tables might be constructed for use with the author's instrument similar to those used by Glaisher with the ordinary wet and dry bulb hygrometer.

Mr. W. Watson replied to some of Prof. Everett's remarks, and pointed out some of the advantages of the method described in the paper.

The society then adjourned until Jan. 24, 1902.

PROVISIONAL PATENTS, 1901.

DEC. 9.

25022. Improved armature for (small) electric generators or motors. Bertil Brander, 43, Wood End-road, Erdington, Birmingham.

25025. Improvements in rods for Nernst incandescent electric lamps. Leigh S. Powell and Nernst Electric Light, Limited, 18, Southampton-buildings, Chancery-lane, London.

25076. Improvements in insulators for high potential currents. Rudolf Gaertner, 6, Lord-street, Liverpool. (Complete specification.)

25081. An improved telephone receiver box. Max Sensenschmidt, 55, Chancery-lane, London. (Complete specification.)

25087. Improvements in electric glow lamps. Albert Jones Harding Gurney and Alfred Sidney Blundell, 77, Chancery-lane, London.

25095. Improvements in electrical fittings. Montague Churchill-Shann, 111, Hatton-garden, London.

DEC. 10.

25125. Improvements in and relating to means for electrically signalling railway trains, tramcars, and the like. Montague Butt, 27, Parkdale, Wolverhampton.

25132. Improvements in electric switches. Henry Charles Gover, 17, Approach-road, Margate.

25138. Improvements in telephone switchboard cords. Alfred Whalley, "Ashville," Helsby, near Warrington.

25143. Improvements in or connected with telephone transmitting apparatus. Max Sensenschmidt, 15, Water-street, Liverpool. (Complete specification.)

25146. Improvements in switching apparatus for electric lighting, telephones, and other purposes. Joseph Devonport Finney Andrews, 2, Park-avenue, East Sheen.

25155. Improvements in the construction of induction coils and transformers. Herbert Charles Newton and Russell Stuart Wright, 3, Fleet-street, London.

25171. Improvements relating to electric telephone systems. George Alexander Cardwell, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25174. Improvements in electric apparatus for illuminating the mouth or throat. Friedrich Wilhelm Schumacher, 65, Chancery-lane, London. (Complete specification.)

25175. Improvements in electric signalling. Jacob Baker Struble, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25182. Improvements in electric furnaces and in the production of chemicals in such furnaces. Griffith Brewer, 33, Chancery-lane, London. (Edward Randolph Taylor, United States.) (Complete specification.)

26186. Improvements in accelerometers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Fred B. Corey, United States.) (Complete specification.)

25215. Improvements in telephone receivers. Francis John Orr, 53, Chancery-lane, London.

25218. Improvements in resistance coils. George William Johnson, 47, Lincoln's-inn-fields, London. (The Electric Controller and Supply Company, United States.) (Complete specification.)

25219. Improvements in controlling devices for electric motors. George William Johnson, 47, Lincoln's-inn-fields, London. (The Electric Controller and Supply Company, United States.) (Complete specification.)

25208. Improvements relating to electric welding apparatus. Henry Bosshard, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25221. Improvements in compounding alternate-current generators and motors. Alexander Heyland, 47, Lincoln's-inn-fields, London.

25227. Improvements in fittings for electric installations in buildings. John Meehan, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 16, 1901, being date of application in United States.)

DEC. 11.

25265. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Walter C. Fish, United States.) (Complete specification.)

25266. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

25270. Improvements in electric gas lighters. Hans Baader and Emil Rau, 111, Hatton-garden, London. (Complete specification.)

25282. Improvements in apparatus for the generation and electrolytic application of electric currents. Francis Howard Elmore, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (John Oliver Surtees Elmore, India.)

25315. Improvements in incandescent electric lamp holders. Wolf Defries and Victor Isidore Feeny, 60, Queen Victoria-street, London.

25318. Improvements in electricity meters. William Edward Evans, 27, Chancery-lane, London. (The Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

DEC. 12.

25374. Improvements in electric clocks and timepieces. Robert Mann Lowne, 23, Southampton-buildings, Chancery-lane, London.

25380. New or improved method and means for attaching the carriers of electric light shades to their standards or supports. Sidney Benjamin Marshall, 165, Queen Victoria-street, London.

25384. An electric hand lamp to give out violet and ultra violet light. Leslie Bradley Miller, 93, Hatton-garden, London.

25387. Improvements in electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Philip Farnsworth, United States.) Complete specification.)

25388. Improvements in electric fuses. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry Geisenhoner, United States.) (Complete specification.)

25389. Improvements in electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frederic W. Hild and Samuel B. Stewart, jun., United States.) (Complete specification.)

25390. Improvements in electric rheostats. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frederick Mackintosh, United States.) (Complete specification.)

25391. Improvements in braking systems for electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

25396. Improvements in machinery or apparatus for perforating telegraphic tape for use in the automatic transmission of telegraphic messages. Frederick George Creed, 46, Lincoln's-inn-fields, London.

25403. Improved electric energy meter. William Phillips Thompson, 322, High Holborn, London. (Louis Decombe, France.)

25426. Improvements in and relating to the controlling of electric circuits. Sebastian Ziani de Ferranti, 18, Southampton-buildings, Chancery-lane, London.

25427. Supports for trolley and track wires for suspended cable roads. Henry McLellan Harding, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25433. Speed-regulating devices for overhead electric carriers. Henry McLellan Harding, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25434. Improved means for suspending electric lights. Walter Jonathan Chesterton, 128, Colmore-row, Birmingham.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Jan. 4.

1900.

16225. Measuring electrical energy and apparatus therefor. Kennedy.

22824. System of distribution for independent polycyclic electric currents. Arnold, Bragstad, and La Cour.

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22515. Automatic tolling contact for electric bells. Mudie.

22848. Arc lamps. Andrews.

22902. Electrolytic method and apparatus. Edser and Wilderman.

23103. Means for signalling between the drivers on electrically-propelled vehicles or trains. British Thomson-Houston Company, Limited. (Potter.)

23234. Electrical apparatus for operating signal and other levers. Alioth, Bernheim, and Sartiaux.

23393. Preventing fluctuations in rotary motors. British Thomson-Houston Company, Limited. (Wood.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Dec. 14	579	599	– 19	21,817	19,911
Birmingham Tramways	—	—	—	—	—	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 13	450	432	+ 18	25,093	22,293*b*
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 14	135	147	– 12	20,649	19,999*b*
Bolton Corporation	,, 15	1,306	1,267	+ 39	72,202	59,831*b*
Bradford Corporation	,, 15	921	756	+ 165	45,661	24,049
Bristol Tramways Company	,, 13	3,717	3,579	+ 138	—	—
Carlisle Tramways Company	,, 14	116	121	– 5	4,238*b*	4,223
Central London Railway	,, 14	6,858	6,006	+ 852	148,110	—
City and South London Railway	—	—	—	—	—	—
Cork E. T. and L. Company	,, 12	368	372	– 4	23,853	20,368*b*
Darwen Corporation	,, 13	179	175	+ 4	9,415	7,789
Dover Corporation	,, 16	167	163	+ 4	10,795	10,250*b*
Dublin & Lucan Electric Railway	,, 15	70	70	—	2,749	2,373
Dublin U. T., electric cars	,, 13	3,285	3,355	– 60	—	—
Dublin S. District, Electric	,, 13	690	794	– 104	—	—
Dundee Tramways Company	,, 11	637	481	+ 156	—	—
Glasgow Corporation	,, 14	10,189	9,083	+ 1,106	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 14	1,568	1,552	+ 16	41,342	34,265
Liverpool Corporation	,, 7	8,817	8,050	+ 767	440,032	387,653*b*
Liverpool Overhead Railway	,, 15	1,336	1,527	– 191	37,739	39,658
Portsmouth Corporation	,, 14	816	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 15	3,129	—	—	—	—
Southampton Corporation	,, 12	725	644	+ 81	—	—

* Fortnightly. *b* From Jan. 1.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £312 decrease.
Barcelona Ensanche y Gracia, £54 decrease. Barcelona, £170 increase.
Brisbane, £302 increase (month of Nov., £1,286 increase).
Buenos Ayres and Belgrano Electric, £45C increase.
Calcutta, £20 decrease.
Cape Town (month of Oct.), receipts, £14,063; expenditure, £6,817.
La Capital Traction and Electric, Buenos Ayres (month of Oct.), £1,350 increase.
Mexico Electric (month of Nov.), receipts, £17,300; expenditure, £10,500.
Perth Electric, £100 increase.
Port Elizabeth (month of Oct.), receipts, £3,240; expenditure, £1,960.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅝-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-⅜
—— Ordinary, 1-125,000	1 ..	⅜-½
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-5¾
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5-5½
Brush Electrical Engineering, Ordinary	2 ..	1⅝-1¾
—— Nos. 90,001-105,731	2 ..	1⅝-1⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	112-116
—— Ordinary	5 ..	15¼-16¼
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	⅛-¼
—— 5 per cent. Debentures	5 ..	1¼-2¼
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16¼-17¼
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	23-24
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref.	5 ..	5½-6¼
Willans and Robinson, Ordinary, 1-30,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6-6½
—— **4½ per cent. First Mortgage Debenture Stock, Red.**	100 ..	103-105

Name.	Amount paid.	Last price
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-102
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10¼
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	8¼-9
—— 7 per cent. Preference	5 ..	8¼-8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7¼-8¼
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10½ xd
Charing Cross and Strand	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105 xd
Chelsea Electricity Supply	5 ..	5¾-6¼
—— 40,501-50,936	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¼-6
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ltd., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4¾
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1¾
—— 6 per cent. Pref.	5 ..	3¼-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	94-98 xd
Metropolitan, Ordinary	10 ..	13¼-14¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	113-116
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7¼-8
—— £4½ Shares, New	4½ ..	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15¼-16¼
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	11¼-12¼
Electric Railways.—		
Central London, Ordinary	100 ..	106-109
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	107-110
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-119
City and South London, Consolidated Ordinary	100 ..	64-66
—— Ordinary	10 ..	6-6¼
—— 4 per cent. Debenture Stock	100 ..	113-117
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, '96	100 ..	125-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	3⅛-3⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-128
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¼-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¼-6¾
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	8¾-9¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14¼ xd
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅞-2
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
—— Prov. Cert., all paid	100 ..	100-103
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅝-2⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22¼
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	104-106
New General Traction, Ordinary	5 ..	2¼-3¼
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	98-102
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8s. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Telephones.—		
National Telephone, Ordinary	5 ..	3⅛-3⅜
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅛-4⅜
—— 4 per cent. Deb. Stock, Red.	100 ..	95-98
—— 3½ per cent. Deb. Stock, Red.	100 ..	100-103
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

Sheet-Iron Panels for Tramcars.—For dry climates it has been proved that wood panels for tramcars are of no practical use, as the very dry weather at certain seasons makes the cracking of the wood almost a certainty. To get rid of this difficulty, the practice in many of the western cities of America now is to use sheet-iron panels for the cars. This plan has proved very successful, the latest firm to adopt it being the company which owns the tramways at San Antonio in Texas.

Subterranean Revolving Platform.—A Paris message mentions a scheme, brought forward by a Mr. Cassalonga, for relieving the congested state of the street traffic in various parts of Paris. The plan is to construct a subterranean moving platform, similar to the travelling footway shown at the last Paris Exhibition. It is said that the proposed revolving footway, which would, of course, be worked by electricity, would be divided into four sections, the fastest travelling at the rate of 13 miles an hour.

Municipal Telephones.—Under this heading last week we shortly referred to the municipal telephone scheme which is to be carried out by the Corporation of Grantham. In a brief mention of its chief features we neglected to mention the name of Major-General Webber in connection with the scheme. This gentleman, as our readers are doubtless aware, has had much to do with promoting cheap rural telephony in this country, and he was practically the originator and sole instigator of the telephone movement at Grantham.

Crystal Palace Engineering School.—The "Wilson" premium for the best paper read before the Crystal Palace Engineering Society during the present session, has been awarded by the council to Mr. S. J. N. Carrington for his paper on "The Widening of the Brighton Line between Balham and Croydon." The premium was presented to Mr. Carrington by Colonel Raban, R.E., Director of Works to the Admiralty, on the occasion of the eighty-seventh distribution of certificates at the above school last Friday.

Unique Presentation to the Institution.—In the absence of Mr. Langdon at the meeting of the Institution on Thursday, Major Cardew announced from the chair that Major-General Webber had presented the society with a striking portrait of her late Majesty Queen Victoria. The picture is from a photograph by a Windsor photographer, and the late Queen had 50 copies especially made for her own private use. No others have been made since 1899, but just recently King Edward gave General Webber permission to have one of the portraits for presentation to this Institution. The announcement was received with warm applause, and the donor was extended a hearty vote of thanks for his unique gift.

Bursting Cast-Iron Flywheels.—Prof. C. H. Benjamin gave an interesting account of bursting small cast-iron flywheels at the annual meeting of the American Society of Mechanical Engineers, held in New York this month. Tests were made on 16 wheels, each 24in. in diameter, the weights varying from 60lb. to 123lb. The author's conclusions are that for wheels of moderate size correctly proportioned a solid rim is by far the safest form, and will require a speed of 350ft. to 400ft. per second to produce rupture. Jointing the arms at the rim and bracing the rim by internal webs have no important effect on strength. Joints in the rims are the principal source of weakness, especially if located between the arms. Hollow rims will permit of a much more efficient joint. The best results were obtained from the type of flywheel devised by Prof. Archibald Sharp, of this country, which consists of a cast-iron rim, with spokes of steel wire secured tangentially to the hub. By tightening up the nuts at the rim securing the ends of the wire spokes, the hub is accurately centred.

Electrical Engineers for the Front.—A detachment of the Electrical Engineers (R.E.) Volunteers, some 50 strong, left London on Friday morning for service in South Africa. This is the fourth contingent of Electrical Engineers which has gone to the front, which testifies to the high appreciation of the authorities for the valuable services already rendered by these skilled electricians in the field. The company, which is under the command of Captain Brady, R.E., were accompanied on the march from the drill hall in Regency-street to Waterloo Station, whence they took train for Southampton, by a large number of friends. At the station many more were waiting to give the detachment a hearty send-off, and among these latter were Captain Phillips, Captain Leaf, and Lieutenant Stubbs, of the Electrical Engineers Volunteers. The men were dressed in khaki, but all wore greatcoats to protect them from the keen frosty air. The train steamed out of Waterloo Station for Southampton Docks punctually at half-past nine, amid ringing cheers and "God-speeds." We understand that about the middle of January Lieutenant Stubbs will go out with a fifth company (now forming) for work at the front. So ready are the men to see active service in South Africa that some 300 applications have been lodged at headquarters for enrolment in any further detachment which it may be determined to form.

Tramway Accident Claims.—Some interesting figures are given in a recent issue of the *Street Railway Journal* on the great increase which is taking place in the States in the successful claims made against electric tramway companies for personal injuries. The high speeds adopted on the lines in question really bring them more in keeping with electric railways, except that in many places the public streets are used for the tracks. The figures given show that during the year 1901 no less than £231,519 had to be paid by the Brooklyn Rapid Transit Company on account of personal injury claims. The sum represents almost 10 per cent. on the gross receipts of the company. In 1895 the percentage for the same lines was only 4·5 per cent., and in 1891 1·83 per cent. The editor of our contemporary states that this company's lines are not mentioned because the figures are to any extent unusual, but to indicate the tendency of the Courts, certainly in the New York State, to hold the street railway companies accountable for all damage done in consequence of the higher speeds which our modern electric cars have to be worked at. Our contemporary seems to argue that because the public have got the benefit of the more rapid means of transport, they should not hold the companies responsible for persona damages done. While it is quite right to urge that the public should take more care in consequence of the higher speeds, we do not think that a company should in any case be relieved from damage arising from accident. What should be stopped, however, is the awarding of excessive amounts, and particularly the awarding of any damages whatever where the person injured trades on the accident. This kind of fraudulent claim has reached quite a fine art in the States.

New Constitution of the American Institute.—At the next annual convention of the American Institute of Electrical Engineers the provisions of the new constitution will come into force. One of these is to the

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effect that in each State of the United States in which there are 50 or more members or associates an organisation may be formed, which shall have the privilege of being represented at the annual convention by one delegate to each 50 members. Upon the nomination of a delegate, the constitution directs that the appointment shall then be made by the Board of directors. The delegate thus appointed may cast as many votes as he shall hold proxies from his constituents upon any question brought before the convention. An American contemporary points out that in several localities outside of New York City there are already more than the necessary 50 members, and in quite a number of others the shortage is so small that the list could easily be expanded to the required quota of 50. While the choice of a delegate will confer no small honour on the recipient, the names thus brought forward will materially assist the Board in determining upon nominations for vice-president, which nominations by the new constitution are required to be made with a view to maintaining a geographical distribution of the incumbents of that office.

Long-Distance Telephone Working. — In the issue of the *Electrical World* for the 7th inst., the editor puts forward an interesting scheme for relieving the long-distance telephone lines in the States of a large part of the heavy traffic with which they are burdened in the busy hours of the day. Putting it shortly, his plan seems to be to use the lines for about four hours each night for telegraphing messages, which would be delivered at their various destinations by telephone on the opening of the offices in the morning. Assuming the use of an automatic printing instrument at a working speed of 100 words a minute or thereabouts, he points out that in the case of a single line between Chicago and New York, about 500 10-word messages per hour in each direction would be within the range of capacity of the system if such messages were directed to the respective telephone numbers of the recipients. The message slips could be filed away and telephoned to the proper addresses on the opening of business hours, the slips being sent on by post as an additional check as fast as telephoned. The whole operation would only take a few hours, and the result would be a very convenient and cheap method of sending night messages quickly, and a considerable increase in the earning capacity of every long telephone line. As opening up a new source of revenue, the editor regards the scheme as offering a capital opportunity, besides doing the public a favour which would still further increase the popularity of the telephone. Such an arrangement in this country would, of course, not be practicable, as we have no long-distance telephone lines the limits of which could not be reached almost as quickly by post, but in the States, where the conditions are vastly different, we see no reason why the scheme should not work well.

Electrical Extraction of Sugar.—Some months ago Dr. Graf Botho Schwerin, of Munich, introduced a method and apparatus for extracting moisture from comminuted materials of the most varied character, such as wood pulp, peat, fruits, clay sludge, and beetroots. The method consisted in utilising these materials as a diaphragm between perforated electrodes, the water being discharged through the cathode, and the device comprised a perforated cylindrical cathode, an interior concentric anode, and an intermediate helical blade to advance the material and break up surface crusts. The latest development in this line is covered by a patent recently issued to the same inventor, which deals with the problem of the extraction of sugar from comminuted beets or cane. The process is described in the latest issue of the *Electrical World* of New York. The materials are packed between a copper wire-cloth cathode and a filter-cloth diaphragm mounted on opposite sides of a box frame. The anode of zinc, aluminium, or other metal capable of forming insoluble salts with the acids of the crude sugar solution, is placed in water in a compartment exterior to the diaphragm, and into this compartment water is led from the tap to replace that evacuated from the cathode. In operation the current performs a double function: the dissociable salts are electrolysed, the anions uniting with the zinc or aluminium electrode and being thereby precipitated, while the alkaline bases, together with the non-electrolytes — sugars and soluble albumens—pass out with the water through the cathode to the trough. Although the motorial effect of the current is certainly an expensive substitute for simple pressure as a means for forcing the solvent through the mass to be extracted, the coincident purification by electrolysis may render the method industrially practicable. Data regarding the energy consumption are, however, not at present forthcoming.

Telegraphic Delays.—The immense value of the underground telegraph between London and Birmingham was strikingly emphasised last week, when the very severe weather made such havoc and destruction among the wires which ordinarily provide efficient telegraphic communication with the midland and northern counties, Scotland, and Ireland. Practically, every overhead wire was "down," and but for the existence of this single underground line above mentioned, telegraphic communication between London and Birmingham would also have been entirely cut off—at least, for a time. The same fate overtook the telephones working through to Manchester, Liverpool, Leeds, and other northern towns, and great inconvenience and delay resulted. In his reply to the petition of the London Chamber of Commerce, which appeared in our correspondence columns last week, the Postmaster-General holds out no hope that the present aerial system of telegraphs and telephones will be replaced by underground wires. One reason which he gives for this conclusion is that underground lines are not fitted to afford efficient telephonic communications between distant towns. The efficient working of the trunk telephones can only be assured by a large use of overground wires, and there are several methods of telegraphy which it would be impossible to work if only underground wires were available, but Lord Londonderry feels as strongly as the Chamber of Commerce that efforts ought to be made to provide underground wires for telegraphic purposes by way of supplement to the aerial lines, and to prevent a total interruption of communication between the principal towns. In the present condition of the national finances, however, the Postmaster-General concludes it will be impossible for the Department to undertake the large capital expenditure which would be necessary to change the present state of affairs.

The Proposed Electro-Therapeutical Society.—As we announced in our last issue, it is proposed to form a society for those practising electro-therapeutics, and in connection with this three letters have appeared in the correspondence columns of the current number of the *Lancet* which support the view that such a society is much needed. One of the writers draws attention to the fact that there is grave prejudice existing in the mass of the medical profession against what may be called electrical treatment, and he thinks that such a society as that suggested, if well supported, would do much to rescue electro-therapeutics from the lay "medical electrician" and the vendor of the so-called "electric belts." Another writer, while not disagreeing with the movement, points out that the council of

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the Röntgen Society have decided to enlarge the scope of the society so as to include the investigation of other radiations than those immediately connected with its name, and the question of a possible modification in the name of the society is also under consideration. It is felt, he says, that the new therapeutic agents, such as high-frequency electric currents, Faisen light, etc., call for so much further investigation that it would not be wise to exclude the valuable help of physicists who have leisure to undertake such enquiries, few medical men having the time at their disposal for original research. This plan, he adds, has worked well in the Röntgen Society in the matter of the X-rays, and, as a result, the medical profession has now in its hands better apparatus and fuller knowledge than would have been possible had there not been the co-operation referred to above. The third letter which appears in our contemporary expresses the wish that the scheme will bear fruit. "An electro-therapeutical society," it says, "is really wanted." The editor of the *Lancet*, who adds a few words to the correspondence on the subject, is also in favour of the movement. He considers that, having regard to the numerous additions to the ranks of those interested in electricity lately, it may reasonably be supposed that there are now enough to keep a special society alive.

Conversion of Steam Lines in America.—We understand from the *Street Railway Journal* that the entire system of the Milford, Holliston, and Framingham Street Railway Company is expected to be opened and running by electricity in a few weeks' time. The total length of the system, including the extensions which have been carried out during the past year, is close on 50 miles of single track. About 20 miles of this is an old steam road, and the reconstruction of this part of the system for electric traction is particularly interesting in view of the fact that it had to be carried out without interrupting the steam traffic. Thus, the poles for carrying the overhead wires were erected before the bracket arms were attached. This left a pole line on which the wires could be rapidly strung. For this purpose a train of four cars and an engine was used to string four wires at a time, and on one Sunday 24 miles of wire were put in position without interference at all with the regular steam traffic. After the four wires, which consisted of the conductors of the three-phase circuit and a large aluminium feeder, had been put on the poles, the brackets were attached. In order to furnish the workmen with a strong support while placing the bracket in position, a novel form of platform was designed so as not to be in the way of passing trains. These platforms consisted of a plank about 6ft. long and 1ft. wide, provided with wrought-iron braces or frames, and cut at one end to fit around the pole. When lifted to position at the top of the pole by means of ropes, a firm support was given the workmen. Guy ropes from the end of the platforms were attached to the track to increase the rigidity of the platform. Upon a train passing it was only necessary to remove these guy ropes and leave the track entirely free. One of the branch lines, which runs to North Grafton, is intended to be operated by a high-tension transmission line between the Milford power station and the Grafton sub-station. The transmission line consists of No. 4 B. & S. aluminium wire, and the transmission is made by a three-phase 10,000-volt circuit. Besides the high-tension aluminium feeders, there is a 360,000 circular mil aluminium feeder for direct-current distribution. This aluminium feeder is equivalent to a No. 0000 copper feeder, and with the aid of the Grafton sub-station it will be amply sufficient to supply the trolley wire of this branch with the required current.

Standardisation of Engines. — The American Society of Mechanical Engineers appointed a committee some time ago to consider the standardisation of steam-engines required to drive dynamos, and to a certain extent of the dynamos themselves. The results of this committee have recently been reported to the society and adopted. The report only deals so far with direct-current generators up to 200 kw. capacity. The sizes commence with 25 kw. output, and go up to 35, 50, 75, 100, and then 200 kw. The speeds standardised for these outputs seem to us to be low in view of the excellent high-speed engines which can be obtained on this side. Thus, the 25-kw. set is standardised to run at 310 revolutions, and even the 200-kw. only runs at 200 revolutions, which is considerably below what is often the case in this country. The other points standardised are the diameter of the armature core, the diameter of the engine shaft, and the length allowed on the same shaft to receive the dynamo. This has been found rather difficult to do, owing to there being what the committee call long and short dynamos in use. They have accordingly two standard lengths for each output, the difference between them being, as a rule, 6in. It is pointed out that this extra length can be easily allowed as an extension piece on the bed-plate pattern. The height of the axle above the bed-plate is fixed, and finally a good deal of information is given as to the keyways to be adopted under the shaft, and the diameter and number of holding-down bolts. We admire the pluck of the society and of the committee in fixing these dimensions, and we shall still more admire the engine and dynamo manufacturers in the States if they will work to them. Advantage will accrue to all parties concerned from so doing. Unfortunately this advantage is not immediate, as in many cases it will entail the scrapping of existing types. One point in the report which deserves special attention is that dealing with the overload capacity of the engines and generators. In future, standard electric light engines in America are not to be required to give more than 25 per cent. over their rated capacity. This is an important point which has to be borne in mind when purchasing plant, as such a machine is obviously not worth so much as one which will give 50 per cent. or even 100 per cent. overload.

An Automatic Telephone Exchange.—We see from the *Electrical World* of New York that a new automatic telephone exchange has recently been opened in the city of Fall River. This is worked with the Strowger instruments, as is the exchange at New Bedford, which was opened in November of last year. In this new exchange, which is put up to compete with the Bell system, all the main wires have been laid underground in liquefied clay conduits. These are laid throughout the city, but the final distribution from the underground wires is done from distributing poles, as is the case in one or two of the country towns in England. The switchboards, which are on the first floor of the building, are designed to receive instruments for 2,700 subscribers. The space which will then be occupied is 35ft. by 41ft. All the electrical energy required to work the automatic instruments is supplied from a storage battery in the basement of the exchange buildings. This battery consists of 50 cells of 80 ampere-hour capacity, and 50 cells of 20 ampere-hour capacity. These are all charged from the public mains. It is claimed in the article before us that the whole of the 615 subscribers already obtained at Fall River are so automatically arranged that only one attendant is required, and this naturally results in a low maintenance charge. In fact, it is stated that 1,000 more subscribers can be connected before any more attendants are necessary to look after the automatic switch

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gear. The subscription rate is fixed at £7. 4s. per annum for a business house or £5. 16s. per annum for a residence, which is more than 60 per cent. below the rates charged by the local Bell Company. The other claim made for this automatic system is that it gives absolute secrecy, which is said to be greatly appreciated by the large manufacturing corporations of the district, who, being all cotton or cloth brokers, or mill supply houses, wish to keep their business to themselves. Some figures are given as to the energy required to work this exchange for the month ended Nov. 27 last. From these we gather that 76·2 kilowatt-hours were required for the storage battery which works the magnets for the automatic instruments, while the motor-generator that rings the bells absorbed 54·2 kilowatt-hours. The whole cost for electrical energy, which was charged at 5d. per Board of Trade unit, comes out at under 1d. per subscriber per month. All the subscribers connected to this exchange have unlimited service.

Private versus Municipal Enterprise.—Mr. R. Percy Sellon delivered an address on "Electrical Progress and Legislation" before the Electrical Trade Section of the London Chamber of Commerce on the 18th inst. Lord Avebury, who presided, opened the proceedings with a few remarks on the importance of the subject, in which he referred to the municipalisation of the London tramways by the London County Council. He pointed out that the southern system, which was worked by the Council, had only yielded a profit of £14,300 during the past year, as against £37,700 in the case of the northern tramways, which were leased to a company. *Primâ facie*, therefore, it seemed as if the ratepayers would benefit to the extent of over £20,000 a year if the County Council were to lease the southern lines instead of working them themselves. He believed that, as a rule, there was a loss upon municipal operations. Mr. Percy Sellon followed with his address, in the course of which he remarked that the Legislature had applied to electrical science those principles of common ownership or collectivism which during the last half of the past century had gradually established an increasing hold on men's minds in this country. It was a pertinent question, he thought, to ask why in the United States there were some 15,000 miles of electric tramways, while there were not 500 miles in Great Britain. No one acquainted with the facts would deny that that was traceable to the Tramways Act, 1870. Less than 50 miles of electric traction were carried out in Great Britain until the passing of the Light Railways Act, 1896, although during that interval 10,000 miles had been introduced in the United States. The practical development of the electrical industry in Great Britain was in arrear of other leading industrial countries. This was mainly traceable to the policy adopted by the Legislature of favouring State and municipal enterprise to the exclusion of private enterprise, which policy had hitherto had the effect of discouraging capital, of checking invention, and of dwarfing manufacture. A new era, however, of cheap electricity supply for industrial purposes, and increased facilities for suburban and inter-urban communication by means of electric traction, was upon them, offering a promising solution of the problems of congestion in towns and of the housing of the working classes. In his opinion, existing legislation was restrictive of that development so far as it was applicable, and inapplicable where it was not restrictive. Amended legislation was, therefore, desirable, and should clearly define what was to be the future relation of municipal enterprise towards the electrical industry. He suggested that it was desirable that a standing committee or other body representative of the electrical industry should be created, with whom Government and State departments should confer when framing or amending legislation or regulations affecting the industry. Replying to some remarks on his address, Mr. Sellon said it was quite right that the invention of the telephone should have been developed in the first instance by private enterprise, and he thought that the National Telephone Company were entitled to look for fair and adequate consideration at the hands of the Post Office.

Water Power in South Africa.—The utilisation of water for power generating purposes in South Africa was very ably dealt with in a lecture recently delivered in Cape Town by Prof. G. T. Morrison, professor of physics at the Victoria College, Stellenbosch. In the Orange River Falls South Africa possesses the source of far more than sufficient convertible energy for working the Cape Government Railways, and although these are not the only falls capable of being so converted, the lecturer selected them as being the most suitable for the purposes, in spite of their rather inconvenient situation. The Orange River Falls are 400 miles away from Cape Town and Port Elizabeth respectively, and 500 from East London, and the question first discussed by the professor was whether from a financial point of view it was practicable to transmit electrical power over such long distances. He ventured the opinion that it was, notwithstanding the fact that were the scheme entered upon it would entail the longest transmission of power yet attempted, and he quoted figures in support of his contention that such a scheme would be financially profitable. Taking the returns of the year 1897 as a basis, he found that the Cape Government Railways used something like 10,000 h.p. That would mean 50 engines in constant use, but the probability was that 100 were used. These would be of 200 h.p. each. The cost of fuel in 1897, without wages or anything else, was £299,000, representing a cost of £30 per horse-power. In transmitting power 400 miles, the capital cost would be distributed as follows: works at the falls (which are 200ft. high, and capable of producing 30 times the power required) would cost, at an outside estimate, £180,000; 400 miles of copper wire to carry the power at 40,000 volts would represent 5,000 tons of copper, costing £400,000; the erection of the transmission line would cost another £180,000. But the power could not be used at the high pressure existing where it would be received. It would have to be distributed in motors of 200 h.p. each. The cost of copper for this would be £600,000, making the total cost £1,360,000. Nothing depreciated so little as hydraulic machinery, and only 4 per cent. per annum need be written off for this (a very high rate), amounting to £54,400, which with 5 per cent. interest on £68,000 made a total annual expenditure of £122,400. Comment on the comparison between this and the present cost was needless. The change from steam to electrical power could be effected with ease. Steam and electric locomotives could run on the same line, and as the former fell out of use they could be replaced by the latter. But, of course, continued the professor, he would never think of recommending the adoption of such a scheme without experiment. He pointed out that certain portions of the Government lines in South Africa would not require to get their power from the Orange River Falls, as in many cases there were sources of power in the neighbourhood. In concluding, he thought it would be a very serious matter if the Government allowed the right to this water power to pass into the hands of large capitalists without proper taxation or return. He did not want to rail against capitalists in any way; their co-operation was necessary, but certain safeguards ought to be adopted.

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A PERMEAMETER FOR TESTING THE MAGNETIC QUALITIES OF MATERIALS IN BULK.

The following is an abstract of the paper read by Mr. Charles V. Drysdale, D.Sc., before the Institution of Electrical Engineers at the end of last month. In the introduction the author explains the great need of some simple

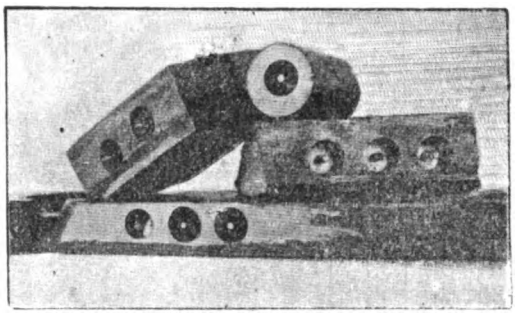

FIG. 1.—Samples of Iron with the Permeameter Holes Drilled in them.

apparatus which will allow of the testing of the magnetic properties of iron in bulk. This is needed so that castings or forgings for dynamo construction can be tested directly they are received and before any labour is expended on the same. The following are the requirements which the author kept before him in the design of his permeameter, and which he considers he has satisfied : (*a*) it should be

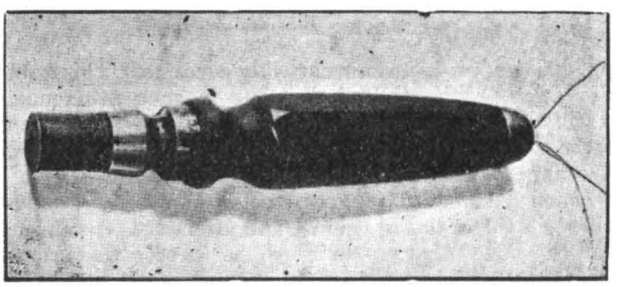

FIG. 2.—The Drysdale Plug with Test Coils.

capable of testing specimens, either in the form of large or small castings or forgings, or in the form of rods or plates; (*b*) the test should be rapidly effected ; (*c*) the apparatus should be self-contained and portable ; (*d*) the instruments should be direct reading, and the test should not require experimental skill ; (*e*) it should be capable of testing either the permeability, the retentivity, or the complete hysteresis cycle ; (*f*) it should be simple and strongly made, and should be capable of being easily checked or recalibrated if deranged—it should *not* depend on previously standardised specimens.

After a brief review of the relative advantages of the various methods of testing the magnetic properties of iron, the author pronounced in favour of the yoke method which he has adopted. He uses a drill of a special form, which cuts a circular hole in the specimen, conical at the top, leaving a pin in the centre of it, as shown in Fig. 1. In the instrument as usually made this hole is $\frac{3}{8}$in. diameter and $\frac{5}{8}$in. deep, and the diameter of the pin is $\frac{1}{10}$in., but the author says that these dimensions could be considerably reduced if necessary. The testing arrangement consists simply of a soft-iron plug, carrying a bobbin on which are wound two circuits, a magnetising coil and a search coil, and it is represented in Fig. 2. The plug is split, and is turned slightly conical on its outside surface, while the drill cuts the cone of the same angle as that of the plug. It will thus be seen (Fig. 3) that on drilling the hole and inserting the plug a perfect miniature permeameter is produced, having an exceedingly good magnetic circuit, and in which either the permeability, retentivity, or hysteresis

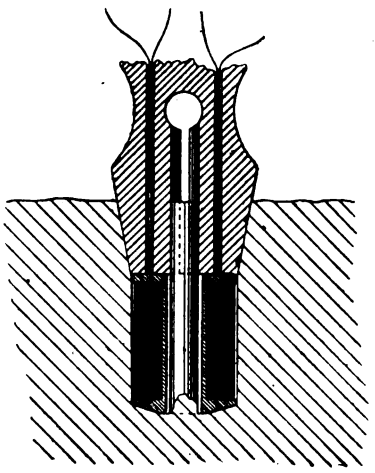

FIG. 3.—Section through the Plug and Hole, showing the Pin to be tested.

can be determined by ordinary methods. The hole required is $\frac{5}{8}$in. deep, and $\frac{3}{8}$in. diameter could be drilled in all ordinary castings or forgings without objection arising. With the drill made by the author it took from 10 to 20 minutes to drill the hole, according to the material to be examined. The next part of the paper deals with the various methods by which the test can be made when the hole has been drilled and the plug inserted. The author prefers the ballistic method, and has arranged a suitable portable set of apparatus for workshop use. This is illustrated in Fig. 4. It will be noticed that he graduated the two galvanometers to read directly in values of B and H respectively. A simple set of apparatus to give only the permeability and retentivity can also be obtained. With the apparatus as designed for workshop use, the author has obtained the following results : Fig. 5 shows total and residual magnetisation curves for three specimens of mild steel, wrought iron, and cast iron, while Figs. 6, 7, and 8 represent the corresponding B-H cycles obtained in this way. The paper contains tables giving the readings actually obtained, while Fig. 1 shows the specimens which were employed.

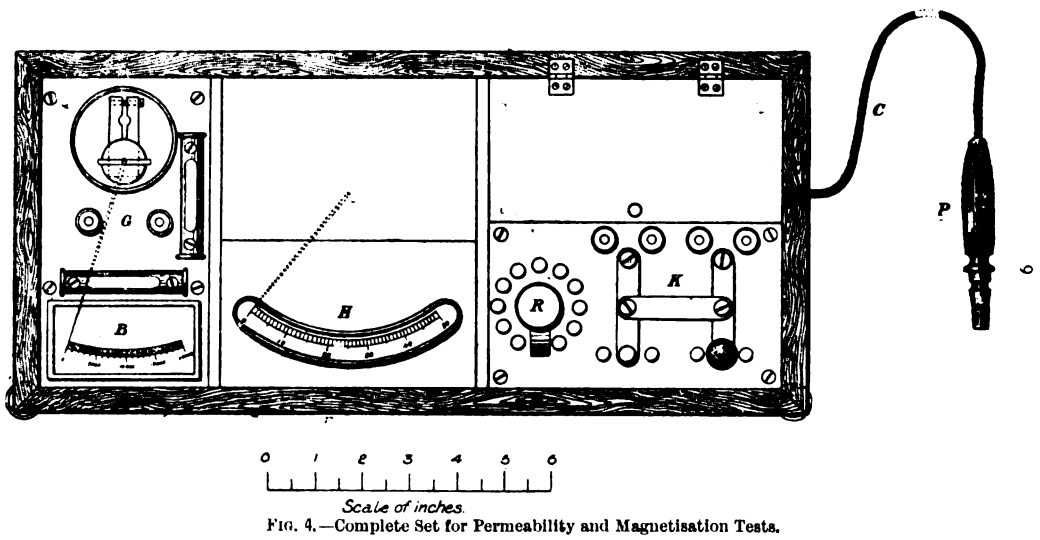

FIG. 4.—Complete Set for Permeability and Magnetisation Tests.

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As regards the details of construction and the calibration of the apparatus, Mr. Drysdale points out that the drills are made with a certain amount of relief to the

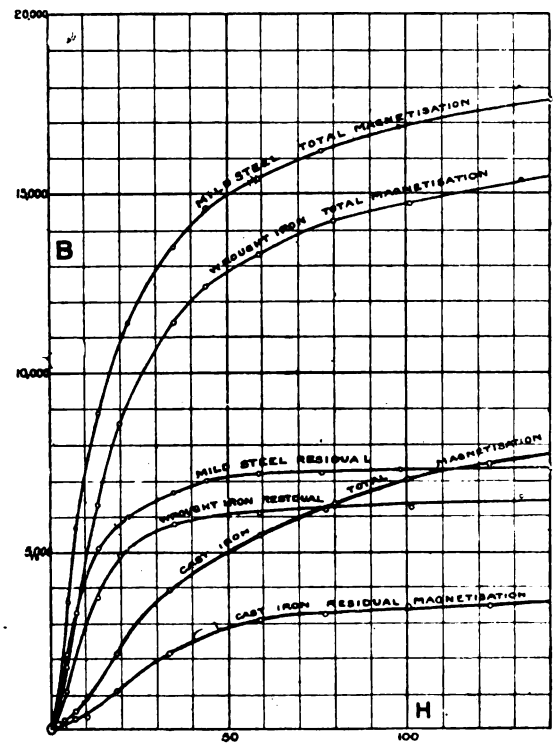

FIG. 5.—Curves of Total and Residual Magnetisation.

cutting edge. The plug demands a little more attention. To make the magnetic joints as perfect as possible the plug is very carefully turned to have the same angle as the drill, and the central hole the same diameter as that

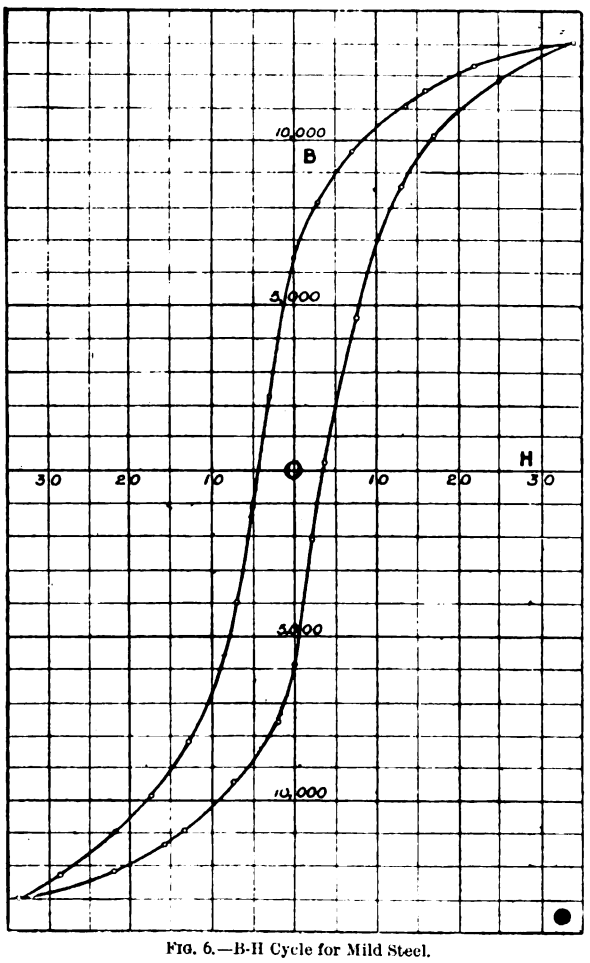

FIG. 6.—B-H Cycle for Mild Steel.

of the pin. In order, however, to ensure perfect contact, the plug is split longitudinally, as will be seen on looking back at Fig. 3, so that on pushing it into place it grips tightly on the pin. Great care is taken to have the bottom edge of the aperture in the plug quite sharp, so as to give certainty in the length of the pin used. The magnetising and search coils are wound on an insulated brass bobbin

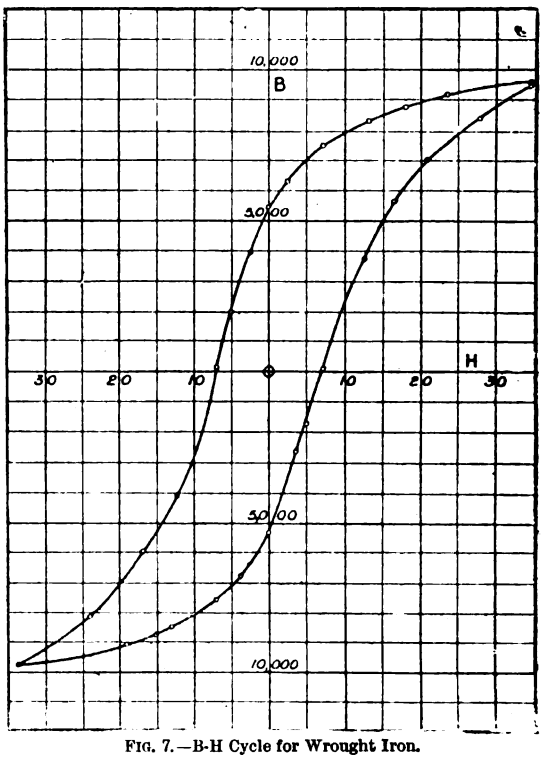

FIG. 7.—B-H Cycle for Wrought Iron.

split longitudinally to prevent eddy currents. This bobbin is screwed to the end of the plug in such a manner as to still allow of the yielding due to the slit, and the ends of the coils are brought up through the plug as shown. In order to arrange for a perfectly definite length of specimen a standard piece of steel is kept which has been drilled in the ordinary manner and afterwards cut through near the edge of the cavity so as expose the interior. The plugs are then turned or ground down until, when they are pushed home in this specimen, the length of the pin exposed is exactly $\frac{1}{2}$in. Since the value of H is $\frac{4\pi}{10}$ the ampere-turns per centimetre length, the number of turns required for the current in milliamperes to equal H in gausses is $\frac{10^6}{4\pi \times 39{\cdot}37 \times 2} = 1{,}010$ turns.

One other matter is pointed out by the author. The

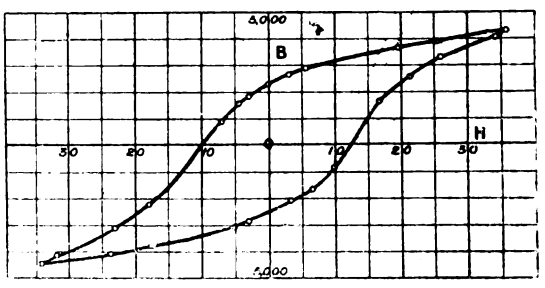

FIG. 7.—B-H Cycle for Cast Iron.

small size of the pin makes the gap between it and the search coil of some influence on the results, as the coil not only cuts the lines passing through the pin, but those in the annular space between it and the search coil. The effect is not large, but it can easily be allowed for by the simple expedient of winding a few turns of wire in the magnetising and search-coil circuits together round a bobbin. A reading is first taken by reversing the current without the iron core. Then if D is this deflection, d_1 and d_2 the diameters of the pin and search coil, the deflection due to the space may be approximately taken as $\frac{{d_2}^2 - {d_1}^2}{{d_2}^2}$ D. The number of turns in the compensating coil is adjusted to give this deflection in the opposite direction, and thus eliminates the effect entirely. The highest value of H employed is

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100, which corresponds to 100 milliamperes of current from the cells. As this is only on for the time of making and throwing over, there should not be much trouble with deterioration of the primary cells used.

As regards the accuracy of the method, the author has made experiments which prove (*a*) that the diameter of the pins could be relied upon to be constant within half a mil, or less than 1 per cent. of the area of cross-section; (*b*) that the effective length of the pins did not vary by ·2 per cent. for different insertions of the plug; (*c*) that the resistance of the magnetic joints was constant for different insertions of the plug: (*d*) that the reluctance of the return path through the body of the iron was negligible; (*e*) that the pin was not twisted in the drilling process.

In conclusion, Mr. Drysdale expresses the hope that the method will commend itself to engineers, and that it will be found satisfactory after extended use. So many testing instruments which have been born and carefully reared in the laboratory develop troubles when exposed to the rough conditions of commercial work, that it behoves one to be cautious in predicting the ultimate success of a new one. So far as it is possible beforehand to guard against such difficulties, he thinks it has been done, and from the experience he has had of the apparatus, under somewhat rough conditions, in the laboratories of the Northampton Institute during the past six months, he has every confidence in its behaviour. The sole point upon which experience is required is, he considers, in the drilling of the specimens. He has never yet found any trouble in drilling specimens of metal such as can be put on a lathe, but for larger castings, etc., some form of portable drilling machine would be necessary. He has not yet used the drill in such a machine, but is assured by many engineers that no difficulty would be experienced. Should any difficulty be found in getting the drill properly centered, it would probably be well to drill a shallow hole first, with an ordinary twist drill or rose cutter, and any trouble as to wearing of the drills could be avoided by keeping a standard drill for a finishing cut. There is, however, no reason at present to suppose that such expedients would be necessary, and in any case all trouble would be avoided if small projections were left on the castings or forgings and cut off before drilling.

Finally, he expresses his most cordial thanks to his assistants at the Northampton Institute for the help they have given him, mentioning specially the names of Messrs. Jolley, Greenfield, Phillips, and Marineer.

DISCUSSION.

The **President** invited Mr. S. Evershed to open the discussion on the above paper.

Mr. Evershed said he was very glad to see from the paper that the seeds scattered by Mr. Esson, Mr. Hammond, and himself in discussing a paper on "The Magnetic Testing of Iron," about a year ago, had fallen on such good soil. They would all join with him, he was sure, in congratulating Dr. Drysdale on the very admirable apparatus he had shown that night. At first sight one felt a little discouraged at every piece of apparatus that was brought forward for testing iron, but he did not think they would get anything simpler than the ballistic galvanometer, especially with use of the instrument just described. The speaker then humorously referred to Dr. Drysdale as "dealing with his blocks of iron very much as a cheeseman tested his cheese," and went on to offer some criticism of the instrument. The first essential in all ballistic testing was that it should be carried out by a method certain to give accurate results, and he thought that one of the drawbacks of the yoke method was that the joint might give trouble. Referring to the apparatus in question, he said that a conical joint was employed, but the pin where it passed into the plug necessarily left a small air-gap, and he thought the evidence of the curves themselves that were shown was sufficient to prove that the air-gap had a practical influence on the results obtained. In Fig. 7 the residual induction was given as 5,000, which was a very small value. Testing a complete ring turned out from wrought iron, it was very rarely that one found the residual induction less than 9,000. He quite agreed that the secohmmeter should be "shunted" in testing iron, but believed that it was better to rely on the ballistic galvanometer. He mentioned one other "source of error" in this method of testing. He gathered from the paper that Dr. Drysdale's method was to take deflections which gave a difference in the induction corresponding to the difference in the current. He had shown, some 10 years ago now, that the disadvantage of this method was that after taking the first deflection and during the time you were waiting to take the next the magnetisation of the iron changed, with the result that the second deflection did not start from the point where the first left off, but higher up the sample. In order to get over this difficulty it would be necessary to always take the whole deflection from the negative maximum, which would give curves really representing the proper hysteresis, etc. Going back to the question of the joint, he thought a little study of Prof. Ewing's work on magnetism would lead Dr. Drysdale to so improve his plug that the effect of the joint would be entirely eliminated. He felt certain, however, that Dr. Drysdale was on the right track, and heartily congratulated him.

Dr. R. T. Glazebrook felt considerable doubt as to whether Dr. Drysdale had really got over the effect of the joint, particularly when one considered the extreme smallness of the pin, and that only slight variations would produce defects and weaknesses in the method as explained to them. Then, again, he did not feel convinced with the explanation given of the method for correcting the small air-gap between the pin and the search-coil. As he understood it, the author had worked that correction out practically on the basis that the distribution of lines of force in the air-gap was the same when the plug was in the air as when it was not in the hole. In his view, the lines of force were considerably modified by the position. Another difficulty was that he did not feel satisfied that an instrument which took the search-coil a depth of only §in. into the interior of the casting really gave them the information that was wanted. He suggested that tests should be carried out to see with what degree of accuracy it was satisfactory to make a test only §in. from the surface. He joined in congratulating the author on the real advance he had made in this matter.

Mr. W. B. Esson considered that what was wanted in testing iron was extreme simplicity. The question of the joint, which had been raised by the previous speakers, was important merely in respect of the point of view from which you regarded the instrument. If you were wanting to make scientific tests in the laboratory, of course the matter was all important, but in dealing with large castings what were wanted were qualitative tests. Manufacturers of iron and steel required to compare the castings sent in with some standard or other and from this point of view the joint was of no importance. The real difficulty with the instrument was that the pin would probably not always remain of the same diameter. He foresaw there was going to be considerable difficulty after drilling due to this, but apart from that he could see no objection to the use of the instrument. The practice at present was to test sample bars, and up to now there had been no guarantee that the sample bar was the same as the bulk, but the author's instrument was really a considerable advance on other methods, because there was a great deal more likelihood that the castings in bulk would come up to the test to a depth of §in. than there was that they would equal in quality a sample bar, which would possibly be cast quite separately. Dr. Glazebrook, of course, wanted perfection, but even if you bored the casting through and through, and found that the tests so made corresponded with the tests made to a depth of §in., there was no guarantee that the next lot of iron which came into your place would give the same results. What they really wanted was to obtain an accurate measurement of the permeability, and the question of hysteresis was really unimportant. For testing the hysteresis loss, however, Prof. Ewing had devised a very good instrument. In conclusion, he described Dr. Drysdale's apparatus as a "beautiful and practical instrument."

Mr. W. M. Mordey claimed to be the originator of this instrument. Some time ago when Prof. Ewing read a paper on a permeability measurer, he (the speaker) dealt at some length in the course of the discussion on the importance of testing in bulk, and he thought he ought to figure in the trio of names to which Dr. Drysdale referred at the beginning of his paper. He, therefore, put in a claim to ·25 of the credit. He was very glad to see that the author had tackled the subject in such a pretty and, he hoped, practical manner. Referring to the great variation there was in the quality of iron, he quoted a case in which the results obtained from tests with the ordinary methods now in use differed by nearly 70 per cent. If the instrument in question turned out a success, his one regret was that it would do away with the last defence of the electrical designer, for what was he to say when his designs were shown not to come out as they ought to? When Prof. Ewing brought out his instrument, the sole object of which was to measure one value only, he (the speaker) pointed out that one value was not sufficient to show the permeability, and this had turned out to be right. In testing iron and steel a great deal depended upon the physical state of the metal, and he was afraid that the process of drilling would give inaccurate results—that was to say, that the effect on the pin of drilling, unless some process of annealing were adopted, would make the results obtained misleading. Then, of course, there were the difficulties as to the variations throughout the mass of the metal, and these were very great indeed. The local variations of permeability and resistance in iron were really marvellous. He asked whether the conical hole might not be done away with—whether a plane surface could not be used equally well? It seemed to him that the author had done himself an injustice in only claiming the use of the instrument for testing in bulk, whereas, in his opinion, it could be very well used for samples. Personally, he expressed a preference for weighing methods, such as that adopted by Prof. Ewing, but he hoped the author would find his instrument very useful for the purposes to which it was intended to be applied.

Dr. R. M. Walmsley joined in the chorus of congratulation to the author for his instrument, which, he said, might lead to a revolution in commercial methods of testing iron. He quite agreed with Mr. Evershed as to the probable effect of the existence of the air-gap, but thought that the question of resistance did not enter into consideration from the manufacturers' point of view, who required an instrument which would accurately measure the permeability of the metal.

Mr. S. F. Walker mentioned one point which, he thought, Dr. Drysdale had not looked into. It was a thoroughly practical instrument, and he agreed in leaving out resistance coils, etc.; but in leaving out resistance coils you were depending upon the E.M.F. of your battery remaining absolutely constant, and he never yet knew a battery which would keep its E.M.F. constant for very long. There were, however, many simple well-known methods for getting over this difficulty.

Mr. B. Atkinson said what occurred to him was that the author

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had proved everything except that the instrument gave the permeability of the specimen tested. There appeared to be in the paper no direct comparison of the results obtained from this instrument with those from ordinary methods. No doubt the author would tell them that he had made such tests, but he (the speaker) thought the air-gap might have very considerable effect on the result. He thought, however, that the instrument had a great field with practical engineers for determining whether there were those very large differences in the quality of iron of which Mr. Mordey had spoken. In conclusion, he offered the suggestion that two drills should be used instead of one—viz., a roughing-out drill—and the other a finishing drill.

Mr. S. Joyce thought that all manufacturers of dynamos and motors would thank Dr. Drysdale for his instrument. He entertained no difficulty in connection with the air-gap, for if it were true that it had an effect on the results obtained, it was of a permanent nature, and could be allowed for. The information manufacturers of dynamos and motors really wanted was the value of the metal they were supplied with compared with some other tested sample. He was afraid that the amount of steel used in some small motors would not admit of being tested in this way, because the required size of hole could not be obtained in it.

Prof Perry suggested that the pin should be taken out and reduced to a very small diameter, which would tend to get rid of the difficulties of the joint.

The **President** was satisfied that the author would be very grateful for the opinions which had been expressed in relation to his invention, and called upon him to briefly reply.

Dr. Drysdale said he had anticipated all the points which had been touched upon in the course of the discussion. He admitted that there were difficulties still to be met. The apparatus did not give the same results as other well-known instruments at even induction densities. But if there were an air-gap in his instrument, it was a remarkably constant one. Throughout the tests he had made he had found that he could take out and replace the plug several times and still get constant results. The question of the air-gap, therefore, did not, in his opinion, affect the instrument from the commercial point of view. The whole point, he thought, turned on the drilling operation, and there was no doubt it was a critical matter. All he could say was that it could be done, and he would ask any engineer which he would prefer to do. Did he prefer to spend an hour or so in thus testing the casting when delivered, or did he prefer to wait until the whole thing was machined out to look for defects? Whatever the difficulties might be, manufacturers wanted this information, and whether the quality of the casting might or might not agree at different points, there was no doubt that the instrument would give a very fair idea of the quality of the casting as a whole. Referring to Prof. Perry's remarks, he thanked him for his suggestion as regards the pin. He might say that he had tried the experiment of having a drill which had a pin $\frac{1}{70}$in. in size instead of $\frac{1}{16}$in., but he could not put it forward as a practical possibility. For laboratory purposes, however, he admitted that the smaller pin might prove serviceable.

A vote of thanks was warmly accorded the author for his paper.

ELECTRIC CAR EQUIPMENTS AND THEIR MAINTENANCE.

BY A. W. WIGRAM, ASSOCIATE.

The main features in the construction and the maximum requirements expected of the equipment are generally laid down definitely in the specification. Many engineers fall into agreement on most of the principal points, the type gets much asked for, and is accordingly standardised by the builders. But after a car has been running for some time a large number of small things crop up—sometimes questions affecting the design of the body, or sometimes merely the position of details—even though the car is most satisfactory as a whole. Most builders are ready enough to make small changes where material or design is clearly unsuitable, but there is much that cannot be fairly expected of them, and therefore remains for the buyer to do. But he should see that these things are put right in the first place when he next orders cars. It is the writer's intention to put forward a few points that have come under his personal notice. The paper will be divided into two parts—firstly, a criticism on some constructional details prominent in modern practice, and, secondly, a few notes on maintenance.

Both principles and details of construction are fairly well standardised and do not differ much on either side of the Atlantic, though the type of car in general use varies a good deal. No fixed rules can be laid down for selection, for density of population and frequency of headway, grades and bridges, are the elements which determine what the type may or can be. But the writer is of opinion that ordinary urban service is best worked with single-truck, double-deck cars, and that if the capacity of these is likely to be exceeded, the headway should be reduced to the minimum before the type is altered. For interurban and light railway work at higher speeds, the double-truck car is indispensable. The notes on car body and equipment comprising the first part of the paper will be further sub-divided: (1) the car body itself; (2) the car equipment, being truck, lifeguards, and the like; (3) the motor equipment, and all the gear, mechanical and electrical, connected therewith.

1.—Car Bodies.

Stairway.—The first point to tackle, with double-deck cars, at any rate, is the stairway. The old type, coming down rather directly from the roof, is being rapidly ousted by the reversed, sometimes called the "Liverpool" or "Bellamy" type. But this is a doubtful improvement. Some extra seats on the top are certainly obtained, but in ordinary service a car is never run full, and in a crush passengers are only too glad to stand. The stair has to start from the extreme front of the canopy, to allow room for the motorman to stand beneath it, and consequently comes down on a curve the whole way. At the bottom it comes right against the end panel of the car, and the passenger, after making a turn of 90deg. to the left, finds himself blocked by a stream of people pouring out from inside. So top deck and interior have to empty separately, and the car spends more time at important stopping stations. In some towns the top-deck passengers are made to get off at the fore end, but there is not always sufficient clearway between the tracks to allow this. The writer has certainly seen a car emptied in only a little over 30 seconds, but the circumstances were exceptional—the passengers were all males, in a hurry, and both ends of the car could be used. But at a crowded junction, with ordinary mixed traffic, that time must be multiplied by 6 or 8 to get a correct estimate. Another disadvantage is the obstruction this stairway offers to the motorman's view on the pavement side. This side of the car generally comes in for the most damage anyhow. Probably the best type is that which has been adopted by the London United Tramways—two straight stairways with a turn of 180deg. halfway up at a landing. It is so constructed that the passengers from the upper deck are delivered in a separate stream to those from inside, thus making full use of a step extending the full length of the platform. This stairway is placed transversely across the car, so that passengers cannot be thrown down by either sudden stopping or starting.

Ventilation.—Ventilation of the interior is a much neglected detail. The small clerestory windows, even when all can be opened, are not sufficient, and ventilators in the doors make bad draughts if they are large enough to do any good. It is the method rather than the means which is at fault. If the foul air is extracted, fresh air is quite ready enough to force its way in to supply the place. Four or six of the clerestory windows should be removed, and air extractors—of which there are several good types—should be substituted. All but two of these should be fitted with cut-off grids. Two should be left without them, for it is well to have a little compulsory ventilation. The others can be opened or shut according to the season and the number of passengers. The writer had four Eros air extractors fitted to a 22ft. single-deck car. These were found to be quite equal to all ordinary conditions of service, with all the other windows of the car closed; and even in busy times the air in that car was much fresher than in similar ones which had all the clerestory windows kept open.

Details.—Interior details should always be of a light colour, and not too ornate; the windows large, with light posts and framing. These should be of oak for choice (though ash is often used), and strengthened with hidden iron tees. The side and rocker panels are generally of light wood, $\frac{3}{8}$in. or so thick, glue canvased, and well blocked on to the ribs. This thinness makes it very difficult to put in a satisfactory patch after a slight accident. The whole space between the ribs must be filled up on the inside of the panel, and the block well fastened to the ribs. The edges of both patch and panel must be well fastened to this both with glue and screws. Even then the patch is liable to work and crack the paint. But it is by no means certain that this would be avoided by having heavier panels, as it depends so much on the rigidity of the whole structure. Panels of sheet iron, as are sometimes put on German-built cars, should be avoided. A slight blow dents the sheet, and cracks the paint in a great spider's web, and it comes off in flakes. It is impossible to get the dent out completely, as the blow expands the metal. The only thing to do is to fill the place up with lead stopping. The writer has heard of panel coverings of papier maché, but has had no experience with them. It is hardly likely that they would stand a scrape, but they could easily be replaced, and would do well on a patched panel, as slight working of the patch need not disturb the surface. During a busy season the writer has run cars, which had been smashed in, with panels of cardboard. These lasted excellently, for a temporary measure. So there is no reason why a properly prepared and fixed board should not do for a permanency.

Dash-plates are generally of No. 12 or 14 plate, and are open, in a small degree, to the same objection as sheet panels. The knocks they get are generally harder, but the dents can be got out by removing the whole dash-plate and passing it between a pair of rolls, or hammering it on a marine ventilating cowl former. Sometimes they are made of $\frac{1}{8}$in. boiler plate. This is an advantage if they are well fastened to the platform. They will then take a lot of shifting, and are a real protection to the controller and other gear.

The exterior painting should be of the neatest and plainest design. Dark colours—lake, green, and blue—wear best, and all lettering and coats-of-arms should be transfers. A very neat and rapid method of gilding is to put on the leaf with a small roller, doing both thick and thin lines at one sweep, but this is rather extravagant in gold leaf. Recently, however, gold lines have been put on the market in transfers. The car number is usually put on the dash-plate, but a better place would be the decency board, over the canopy. It would be easily visible from here without being of excessive size, and would help to fill up a place which is generally a void, though sometimes partly covered with a stencilled pattern. The number should also be put conspicuously inside the car, and on the top, preferably on the inner side of the decency board, above the stairway.

Some of the metal fittings of a car are of burnished cast brass, but the majority—handrails and the like—are of iron pipe brass covered. It is very difficult to keep these properly bright. Possibly pipes nickel-plated on copper would be better. There are also alloys of aluminium which keep their polish well, and have been in use for some time as ships' cabin fittings. These are well worth trying.

2.—Car Equipment.

Trucks.—The most usual dimensions in this country are 18ft. to

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers.

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20ft. bodies for double-deck and 20ft. to 22ft. bodies for single-deck cars. These are about the limits for a single truck. Brill's and Peckham's are the most favoured types; a few also are of Brush, Lord Baltimore, and MacGuire make. Of the two first, Peckham's has a built-up frame, Brill's a forged bar frame, and this is the type most in use. In the matter of weight there is not much between them, Brill's being lighter. It is also simpler, and is really the best all-round truck. The only weak point is the poor support given to the car body at the ends, but this is easily overcome by fitting cantilever extension pieces. These should always be fitted, though they very seldom are, for not only do they steady the car while running, but they effectually prevent the body from sagging. Peckham's truck can be made with a very long spring base, and while the end springs are in good order the car rides very easily. But it gallops badly as they get old, or if it is unevenly loaded, though this also can be modified by the fitting of cantilever extension pieces. Brush and MacGuire trucks are practically identical. They are a modification of Brill's, the springs being slightly different, and the lower horizontal bar and nipples for cantilever extensions being absent.

The great disadvantage of a single truck is the necessity for a short wheel base, the car body overhanging at each end by an amount equal to about twice this. In the act of taking points the car is pivoted on its rear wheels, and has its direction changed by a force applied at the forewheels, which has, consequently, to be great. Taking the case of a car body 30ft. over all on a 6ft. wheel base, it is applied at a radius of 6ft. on a body extending 18ft. from the pivot in one direction and 12ft. in the other, though the greater part of the weight is concentrated between the wheels, and on this it acts at a slight mechanical advantage. But the shock is felt through the whole car, and felt severely if the points are not carefully laid. This is one of the factors leading to the introduction of double-truck cars. But it is rather hard to condemn a type when the fault really lies in the track. One may ask in this connection why it is that manufacturers make points so thick. They cannot be laid to gauge, and have to wear down to it, at the expense of the wheel flanges. It is not improbable that this is a help towards broken axles, for the wheel will not bend, so the axle must, and it does so at the hub, where it changes to a smaller diameter. And this is notoriously the place where axles break most. There are so many other causes for broken axles that this is generally neglected, but repeated small bending will always leave its mark, as can be seen at the fracture of a trolley wire which has broken through being put up with an excessive amount of slack. Railway men have for long machined their points off carefully, almost to a knife-edge. This can be done to a considerable extent in tramway work. The tongue need not be cut right down—it is quite enough if it is done for a depth slightly exceeding that of the flange of the wheel, and the rest left thick. The double-truck car is easier in riding over badly-laid points, because of its very long wheel base. Not only is the proportion of overhang very much reduced, but it is often actually less. Moreover, each truck being an entirely separate unit, only a portion of the weight of one motor is dealt with at one time.

Speaking generally, the writer has a strong objection to maximum traction trucks, especially to those which have no fixed radiating point, combined with springs or shifting cams for altering the percentage of weight on the wheels. This may seem rather sweeping, as it condemns one of the types most in use—Brill's Eureka—but the objections mostly come from the absence of a fixed centre. The compensating point has to be forced out of a trench and along a sharply inclined plane against the pressure of a powerful spring, and it often does this with considerable reluctance. The position of the radiating point alters as the ratio of the weight on the two pairs of wheels alters. But this ratio is fixed when the car is running on the straight, and fixed again on curves of perhaps 60ft. or less radius. In the first case the compensating point is not touching, and in the second it has shifted out of the trench, and has the maximum pressure on it. The transition period is so short that it may be neglected, and the radiating point fixed to suit case 2 (for it is obviously a matter of indifference where it is when the car is on the straight). It will be found to be a few inches behind the centre of the driving axle, and the car will attempt to swivel round this, even though all the guides are centered on a point midway between the axles. The result is some very peculiar and uneven wearing of the body supports. In some other trucks, such as the Brush maximum traction truck, the proportion of weight taken by large and small wheels is fixed, and can be varied by slinging the motor between or beyond the axles. The objections which apply to all types of maximum traction trucks are the slipping of the driving wheels and the difficulty of proper adjustment of the brakes. The first only becomes a serious matter on hilly lines, the second is present everywhere. The pressure is put on to the small wheels through a spring, and the trouble lies in the correct adjustment of this. One generally sees one, or even two pairs of wheels picked up when a car is making a sudden stop.

Brakes.—Brakes, for a complete description, almost deserve a paper to themselves. Remarks on all sorts will be put together, though some are mechanical and some electrical and electromagnetic, and might more properly come in with the motor equipment. The ordinary hand-brake, if properly designed, leaves very little to be desired for light cars. But some bad slips are sometimes made, the most usual being: (1) Incorrect placing of brake rod on brake lever. The mechanical advantage of the hand-brake is of necessity very large, and the movement of the brake lever at the end at which power is applied correspondingly great. So unless care is taken in determining that point and in giving good clearance, the bolt fastening brake rod to lever may come up against the cross framing of the car, and prevent the brakes being put on at all, unless the shoes are adjusted right up to their work. The only thing to do is to take the brake gear down and drill a fresh hole in a better place, even if it reduces the leverage, for otherwise the car-shed examiners will be always at work adjusting the blocks and keeping them close up to the wheels. (2) Incorrect cranking or placing of the adjusting rods so that the rod fouls the gear case when brakes are applied. There is sometimes considerable stiffness in the gear when the blocks are on the wheels, which may be caused by the pull on the brake rod and the motion of the brake lever being in different planes, but is more generally due to bad release springs. Of these there is only one good type, a helical spring about 8in. long, having an extension of 1in. for 60lb. to 80lb. and $\frac{3}{4}$in. adjusting bolts. Many cars are sent out with flat S release springs, incapable of adjustment. This is a great mistake. The whole brake system is a quadrilateral suspended by four links at the corners, and free to move, to a limited extent, along the diagonals. Consequently, as one spring is sure to be stronger or one link stiffer than the rest, the whole system is pulled out of square, so that two brake blocks at opposite corners are continually rubbing on the wheels. A spring of the kind described should be fastened to each corner, and the blocks adjusted so that they will come hard on in a turn and a quarter of the handle. Then, if it is noticed that one block is wearing faster than the others, a little extra tension will put it right. If the brake system is kept properly free, a very little tension in the springs will suffice, the blocks almost falling off by gravity. They sometimes stick when nearly worn down from the binding of the rag into the flange of the wheel. But it is not really necessary to have a keep of any sort on the brake block to bite on the flange. The tread is quite flat and the distance between the blocks is firmly fixed, so there is no danger of their being forced outwards, as would be the case on locomotives if no special provision were made.

Air-brakes are no use on urban cars. They are too constantly in use, and are a fruitful source of flat wheels through the carelessness of motormen.

Slipper brakes should always be fitted to cars running on grades steeper than 1 in 12 or 15, where there is much traffic coming out of macadamised side streets. The wood blocks bite well on the rail, and can be adjusted to keep the car going the grade at a steady pace, the ordinary hand-brake being used for stops. They are also excellent track cleaners, though their scope in this direction is more limited than some of their more fervent admirers would lead one to think.

Rheostatic brakes cannot be condemned too much. Their action, in causing the motors to generate current through a low resistance, depends entirely on the heating of armature and resistances. The pinions get worn away to knife-edges, the whole strain falling on the most expensive part of the equipment. Every car should, however, be fitted with an *emergency brake*, the motors being reversed and short-circuited; but there must be no intermediate notches, or the motorman will use this brake for service stops as well. The amount of current generated on the emergency brake is very large. The writer connected an ammeter marked to 150 amperes in series with one 25 A "English Electric" motor, and at first applying the brake the needle went hard up against the stop, falling again and surging between 90 and 120 amperes. The resistance of the circuit being about 1·25 ohms, it will be seen that the motor was generating from 10 kw. to 18 kw., at which load the wheels skidded even with sand. But the strain on the armature must be measured by the magnitude of the current, not by the amount of the power. The pressure may be only 110 to 150 volts when the brake is in operation, though a much more severe strain is put on the insulation at the first flick, when a current of 150 amperes or more is flowing. Then not only resistance by induction must be overcome. The amount of current generated depends far more on the condition of the track than on the speed at which the car is running. Eighty amperes can be got at two miles per hour, the car stopping suddenly at this. When the brake is applied at moderately high speeds, the direction of rotation of one motor is frequently reversed.

Electromagnetic brakes come under a very different category to rheostatic. Here the braking effect is not by a large current, but by the large magnetising effect produced by a small current. The brake may either pull the ordinary brake blocks on to the wheels, or act by eddy currents or actual frictional contact on a special disc. But if a car is fitted with hand, slipper, and electric emergency brake, no other is necessary, no other being as good as each of these are severally in their own province.

Sanding Gear.—Another feature of car equipment frequently unsatisfactory is the sanding gear. What is required is a constant stream of sand directed to the proper place, as is done on locomotives. And if this is necessary on the clean track of a railway, how much more is it wanted on a rail which is kept covered with a greasy scum by other traffic! Even when the track is clean, sand is necessary for a sudden stop. There is an impression that it is only in greasy weather that trouble may be expected. But this is not so. The track can get very bad in a long drought—so bad, indeed, that a car running at eight or ten miles per hour will slide on absolutely unchecked for 100 or even 150 yards when the emergency brake is applied without sand, the wheels being almost locked. The ordinary hand-brake is far more successful than a magnetic or rheostatic brake both under these conditions and in ordinary slippery weather, probably because it cleans the greasy film off the wheels. The types of sanding gear giving a continuous flow are apt to stick open, so that a car has to climb over a mountain when starting after a stop, and goes on with empty hoppers. The reciprocating type is more satisfactory than this, but its use is much hindered by its being made to work with the right foot, so that the brakes must be locked before sand can be applied. But unless the brake handle is kept in the hand, and the pressure eased from time to time, there is a great likelihood of the wheels skidding; and to work the brake thus it is necessary that the motorman's weight should be on his right foot, his left being free. The pumping of sand is a continuous business, and should be put to the free foot and the gong pedal to the right, for that is a momentary operation, not often required, and it can be done without the motorman shifting his weight. A central position of the pedal also ensures that both sides get an equal motion; with the ordinary arrangement that on the far side is often weak.

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Lifeguards.—Lifeguards may be divided into two types—those that pick the body up, and those that clear it off the track. The simplest form of the first is a net fastened to the truck; but this is rather uncertain in its action. Unless the front bar is carefully bent to suit the camber of the setts, the guard must be set about 1½in. above the rail. As the car generally pitches when the brakes are applied suddenly, or when it strikes a body, there is a chance that the guard may be at its highest point when it is required to act, in which case one of the extremities may be got underneath, and the whole body will probably follow. The writer's experience of this guard is that it has been successful in about 50 per cent. of its cases. The principal automatic dropping guards are Wilson and Bennett's, Tydeswell's, and Hudson's. All these are fixed underneath the platform. The Hipwood-Barrett and Providence guards, both American, fix on to the collision fender. Wilson and Bennett's is made entirely of metal, and has the disadvantage of great weight. Of course, the guard should be strong, but the writer thinks that 1¼in. of solid iron is a larger diameter than is necessary for the frame of the net. The action is very simple—the front gate swinging back pulls the net over a dead centre, gravity doing the rest. This guard can be let down by the motorman from the platform, and when once down is locked in position. Tydeswell's and Hudson's guards are very much alike at first sight, both consisting of wood strips on a metal frame, but the method of action is different. In Tydeswell's the gate swings back and releases a trigger, and the guard is pulled down and held down by a spring. This guard is very rapid and satisfactory in its action, and from its light weight easily reset. In Hudson's, also, the gate releases a trigger, but the guard falls by gravity, and as it is partially balanced it is rather slower in action. The clearing-off guard is generally preferred on the Continent, and is simply a V-shaped wooden projection fitted to the truck. It has the advantage of being very useful as a snow-plough.

Route Indicators.—These usually consist of (1) a letter or name painted on a board, and illuminated at night; (2) a box containing lamps, the names of the routes being painted in glass. This may be made to revolve, in which case four destinations can be shown, though only three are easily changeable—that on the door being difficult to alter—or the box may be a fixture and the glasses be changeable. In the revolving kind, the nipples give trouble by working loose and turning with the box, which causes the lighting cables to twist or be cut through. In the second, the glasses are frequently broken. A new arrangement has recently been put on the market, in which the destinations are printed on linen and kept on rollers, the box being fixed. This seems to be the most satisfactory type. If glasses are used the name may be stencilled on, or may be cut out of coloured glass by hydrofluoric acid. But a transfer is cheaper than either of these, and a lithographed paper bill cheaper than the transfer. The lithographed bills can be done with white letters on a coloured ground for one quarter the price of transfers, and if properly fastened on last quite as well.

3.—Motor Equipment.

Starting at the trolley wheel, the first point to discuss is the type of groove. If the ordinary V-type of groove is used, the wheel runs very nicely on the wire, but gives a severe blow at the ears, where the diameter is suddenly increased by about 80 to 100 per cent. In the course of time the shock diminishes, but not without leaving its mark on the overhead work. Where the car is taking a heavy current the sparking is sufficient to burn away most of the sharp corners; but on the level or down hill the ear is partly forced up from the wire, and partly worn away. If the wheel groove be made wide enough to take in the ears without shock, it runs noisily and unsteadily on the wire. The best form is a wide groove, with a shallow depression in it, the diameter of the trolley wire and about half its depth. Trolley wheels of this type will run silently on a line put up with flexible suspensions, even when there is a long side-reach, and will go over section insulators with no more noise than the ordinary V-groove type makes going over ears—provided that the line has been in use for some time, for no trolley wheel will run quietly on new work. The lubrication of the trolley wheel affects its life most. Where graphite bushes are used, the amount of metal in the wheel should be so proportioned that wheel and bush wear out together. It is quite a mistake to suppose that graphite bushes will run well without oil. They should be oiled frequently, and their life will be increased by about 40 per cent. Trolley wheels, such as Wood's, with grease lubrication from a hollow spindle, or Brecknell, Munro, and Rodgers's, with oil lubrication from a hollow wheel, will go for long periods without attention. But the writer is of opinion that such an important point as the trolley should have frequent examination. Whatever the type of lubrication, the groove will be worn deep in about two months, so deep that even the type of wheel recommended by the writer will be noisy when going over ears. Possibly a wheel with a renewable centre, somewhat after the type designed by Mr. Hudson, of Bolton, and grease lubrication will be found the best. The hub and flanges will last good for a long time, and new centres can be turned and inserted at a nominal cost.

Trolley Heads.—The two types of trolley head principally in use—Blackwell's and Wood's—leave little to be desired. The best point in Blackwell's is the ease with which the entire globe can be changed, so that a new wheel can be fitted, or a damaged globe repaired at leisure. Unfortunately, the globes are not strictly interchangeable. The whole thrust is taken on a steel ball, and the head swivels very easily. It would be improved if the globe were finished off a little lower down. It would then go easier over frogs and crossings which have deep grooves cut in them for the wheel flanges to run in. Mr. Wood's trolley head has been specially designed for his own overhead material, and is an improvement on Messrs. Blackwell's on this point—taking frogs and crossings with only a slight click. Formerly, the thrust was taken on a ball bearing, but this was always giving trouble, and has now been replaced by a loose steel washer. The bracket is made of aluminium, bushed with steel where the spindle passes through. This head is quieter than Blackwell's, even when both are fitted with the narrow-groove type of wheel. Probably it is due to the grease lubrication, the hub always being a good fix on the spindle. But the globe is apt to swivel stiffly in wet weather.

Trolley Standards.—It is necessary that a trolley standard that is to run under all conditions should fulfil the two following requirements: (1) that the tension at the trolley head should be nearly constant, whatever the height of the wire; (2) that the trolley should swivel easily. To No. 1 may be added this: that the tension shall not decrease when the trolley head is at its lowest point. This is espepecially necessary in trolley standards for single-deck cars, for these frequently run under conditions where there is a range of 10ft. in the height of the trolley wire, and if the head is sluggish in rising, it may give trouble by leaving the line, especially if there is a wide side reach. For No. 2 the standard must work on ball bearings, and arrangements must be made for lubricating the ball races. Standards with plain bearings give trouble on sharp curves which are taken with too few pull-off's. Easy means of adjusting the tension are necessary, also an adjustable stop for limiting the possible rise of the trolley head. Compactness is not so essential for single-deck cars, though it may be necessary in some special cases to limit the height of the standard when the boom is horizontal to 12in. or 14in., but it is very desirable on double deckers, especially when the trolley is placed centrally. These requirements practically throw the external spring trolley standard out altogether as far as double-deck cars are concerned. There are few lines where it is quite suitable. But there are some enclosed spring types which answer to them fairly well. Messrs. Blackwell's is a fair example of these. The tension on the trolley head is constant through a wide range, and there is a ball bearing where the principal pressure occurs; but there is no adjustable stop. The method of armouring the trolley cable by leading it down through a hollow tension rod is excellent, but the writer is inclined to ask for a little more space at the top, between the place where it leaves the bush at the bottom of the trolley boom and the top of the rod—enough space to allow of the connection between the trolley cable and the car wiring to be made there instead of at the bottom.

The enclosed spring standard is stronger than the old type, so in case of accident it is usually the boom only that bends. An arrangement such as that just mentioned would make it possible to change the boom without lifting the standard. It would not often be wanted, for the boom can generally be straightened *in situ*, but it has been managed very neatly by Messrs. Brecknell, Munro, and Rodgers in their standard. A door about 4in. by 6in. has been provided, so that the connector can be got at for fastening and insulating. There are no hinges—the door is let in flush with the rest of the standard, and kept in place by four ¼in. countersunk set screws centered on the join. Care should be taken to insulate the boom well from the standard, and the standard itself should be earthed through two leakage lamps in series, one at each end of the car.

The method of fastening the trolley standard to the roof of double-deck cars is rather primitive. The trolley plank, though it extends the whole length of the roof, and is screwed to every rafter, is usually only the same width as the base of the standard. It does very well when the trolley wire is always over the standard, but it is not a strong enough fastening when there is a wide side reach, especially if the trolley wire is at all slack. After some months' running under these conditions the screws begin to draw, and the standard and plank begin to sway. Then the white lead round it cracks and water finds its way down inside the roof. To prevent this, three or four strong irons, 3ft. or 4ft. long, should be screwed to the trolley plank and to the roof ribs, two perhaps under the base of the standard if the rafters will admit them, and two fore and aft of it. These offer no obstruction if they are made the same size as the wood strips on the roof of the car, and give the standard a firm fastening in every direction.

Controllers.—In their main features controllers are very much alike. There are different methods of getting over the arc—by magnetic or by solenoidal blow-out, or by simultaneous breaking at several contacts. Methods of working when only one motor is in use also differ. The simplest of all is by hooking back a contact finger from the reversing barrel, and bringing the main handle round to the parallel notches. The General Electric and English Electric controllers have small switches, while in the Westinghouse half the reversing barrel is turned through an angle of 90deg. In the General Electric and Westinghouse controllers a lock is arranged so that the parallel notches cannot be reached when one motor is cut out; but the English Electric Manufacturing Company have their connections arranged so that this is unnecessary. A good point in this controller is that it is raised some inches above the platform on a cast-iron base—thus kept well out of the wet. The Brush Company arrange their controller doors well, splitting them down the middle, so that they open right and left.

The American system of running all the leads from the controllers in a canvas hose is going out, and a system of separate multi-core cables is replacing it. That of the English Electric Manufacturing Company is probably the best. In this a five-core cable runs straight between the controllers, and the motor cables are four-core, all the leads in the same cable being braided in different colours. There are no tee'd joints in the motor leads. They are cut and sweated into terminals in a connection box. Separate leads go from this connection box to the motor and to the other controller. This use of different colours makes the wiring of a car or the tracing of connections a simple matter. Take, for instance, a motor cable, red and blue for the armature, black and white for the field. It is only necessary to see that in the one controller red lies above blue, and in the other blue above red, the relative positions of black and white being unchanged. Of course, care must be taken that like colours are put to like in the connection box. This system of coloured wiring is carried throughout the car. For example, the motors, which have three coils per slot, have them in red, blue, and white, and the ends are singled out and sweated into the commutator bar with certainty and dispatch.

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Traction motors are almost the most perfect of machines. They are certainly the hardest worked, and frequently the least troublesome portion of the whole equipment. But care should be taken to provide large inspection doors, not only that over the brush-holders—that is always large enough—but also for the door in the lower half of the casing, for examination of the clearance the armature has from the pole-pieces. This does not want looking at so often as the commutator, but it is very desirable to have a good clear view, and room to get in a gauge. Brush-holders are not quite perfect. The fault mainly lies in the springs, which do not give a sufficiently even pressure all the way down. Sometimes they terminate in a semi-circle, which presses on the top of the brush. The continued pressure on this causes it to spread, so that it catches on the edge of the brush-holder, and does not follow the brush down as it wears. The result is a loose brush, with sparking at commutator and in brush-holder, and frequently flashing over to the motor casing, though this should never happen if the examination is carefully and regularly carried out.

Maintenance.

Maintenance consists of two distinct parts—the daily cleaning and inspection and the periodic overhauling of the car body, paint work, and equipment. The equipment of an electric car is now so perfect that it is well worth while taking care of it; and this care is thoroughly well bestowed, for when the apparatus is in use it has to put up with a lot of hardship under disadvantageous conditions, so that small defects, if unchecked, soon develop into great ones. But by means of careful inspection not only is a longer life given to the apparatus, but there are fewer lost journeys or delays through accident or defect. The whole matter is mainly one of attention to details. The public is very exacting on small points and judges of the quality of the work by the polish on the brass handrail, or by the cleanliness of any notices that may be in or on the car, and such like. Cleanliness is a most important point, and the writer will deal with it first. The practice on different lines varies considerably, in some cases only two cars being allotted to a cleaner, though the number runs up to seven, the average being about three. But in some towns the interior of the car is kept in order by the motorman and the conductor, or the brasswork or windows are cleaned by special men. The writer's experience is that one man cannot clean thoroughly inside and out more than three single-truck double-deck cars, even if the brass cleaning is taken by special men. A brass cleaner should be able to keep all the bright work on eight or ten cars in good order, but it is well to have a slightly larger number of these than is actually necessary, so that some of them can be put on to car washing after a specially busy day, or when any of the regular washers are absent through sickness or unpunctuality.

The method of cleaning recommended is as follows, though it requires modification according to the weather. The upper deck, stairs, and platforms should be swept down nightly, and hosed occasionally, if no good downpour has occurred to make this unnecessary. The truck and lifeguard are best cleaned with a hose or spokebrush, though this need not be done frequently except in muddy weather. The interior of the car should be well dusted, especially around the ventilators, lamp shades, and window frames, the seats well brushed down if covered with carpet, wiped over if they are of plain wood, and the floor swept out. The windows will generally require cleaning—they certainly will want it if there has been any rain. The outside panels and dash-plate should be cleaned with water only, with sponge or chamois leather or a long-handled brush of the softest hair obtainable. Any mud there may be on them should be got off with the water only, not wiped off with sponge or brush, and soap only used to remove stains if they cannot be got rid of in any other way. Strong soap should never be used. This is about the minimum amount of cleaning that can be done under ordinary conditions to cars that are in service for 15 or 16 hours a day. Other work should, if possible, be done by daytime. Some of the regular car-cleaning preparations, such as scarbolate, eukotas, or the like, may be used in the interior, but they are not necessary for the outside if some system such as the following be adopted. Once a week, say, the car should be withdrawn from service, and the inside well cleaned down with disinfectant soap. Occasionally, about every fourth week, this washing should be made more thorough, and the car kept in from service the whole day. In addition to the regular weekly cleaning, the ceiling and outside panels should be washed with soap, and in the case of single-deck cars the roof scrubbed down. The inside seats should be taken right out, and the space underneath cleaned. If the seats are covered with carpet, that should be beaten, and the curtains should be well shaken. Advantage should be taken of the presence of the car in the shed by daytime for its weekly cleaning to give it a thorough examination. The writer condemns examination at night—it requires a larger and expensive staff, and the work is always done in a slovenly and unsatisfactory manner, no matter how well the car-shed may be lighted. Of course, such important things as the trolley (wheel, head, and standard), brake gear, and sanding gear, should always be examined, even if the car has been running only a few hours, but the general examination can be done better and in half the time by day. For the weekly examination, in addition to a general look over truck, lifeguards, seats, stanchions, etc., every nut should be tried, and the commutators cleaned and brushes and brush springs examined. Regular periodic examinations should be made of all bearings, especially those supporting the armature, also of the nuts and bolts fastening the two halves of the gear wheels together. Too much trouble cannot be taken over securing these and over other nuts out of sight. They should not only have lock nuts, but cottars—not small split pins, but good gib cottars with split ends, driven into a slot in the bolt and opened out; cottars of a type which experience taught locomotive builders to use long ago, even though all their nuts are in sight. The writer would have these cottars put to all important nuts, such as those holding the pole-pieces and the two halves of the motor casing. If they are driven home, the examiner has only to look and see that they are there, and then all will be right. The night men should, as mentioned above, examine the trolley and sand and brake gear of every car that has been running. Every second or third night the controllers should be cleaned, contacts adjusted and lubricated. Westinghouse controllers, having no blow-out arrangement, require attention more frequently than this. The examiners should be taught to notice, as they pass through the car, little defects, such as broken door-catches, or hand-straps, or broken wood strips on the floor. These must be put right at once, or they will be forgotten and seen and commented on by passengers.

For a shed with a capacity of 50 cars—turning out about three dozen daily, and 45 on Saturdays and Sundays, and this is as large as any car-shed can conveniently be—the writer would recommend the following staff:

Day Staff.—A foreman, who should be a fitter and also capable of attending to electrical repairs. Three or four handy men, fitters' labourers, who must, under the direction of the foreman, do such jobs as the remetalling and boring of bearings. The amount of fitting work that has to be done on cars, even for the general overhauling, is very small, and should be well within the power of one man.

Night Staff.—A foreman, four car examiners, and one extra handy man—to whom no cars are assigned—to do odd jobs and help the examiners in the heavier work, such as fitting a new set of brake shoes. This man must look after the extra cars on Saturday and Sunday nights.

An evening shift is desirable—a foreman and one handy man—to be on duty from about one o'clock till the night-shift men arrive. Then one handy man less will be required by day. The night and evening foremen can take turn and turn about. These men must be up to repairing all minor defects, such as trouble with lighting circuits and the like, but they need not be fitters. The cleaning staff will consist of 12 car-washers and five brass-cleaners, three of whom will be put on car-washing on Saturday and Sunday nights. There should be three or four cleaners on by day for car-washing and for keeping the shed in order. The day handy men should come on duty about 6.30 a.m., so that they shall be able before starting their regular work to see that the cars are properly supplied with sand. This staff is not only sufficient for running repairs, but also for the complete overhauling. Once a year the car should be run into the paint-shop, and the body lifted and the truck run out for overhauling. The truck should be measured to see if it is square. Built-up trucks should have the rivets examined, the springs should be tried, and the wearing portions of the brake gear looked to. The wheels should be measured, and careful notes made of any parts which, in the opinion of the foreman, require more frequent examination.

Painting.—If this is properly done and properly looked after, it should last for five or six years. The principal thing in repainting any damaged portion is to use the very best materials, and, if lead stopping is necessary, to use it as thin as possible. In most cases of cracking it will generally be found that the layers of paint and stopping have not set alike. But the varnish does require renewal every year, or even more frequently on sea-coast towns, where there is always wind and sand being blown about. Though the care taken in the cleansing department has even more to do with the life of the varnish than this. When a car comes in for re-varnishing it should be well washed down with pumice and strong soap—Monkey Brand does excellently—and then given a coat of the best finishing varnish. The top seats require attention more frequently than this, say every six months, and the inside generally may last in good condition for two years. But certain portions—such as the bottom of the window sash—where the moisture collects from the glass, want looking after yearly. Perhaps an application of an oil furniture cream to such place once a week would keep them in good order. It is a good thing to paint the floors of cars. Of course, no paint will stand the wear in the wood strips, but it is not very difficult to get one that will do between them.

The car-shed tools required are few and simple. Firstly, a set of jacks able to raise car body, with truck and motors, about 36in. clear of the track for rewheeling without removing pilot board or lifeguards. These should be on wheels for portability. Arrangements must be made for supporting the motors from inside when the car is lifted. It is best to put a balk of timber, 6in. by 4in., along each seat, and a piece about the same size across over each axle. The lower half of each motor suspension bearing is removed, and an eyebolt inserted in one of the boltholes. A chain is hooked in this and passed round the transverse timber, and the slack taken up on a turn buckle. Care should be taken to put the cross-girders of the jacks as far back under the corner post as possible, to avoid straining the car body when lifting. The lower horizontal bar of the Brill truck frame must be removed, the nuts should be replaced, the space between them and the truck frame being filled up with washers and short lengths of gas-pipe, so that the car body and truck will lift simultaneously. This is unnecessary with the Peckham truck. Wheel-press, arranged for pressing wheels on or pulling them off, capable of exerting a pressure of 120 tons. A pit-jack on a bogie, for removing armatures—this should be capable of being lowered sufficiently to allow the lower half of motor casing, with the armature resting in it, to be taken down and wheeled out from underneath the car. Some jigs for remetalling bearings—they should be made so that each half of a split bearing can be run in separately. A 10in. or 12in. gap lathe, able to take an axle, an armature on its shaft, or a single car-wheel, for boring and facing. A drill up to 1¼in. hole. For small work, one of Scaife's universal drilling machines, with two stands, one permanently fixed to the bench, the other a portable one with tee-piece and clamps. A car-wheel grinder for removing flats is sometimes added, though if the motormen use their brakes properly this is hardly necessary. This list must be added to or subtracted from according to the

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resources of the district, or the number of cars on the line. As it stands, it will probably be sufficient for a line of 60 to 100 cars, though, perhaps, a chuck lathe for boring bearings might be added. The testing outfit should consist of a detector of about 100 to 120 ohms resistance, with four-cell battery in box with it; a Silvertown testing set, with 60 or 100 volt battery; an ammeter reading to 150 amperes and voltmeter to 600 volts, both spring control, with scale marked into tens.

Care of Equipment on the Road.—It should not be necessary to do much to the cars outside the shed, but occasionally controller contacts will work loose or brush springs give out. What is mainly required is a reliable telephone system, so that all defects can be reported at the car-shed. It is worth while to spend a good deal of trouble in training the motormen. They should be put for a while with the car examiners, and also have the general scheme of wiring and the use of each part of the equipment explained to them by the chief motor inspectors. They must also be well drilled in the use of the brake and in the simplest methods of locating any defects in the equipment.

The only other point to notice is the necessity of a careful record of the work done by each man on each car, especially in the case of the night men, not only for getting at the costs of upkeep of different materials, but also as a check on the care bestowed on the work by the men themselves.

SOUTH SHIELDS CORPORATION ELECTRICITY WORKS.*

BY JOSEPH A. JECKELL, A.I.E.E.

The borough of South Shields, which includes High Shields and Tyne Dock, is situated at the mouth of the Tyne. It is bounded on

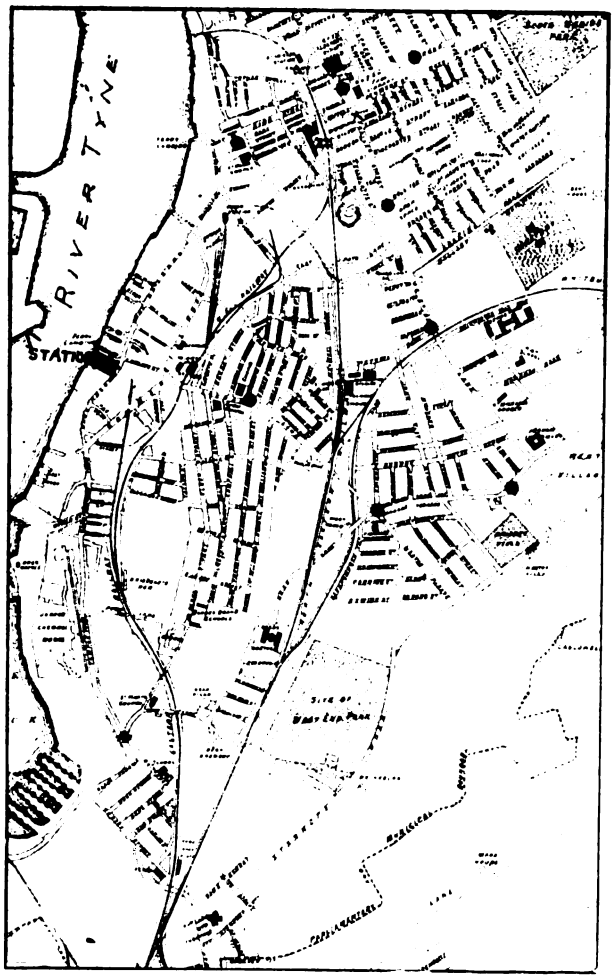

FIG. 1.—Map of Supply Area, South Shields.

the east by the sea, and on the north and west by the Tyne. The river frontage is some 2½ miles in extent, the average width from the river on the west to the sea on the east being 1½ miles. The area is 1,839 acres, while the population is estimated at 108,000, a very large proportion being workmen employed in the shipyards and other works on the river and in collieries. There are practically no fine streets. It was some time before a really suitable site could be obtained. One was at last obtained on the river, about midway between the north and southern boundaries, and close to the largest works (see Fig. 1). Though this site would eventually be in the middle of the area of supply, when the station was first started the current had to be sent 1,100 yards before a single consumer was reached. At the time the works were erected the Board of Trade had not allowed the increase of pressure on low-tension mains which they have now, and multiphase plant was unknown in England. It was therefore decided to adopt single-phase alternating plant as the most suitable for the district, the periodicity chosen being 50, as being much more suitable for motors than 100, the periodicity then most usual. The plant decided upon comprised triple-expansion marine-type engines, iron-clad alternators, marine boilers, rubber-covered mains laid in cast-iron pipes, street transformers, and rectifiers for street-lighting.

Engines.—It was almost universally held then, and very frequently even now, that triple-expansion engines were not economical at light loads, but there was naturally a disposition in a place like South Shields, where there is a large shipbuilding industry, to follow marine practice in the electricity works; therefore it was decided to adopt marine triple engines if the same could be obtained which would be economical at light loads. Up to the time that the writer issued his specification it had been the practice to specify the steam consumption at full load only, but seeing that engines in electricity works, more especially those in works which supply light rather than power, are very seldom running at full load, it seemed that it would be much better to specify the steam consumption as an average of the half, three-quarter, and full load consumption, giving a bonus per pound if the consumption could be brought below a certain amount. The following was the clause inserted in the first specification: "Each engine, alternator, and exciter to be erected and coupled together and run continuously for 12 hours—viz., four hours at full load, four hours at three-quarter load, and four hours at half load. The steam consumption will be taken at each of the above loads, and the average consumption of water per kilowatt-hour measured at the terminals of the alternator not to exceed 28lb. If the contractor can bring the consumption of steam below 26lb. per kilowatt-hour, he will be paid £50 for each complete pound." From the tests which follow it will be seen that the results specified were greatly improved upon. A fuller account of the first of these tests was given in a paper that the author had the honour of reading before the Municipal Electrical Association.

TESTS AND SIZE OF ENGINES—100-KW. PLANTS.

Load.	Pounds of water per kilowatt-hour.		Pounds of water per indicated horse-power.	
	No. 1.	No. 2.	No. 1.	No. 2.
One-quarter..	32·4 A	—	—	—
One-half	23·78	27·3 B	12	13·1
Three-quarter	23·59	25·65 C	12·8	13·0
Full	23·83	25·75 D	13·1	13·7
120 %	—	23·2	—	12·4

—	Pounds of water per hour used by engines.	Pounds of water used per hour by pumps and lost.
A	828	629
B	1,365	958
C	1,924	992
D	2,360	1,140

The air-gap of No. 2 plant was not quite right when these tests were made.

200-KW. PLANTS—ALTERNATOR NO. 299.

—	12 per cent. overload.	Full.	¾	½	¼
Date	24/11/98	21/11/98	18/11/98	15/11/98	23/11/98
Time	2 hours	5 hours	5 hours	5 hours	4 hours
I.H.P.	363·25	315·45	259·68	172·59	122·32
KW.-hours.....	225	192	150	100	56·25
Revolutions	123	123·04	127·19	123·17	125·69
Water per I.H.P. ...	13·3lb.	13·26lb.	13·05lb.	13·41lb.	13·33lb.
Water per E.H.P....	16·6lb.	16·27	16·8	17·3	21·6
Water per KW.....	22·29	21·79	22·6	23·15	28·9
Combined efficiency.	83·06 %	81·59 %	77·49 %	78 %	61·6 %

Water per Kilowatt in Pounds.

12 per cent. overload	22·29
Full	21·79
Three-quarter	22·6
Half	23·15
Quarter	28·9
	5)118·73
	23·74

It will be noticed that the amount of water used per kilowatt on the average of the five loads is in these last plants exactly the same, whereas the amount used at any one load is different. This is owing to the fact that the valves were set a little differently. The tests on the 500-kw. plants were equally satisfactory, as will be gathered from the accompanying tables. A set of indicator cards taken from the McLaren-Richardson set are shown in Fig. 2.

The engines were made by Messrs. J. and H. McLaren, of Leeds, and they all have a standard speed of 125 revolutions with a 2ft. stroke, giving a convenient piston speed of 500ft. per minute. They have proved to be very satisfactory in use, and the author is only surprised that so few stations use this economical and convenient type of engine. It is certainly rather surprising to find in places where coal is much more expensive than it is on the Tyne, triple-expansion engines are almost unknown. The use of triple-expansion engines seems to be in the inverse ratio to the price of coal, whereas the opposite should really be the case. These engines are governed by

* Abstract of paper read before the Newcastle Local Section of the Institution of Electrical Engineers.

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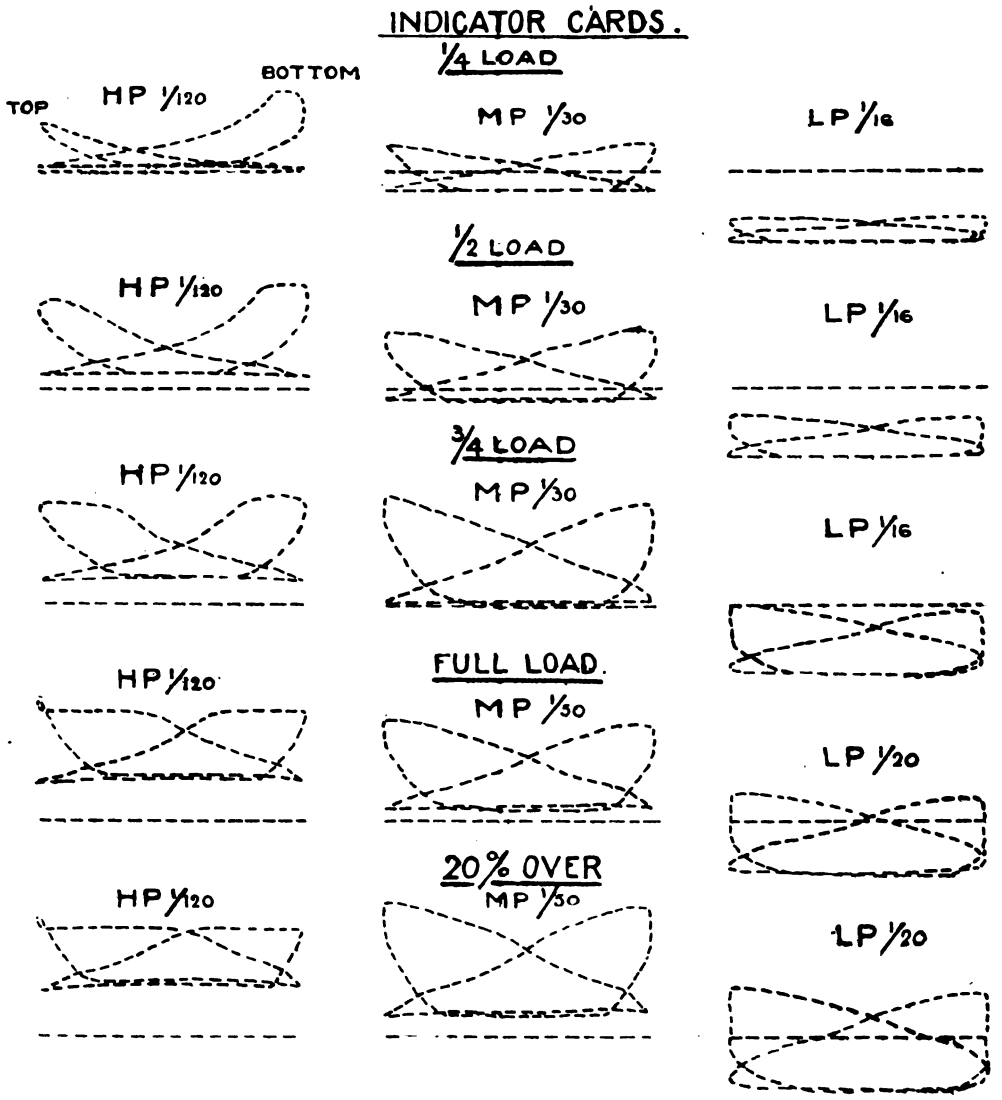

FIG. 2.—Indicator Cards taken from McLaren-Richardson Set, South Shields.

McLaren's shaft governor, which allows of the speed being increased or decreased whilst running. This acts directly on the eccentric of the high-pressure valve, thus varying the cut-off. The engines have the cylinders jacketed throughout. On the larger sizes all the slide valves, which are balanced, are of the trick or ordinary D type. As these engines have small clearances, it is advisable to place a large water separator on each. The engines are surface condensing, the condensers having two square feet per indicated horse-power. These condensers are attached to the back of the engines, each engine having its own condenser. The air-pump is worked from the cross-head of the intermediate rod. A splendid vacuum is obtained—viz., 28in. and 29in. if desired. In the case of the 500-kw. plants the valves of the air-pump are water sealed, there being 2in. of water on the top of the valves. These valves are Kinghorn's metallic valves. The nuts which hold the air-chamber in place are filled with lead so as to prevent the action of the water eating away the thread. Metallic packing is used throughout the engines, "Harbinger," "Combination," and "Elastic Metallic" all being used. This has been found a great advantage over the soft, fibrous packing.

ALTERNATOR No. 282.

—	12 per cent. overload.	Full.	¾	½	¼
Date	12/11/98	14/11/98	11/11/98	10/11/98	12/11/98
Time	2 hours	5 hours	6 hours	6 hours	4 hours
I.H.P.	378·55	322·45	255·5	176·3	104·64
KW.-hours	228·5	193·6	152	95·16	54·25
Revolutions	124·7	124·63	124·78	124·92	124·7
Water per I.H.P.	13·21lb.	13·06lb.	13·13lb.	13·37lb.	14·65lb.
Water per E.H.P.	16·33	16·23	16·5	18·49	21·08
Water per KW.	21·88	21·75	22·11	24·7	28·26
Combined efficiency.	80·9 %	80·09 %	79·7 %	72·3 %	69·48 %

Water per Kilowatt in Pounds.

12 per cent. overload	21·88
Full	21·75
Three-quarter	22·11
Half	24·7
One-quarter	28·26
	5) 118·70
	23·74

TEST OF 1,000-H.P. TRIPLE-EXPANSION CONDENSING ENGINE (COUPLED DIRECT TO 500-KW. SIEMENS ALTERNATOR) MADE BY MESSRS. J. AND H. MCLAREN, MIDLAND ENGINE WORKS, LEEDS, FOR THE SOUTH SHIELDS CORPORATION.—SUMMARY OF RESULTS FROM ENGINE.

	1	2	3	4
No. of trial	1	2	3	4
Date of trial	Dec. 15	Dec. 14	Dec. 13	Dec. 15
Load	Full.	¾	½	¼
Duration of trial	3½ h'rs.	6 hours	6 hours	1 hour
Mean boiler pressure	167	166·6	166	167
Temperature of engine-room	72° F.	69° F.	66·6° F.	72° F.
Mean revolutions per minute — Counter	125	125·8	125·6	125
Mean revolutions per minute — Tachometer	118·8	119·3	119	118·6
Mean steam-chest pressure — H.P. cylinder	160·2	164·9	164·7	157·3
Mean steam-chest pressure — I.P. "	63·2	44·9	30	17
Mean steam-chest pressure — L.P. "	8·01	1·71	- 4·75	- 4·3
Mean effective pressure — H.P. cylinder	47·73	43·36	33·62	22·71
Mean effective pressure — I.P. "	25·13	17·83	12·23	7·01
Mean effective pressure — L.P. "	12·55	8·59	5·62	2·99
Mean I.H.P. — H.P. cylinder	221	202	156·5	105·2
Mean I.H.P. — I.P. "	278	198·4	136	77·5
Mean I.H.P. — L.P. "	344	237·2	155	82
Mean I.H.P. — Total	843	637·6	447·5	264·7
Mean vacuum gauge reading	27·24	27·5	27·2	27·2
Mean temp. of condensed water at pipe	99·2	94·9	94	90·6
Mean water condensed in condenser per hour	10,419	7,489	5,081·6	3,179
Temperature of circulating water — Entering	48½°	48·7°	51°	—
Temperature of circulating water — Leaving	79°	83°	76°	—
Mean jacket water per hour — H.P. jacket	153	185·5	178·3	111
Mean jacket water per hour — I.P. "	240	210·6	172·8	83
Mean jacket water per hour — L.P. "	255	202	176·1	82
Mean jacket water per hour — Total	648	598·1	527·2	276
Mean jacket pressure — I.P. jacket	76·9	79·5	80	76·7
Mean jacket pressure — L.P. "	36·5	40	42·4	36
Total water condensed per hour (condenser + jackets) (lb.)	11,067	8,087·1	5,608·8	3,455
Total ditto per I.H.P. hour (lb.)	13·1	12·66	12·52	13·03
Total ditto per kilowatt-hour (lb.) — A.	21·5	21	21·58	26·8
Total ditto per kilowatt-hour (lb.) — B.	21·4	20·7	22·5	29·9
Total ditto per kilowatt-hour (lb.) — C.	20·9	20·3	21·4	26·5

(To be continued.)

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CHRISTMAS GREETINGS.

This year, owing to the respect which our compositors and printers bear for Boxing Day, we are issuing the *Electrical Engineer* on Christmas Eve. Theoretically, therefore, it should reach our subscribers on Christmas morning, and be in time to convey to them our Christmas greetings on the proper day. If the numerous other Christmas greetings with which the British Post Office has to deal should prevent ours coming in time, the belated receipt will not lessen the heartiness of the same. We wish all electrical engineers a happy Christmas, to be followed by a prosperous New Year. Although a fair number of electrical engineers engaged on our large electrical supply undertakings have duties to attend to on Christmas Day, the season has no longer the terror it used to have for these members of the profession. Only two years ago resident engineers in a number of towns in England had a wholesome dread of the Christmas load. What with manufacturers fifteen months behind in their deliveries, and the consequent insufficiency of plant, the question was always before them as to whether a 300-h.p. engine would continue to give 450 h.p. without a murmur. There was also the question as to whether the overworked dynamos would not be cooked beyond repair before the turkeys came on on the 25th. All these nightmares of the resident engineer are now things of the past, and in 1901 he can read in his office the reports of his shift engineer with a calm mind, and speculate on the great increase in his salary which will result from the enormous loads he is successfully supplying. Still, even to-day Christmas to the central-station engineer is a time when the maximum load has to be considered rather than the load factor, but he has no longer to burn candles in the station, so that all available juice may be turned into the unsatiated mains. A perusal after dinner on the 25th of Mr. Wright's paper before the Institution of Electrical Engineers may lead to pleasant dreams of the happy day when the traction and motor loads will have wiped out the undue importance of the peak in the lighting load curve. To the electrical manufacturer this Christmas comes as a pleasant break in a strenuous fight against foreign competition. The days are gone by, which are referred to above, when the central-station engineer had to beg the manufacturers for plant with which to supply the Christmas load. Still, in spite of the lowered prices due to the electrical crisis in Germany, we are pleased to see that our electrical manufacturers are, as a rule, facing the storm well. News reaches us of the standardisation of machines, the reorganisation of old works, and the building of new shops, which are signs that English manufacturers will not give way to temporary panics; and that they are preparing in dark times for the work of the future. Although in the past these manufacturers have not gone ahead so fast as they might have done, they can, as a rule, congratulate themselves at the present time that they have been working for cash, and not for paper, and that their financial positions are sound. This year one's thoughts on Christmas Day will go out to the three hundred electrical engineers serving in South Africa. While we have done our best to make their Christmas fare ample, we know that they are on no pleasure trip, and that short commons and hard work are regularly borne by them cheerfully. There is some credit in being cheerful when repairing a telegraph line in a country invested with snipers, and where a man knows that his position up a telegraph post makes him an attractive and ready mark for hidden marksmen. The work done by these men and the other contingents of the Electrical Engineers (R.E.) Volunteers in South Africa is work of which all members of our profession are proud, and we know that

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many of these men who are hastening the conclusion of the war will similarly quicken the revival of industry after the war is over. We cannot only hope that a large number of them will in the new year get a fair share in the profits of their labours in this direction.

FORTHCOMING EVENTS.

SATURDAY, DEC. 28.

Royal Institution.—At 3 p.m., Prof. J. A. Fleming on "Wave Motion, Waves and Ripples on a Water Surface."

TUESDAY, DEC. 31.

Royal Institution.—At 3 p.m., Prof. J. A. Fleming on "Waves and Ripples made by Ships" (Lecture II.).

THURSDAY, JAN. 2.

Rontgen Society.—At 8.30 p.m., ordinary meeting. Mr. C. E. S. Phillips on "The Function of an Auxiliary Electrode in X-Ray Bulbs"; Mr. Prosper H. Martin on "Radiography Applied to Dental Surgery."

Royal Institution.—At 3 p.m., Prof. J. A. Fleming on "Waves and Ripples in the Air" (Lecture III.).

SATURDAY, JAN. 4.

Royal Institution.—At 3 p.m., Prof. J. A. Fleming on "Sound and Music and Singing Flames" (Lecture IV.).

TELEPHONE CONFERENCE.

On Monday last at the Guildhall, in the city of London, a conference was held of representatives from all the local authorities within the London telephone area. It was opened by the Lord Mayor, Sir Joseph Dimsdale, M.P., who in a few well-chosen words welcomed the delegates. He said that the meeting had been convened without any idea of party politics, and he hoped that the subject before them would be discussed only from a business point of view. Just as the Post Office system and the telegraph system had become necessities to every business man, so the telephone had grown to be equally an essential part of their daily career. It was from that point of view that they should treat the matter before them. Alderman A. C. Morton was then elected chairman of the conference, and Mr. H. M. Bates the clerk of the conference.

Mr. ALDERMAN MORTON, in taking the chair, said that all the 81 local authorities within the London telephone area were represented there that day. Seventy-six of these had sent three delegates each, and the other five, two delegates, making in all 238 representatives. He then reviewed the situation, condemning what he called the excessive charges under the Post Office agreement. He said that the promises made under Mr. Hanbury's *régime* had not been fulfilled by the Postmaster-General. His belief was that the agreement was illegal, and could not be sustained. All such agreements should be submitted to Parliament for approval, as the 1893 agreement had been. He believed that the company would have had to reduce its terms if true competition had been established. As regards the value of intercommunication, he held that this was equally necessary to the National Telephone Company as to the Post Office.

The CLERK then submitted the statement of the rates of subscription. Four resolutions respectively from the metropolitan borough of Southwark, the metropolitan borough of Wandsworth, the Precinct of St. Ann, Blackfriars, Farringdon Within Ward, and the Langbourn Ward Club were read, and also the resolution which had been passed at 25 wardmotes. Amongst the letters which were then read was one from Mr. A. Nicholson, of Tunbridge Wells. It informed those present that within five months of the opening of the Corporation's competitive exchange in Tunbridge Wells they had obtained six times as many subscribers as the National Company had when the competition was commenced. Only 20 per cent. of the subscribers belonged to both systems, and they in this way obtained connection with 1,000 subscribers on two systems for less money than they previously paid for a single instrument connecting with only 200 subscribers

Another letter was read from a gentleman in which the correspondence between himself and the National Telephone Company showed that the earliest date at which he could get connection from the company on the message rate system would be February, 1903.

The following resolution (A) was then proposed by Mr. HUDSON, and seconded by Mr. YATES (Holborn): "That this conference of local authorities, representing the London telephone area—about 634 square miles, with a population of about six millions, and a ratable value of about fifty million pounds—desires to call attention to the report of the House of Commons Select Committee on Telephones, dated Aug. 8, 1898, which, among other recommendations, stated: 'On reviewing the whole of the evidence, your committee is strongly of an opinion that general, immediate, and effective competition by either the Post Office or the local authority is necessary, and consider that a really efficient Post Office service affords the best means of securing such competition. We further consider that when in an existing area in which there is an exchange, the local authority demands a competing service, the Post Office ought either to start an efficient telephone system itself or grant a license to the local authority to do so. Your committee in thus recommending a Post Office service assume that it will constitute a real and active competition.' That the said report was afterwards practically adopted by Parliament. That the London people fully expected that the Post Office authorities would carry out the promises thus made, and give to London, by 'real and active competition,' an efficient telephone service at reasonable and fair charges, which the Select Committee declared was 'a service so important to the trade of the country.' That this conference desires to strongly protest against the proposed scale of charges as set out on the Postmaster-General's circular, to ask for a revision and reduction of the proposed charges, and to express the hope that the agreements with the National Telephone Company referred to will not be ratified until Parliament has had an opportunity of considering them and the proposed scale of charges. This conference also desires to express its grave regret that the Postmaster-General did not in any way consult the London local authorities before fixing the rates for the telephone service, this being the more to be regretted as he does seem to have consulted the National Telephone Company throughout."

Mr. BEECHCROFT (of the London County Council) said that the veto which the London County Council had over the laying of underground wires was practically taken away by the agreement they were discussing. He urged that any lease of wires granted by the Postmaster-General to the National Telephone Company should be terminable on Jan. 1, 1905, when the rates were to be revised.

Mr. BENN followed on the same lines, and urged that even if the Postmaster-General had the right to make such an agreement, it was hardly fair for it to be done without consulting the local authorities. He held that their veto had been stolen.

The CHAIRMAN here interposed that the Corporation had fought the Postmaster-General before on this question as to the laying of mains under the public streets to be used by companies. The Corporation had then received a letter from the Postmaster-General stating that this would in no case be done in future without consulting the Corporation of the city of London. This course had not been followed in the present instance.

The next speaker, who hailed from Willesden, spoke in favour of the Postmaster-General's agreement and against telephone competition. It was only in Norway and Finland that competition existed, and we should not follow these countries. The argument about the streets was fallacious, because it was better to have only one authority ripping them up instead of two. By the agreement the Postmaster-General had obtained free intercommunication with 44,000 subscribers.

The CHAIRMAN said that a suggestion to add words to the effect that the conference protested against any action on the part of the Post Office in transferring to the National Telephone Company any statutory rights the

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Postmaster-General might have in regard to laying cables, might, if the conference so desired, be taken as part of the resolution.

This was at once unanimously agreed to.

The resolution was then passed unanimously, as were also the following resolutions, which were numbered (B), (C), and (E) on the agenda. The resolution (D) was withdrawn as being covered by resolution (A) :

(B) "That in the opinion of this conference the charge per annum for the use of a telephone in the London telephone area should be based upon the capital charges quoted by Mr. Hanbury in the House of Commons in 1899 for an 'unlimited service,' and that the other charges for the use of telephones should be proportionately reduced."

(C) "That petitions (to be signed by the chairman and clerk of this conference) embodying the foregoing resolutions be presented to the Prime Minister, the First Lord of the Treasury, the Chancellor of the Exchequer, and the Postmaster-General, and that they be respectively requested to give an early reply. That this conference, at its rising, stands adjourned to an early date to receive and consider those replies, and that the Lord Mayor and Corporation be requested to kindly allow the use of the Guildhall Council-chamber for the adjourned meeting, such meeting to be called by the clerk of this conference; not less than three days' notice of such meeting to be given to the delegates."

(E) "That copies of the minutes of proceedings be forwarded to the metropolitan members of Parliament, the clerks of the various councils in the London telephone area, and to each of the delegates."

After a vote of thanks to the chairman, the delegates adjourned to the Mansion House to take tea with the Lady Mayoress.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of he paper. Questions may be sent at any time.

[ERRATUM.—There was an error in Question No. 439 last week. The word should be read *avoided*, not worked.]

QUESTIONS.

441. How is it that strengthening the field in the Elihu Thomson wattmeter increases the speed of the armature, seeing that strengthening the field of a shunt motor at constant pressure decreases the speed of armature?—R. CAMPBELL.

442. In a central station are three 300-kw. Allis-Corliss cross-compound surface-condensing engines with cylinders 16in. and 32in. by 3ft. stroke; steam 160lb. per square inch. At times the low-pressure pistons make a terrific grunting noise, accompanied by great vibration, and occasionally by squeaking of exhaust valves. This is immediately stopped by reducing the vacuum. Can any reader explain this?—BARON.

ANSWERS.

Question No. 435.—What is the cheapest method of reducing the light given by incandescent lamps?

Best Answer to No. 435 (*awarded* 10*s.*).—The reduction of the light given by incandescent lamps connected across alternating-current supply mains, and at the same effect a reduction in watts consumed, is best accomplished by using a transformer, especially if first cost is not of paramount importance. The light varies directly as the voltage in the ratio as 6 : 1, or 1 per cent. drop in volts equals 6 per cent. drop in light on a 100-volt circuit. The transformer could be wound to give 50 volts on secondary, and connections taken off at 92 and 84 volts. The light will be about 50 and 100 per cent. lower respectively; 50 volts will give a very dim light. The Electrical Development Syndicate, Halifax, make a good regulator for alternating current, and Fig. 1

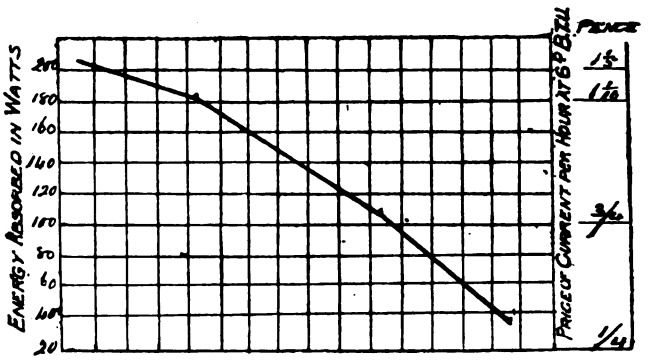

FIG. 1.

is a curve showing the results obtained from a 250-watt regulator made by them. With continuous current it is not so easy to effect a reduction in watts consumed and light at the same time. One arrangement that would be suitable where nightlights are required, such as hospitals, nurseries, corridors, etc., is shown in Fig. 2. It is simply a

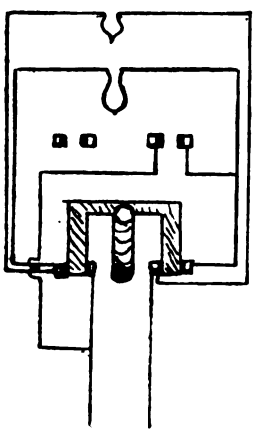

FIG. 2.

double-pole two-way switch with the connections arranged for two lamps, so that they can either be run in parallel or in series. If this is not suitable, a 2·5-c.p. lamp shaded would probably suffice, and would effect a still greater economy in the lighting bill, and also in the first cost, a two-way single-pole switch being only required.

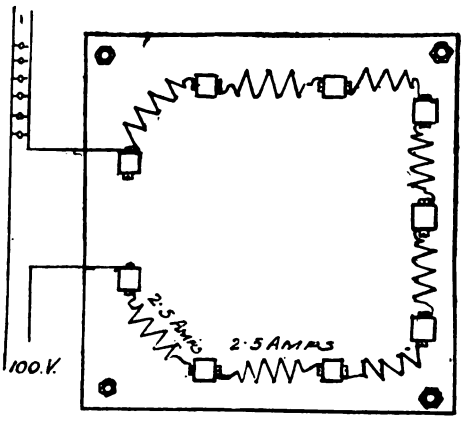

FIG. 3.

For theatre, etc., lighting an arrangement like that shown in Fig. 3 would be necessary with continuous current. The resistance shown in the above sketch is carried on an iron frame, the wire being carried round insulators at the bottom. The connectors are carried on a slate base or slab fixed to the top of frame. The coils are connected in

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series through the connectors. Each coil is wound with 32 yards of No. 20 S.W.G. Beacon resistance wire (the makers give the resistance of this wire as approximately 1·33 ohms per yard). In the resistance described above, each coil takes 2·5 amperes at 100 volts when at working heat. The eight coils when in parallel will take 20 amperes, and in series ·31 ampere. Therefore, the resistance will absorb from 30 to 2,000 watts. This resistance is far preferable to a water resistance, and when constructed in the above manner fire risks are obviated. Customers are apt to regard the water resistance as an apology for a light regulator.—W. C. F.

Answer to No. 435 (*awarded* 5*s.*).—As the candle-power of incandescent lamps falls off very rapidly as the voltage at the terminals of the lamps is diminished, methods of reducing the light by putting resistance in series with the lamps are very uneconomical. These methods are very little cheaper than putting a thick shade round the lamp, and the fire risk is about the same in the two cases. To get light economically, lamps must be run at approximately their normal pressure; hence one good method is to use double-filament lamps. In one kind of lamp, by merely altering the position of a pin, a 5-c.p. filament, a 10-c.p. filament, or both filaments in parallel giving 15 candles can be put in the circuit. One drawback to these lamps is that their life as lamps of variable candle-power is the same as that of the weaker filament, and they are 50 per cent. dearer than two separate lamps of 5 c.p. and 10 c.p. respectively.

Another more primitive method would be simply to take out the ordinary lamp and put in its socket a low candle-power lamp kept specially for the purpose. For 100-volt circuits economical lamps of 3 c.p. can be obtained, and, doubtless, if there were a sufficient demand, lamps of even lower candle-power would be put on the market.

On alternating-current circuits a theoretical solution would be to put a low-voltage lamp in series with a choking coil in the circuit. The writer has tried this method with indifferent results. He put a 1-c.p. 20-volt lamp in series with a choking coil on a 100-volt alternating circuit. The choking coil consisted of ½lb. of No. 16 double cotton-covered copper wire, wrapped around a bundle of No. 20 galvanised iron wire which had been well rusted. The voltage across the choking coil was 89, across the lamp 20, and across the whole circuit 100. Theoretically the voltage across the choking coil ought to have been 98, since $98^2 + 20^2 = 100^2$. The low voltage was probably due to the work done in the core in hysteresis and eddy currents, as the core heated considerably. The lamp had a very long life, but calculation showed that the energy expended in the choking coil was at least three times that expended in the lamp. Hence the method was certainly not economical.—J. C. R.

Answer to No. 435 (*awarded* 5*s.*).—The above question is somewhat vague, as one is left to infer whether the cheapest method means simply cheapest as regards apparatus required, or whether economy in current consumption is meant. Again, it is not stated how many lamps require to be dimmed or for what purpose. Without these data it is difficult to say which would be the best method to adopt. The cheapest method and the one commonly adopted is simply to place a variable resistance in series with the lamps required to be dimmed. This may be either a metal or a liquid resistance, each having its own advantages and disadvantages. For single lamps, as, say, a bedroom light, required to be dimly burning all night, switches are on the market containing a wire resistance, which by simply turning a knob can be inserted at will, and the light correspondingly reduced. It is, however, an uneconomical way of reducing the light, as, though a certain amount of energy is saved, the greater part is wasted in useless heating of the resistance, and it is preferable in a case like the above to put a special low candle-power lamp in and to switch it on for all-night burning. For a room containing two lamps a simple and economical method of altering the light would be to arrange the lamps so that they could either be connected in series or in parallel—in parallel for ordinary burning, and in series when the light is required to be dimmed, all the extra apparatus necessary being a double-pole throw-over switch. The connections would be made as shown in sketch (see Fig. 1). *a* and *b* are the two lamps, *c* and *d* are two ordinary single-pole switches, and E is a double-pole throw-over switch. In the bottom position, as shown in sketch, the two lamps, if switched on at *c* and *d* will both be in series, but by raising the handle and throwing the jaws in contact with the top blocks both lamps will be in parallel, and one or both may be used in the ordinary way. The bar connecting the two sides of the switch is, of course, made of some non-conducting substance, such as ebonite or hard wood.

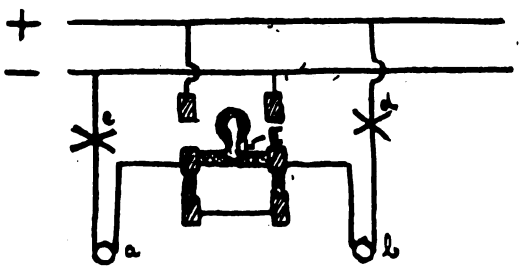

Fig. 1.

The above arrangement would in certain cases be about the best method to adopt, as there would then be no danger of fire from heated resistances, and practically nothing to get out of order, whilst the current consumption would be reduced to about one half the amount required for one lamp, and would be usefully employed in "glowing" the lamps. The greatest advantage gained by reducing the light is that the life of the lamp is considerably lengthened, otherwise there is little to be said in its favour, except, of course, where it is necessary for effect, as, say, on a theatre or music hall stage. For this purpose liquid resistances are generally adopted and put in series with the different circuits. A liquid resistance consists essentially of an earthenware jar containing a weak acid or alkaline solution, into which are placed two metal plates or blocks with a suitable means of altering the distance between them, and so increasing or decreasing the resistance of the circuit. The advantages claimed for a liquid resistance are (1) freedom from danger of fire by heated metallic resistance; (2) less space required; (3) more uniform variation of light than can be obtained by wire resistance; (4) no sparking, and consequently no contacts to keep in order; (5) the cost is less. For ordinary purposes, however, the liquid resistance can scarcely be recommended, as they are rather "messy" things, requiring frequent filling up and overhauling, and giving off when in use gases or steam. The ideal way to reduce the light would be to put some back E.M.F. cells in circuit, so that the energy not required for the lamps could be stored up in the battery instead of wasted in useless resistance. The cost of such a method would, however, in the majority of cases be out of all proportion to the energy saved. If it is simply a case of the white-hot filament in the lamp being too bright for the eyes, the best method would be to get a frosted lamp, as the light then is more evenly distributed, and is much softer to the eye. To dull lamps by resistances, except in special circumstances, is not to be recommended. A far better plan where the light is constantly required dull is to put in lamps of a higher voltage than the supply, the voltage of the lamps required being determined by actual experiment.—C. I. S.

Answer to No. 435 (*awarded* 5*s.*).—The light (candle power) given by an incandescent lamp has been found by experiment to vary approximately as the sixth power of the E.M.F. at its terminals, so that only a small reduction in voltage is required in order to greatly reduce the light. Thus a reduction of only 20 per cent. in voltage reduces the candle-power to something like one-fourth of its original value. The best and cheapest method of producing this volt reduction depends on the nature of the supply, and also on the relative length of time during which the lamps are to be bright and dim.

If supplied from an alternate-current system, there is no doubt that an adjustable choking coil inserted in series with the lamp or lamps forms the most economical arrangement

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as far as power consumption is concerned; but at the same time it would have a higher first cost than a simple resistance. Unless, therefore, a fairly large number of lamps is under consideration, so that the power saved becomes of importance, it would probably pay best to use a plain resistance in series with the lamp or lamps. Such a resistance reduces the watts consumed as compared with the consumption at full brightness by reducing the current through the lamp, and therefore also the product of volts × amperes, but it does not do this to quite the same extent as a choking coil would. Thus, suppose a single 60-watt (16-c.p.) lamp is to have its terminal voltage (and current) reduced by 20 per cent., the watts taken by lamp and choking coil would be $60 \times \left(\frac{80}{100}\right)^2$ + loss in choking coil, which need not exceed about 3 watts = 41·5 watts.

If, on the other hand, a resistance is used, the loss in lamp and resistance will be $60 \times \frac{80}{100} = 48$ watts. This small saving in watts per lamp would only justify the use of a choking coil in the case of a large number of lamps, all of which had to be reduced simultaneously by means of a coil, as in theatre lighting; but with single lamps a small resistance, either separate or, as sometimes supplied, forming part of the lampholder, would be the neater and less expensive arrangement. When the supply is a continuous-current one, the possibility of using a choking coil disappears, and the resistance is practically the only resource.—Q.

Question No. 436.—What is the action of soda and of sulphuric acid in water resistances? Why are they used, and which of the two is the best to use?

Best Answer to No. 436 (*awarded* 10*s.*).—The use of soda and sulphuric acid increases the conductivity of water, and makes it possible to reduce the resistance of a given volume of water to almost any desired extent. Water resistances are mostly used with iron plates, and on these sulphuric acid has a deteriorating effect; soda, being an alkali, does not attack them, and is therefore recommended. Water resistances are often used for absorbing the power of a dynamo in testing, and can be cheaply and readily constructed. A tank, or a number of them, is filled with plain water, and into it is inserted two iron plates, suspended on the edges of the tank by means of wooden bars bolted to the top of the plates; it is usual to fix a piece of wood at the bottom of the plates also, to prevent them being accidentally brought in contact with each other. The wires, positive and negative, are connected to the plates, or, in the event of a number being required, they should be connected in pairs in parallel. The resistance of the water varies as the surface of the plates, as their distance apart, and, inversely, as the conductivity of the water. A suitable area of plate should be chosen. They should be arranged in the tank, or tanks, so as to permit of an adjustment of their distances apart, and a solution of soda can then be added by trial until the desired conductivity is obtained. The writer has frequently used a number of barrels as a temporary water resistance, the plates being, say, 14in. or 15in. broad by about 2ft. 3in. deep (cut so as to clear the bottom of the barrel by 6in.). He found that eight such barrels, connected in parallel, were capable of absorbing 350 amperes without undue heating on a six hours' test. A cold-water supply with a hose pipe should be at hand, and the tanks should have a cock or a plug to enable the heated water to be partly drained off.—R. A. C.

Answer to No. 436 (*awarded* 5*s.*).—Clean pure water alone is practically a non-conductor of electricity, but when it holds in solution alkalies such as soda or acids, such as sulphuric acid or salts, which are bodies formed by the union of an acid and a base, whether an alkali or a metal, then it can conduct electricity, and its resistance may be varied within certain limits by adding more or less of these bodies. If such a salt as sulphate of copper were added to the water, the action of the current would deposit the copper on one of the plates (electrodes) immersed in it, and it would set free the sulphuric acid at the other plate, and a similar action would occur with other metallic salts, but with soda no such disturbance occurs, as for practical purposes the soda is not electrolysable. However, in practice, where the current is sometimes passing and sometimes not, carbonic acid is absorbed from the air, and this will attack lead plates or iron plates slowly. Sulphuric acid is free from all the above disadvantages, and does not injuriously attack lead plates used as electrodes, although the electrolysis of the water oxidises one and reduces the other (the negative). Iron plates cannot be used with sulphuric acid, because they would be dissolved. I consider that sulphuric acid is by far the best to use. Carbon plates are not suitable for electrodes in water resistances, because the positive plate is disintegrated by the action of the current.—F. G. A.

TRADE NOTICES AND NOVELTIES.

Surveying and Drawing Instruments.

From Messrs. W. F. Stanley and Co., opticians, Great-turnstile, Holborn, W.C., we have received a catalogue of their surveying and drawing instruments. The instruments described and illustrated comprise the entire requirements of either a surveyor's or a drawing office in the direction stated. We are told in the preface that drawing instruments have been improved in detail, the working parts being now made by exact machines. One of a number of separate leaflets included with the catalogue describes Prof. Fuller's calculating slide rule. The range of this calculating machine enables, besides the operations of multiplication and division, the results requiring the reciprocals, powers, roots, or logarithms of numbers, to be easily determined. By adopting a cylindrical form for the rule, a length of scale of 500in. is obtained, the number of divisions being 7,250.

Blotting-Pad and Diary for 1902.

We are indebted to the Electrical Power Storage Company, Limited, of 4, Great Winchester-street, E.C., for one of their New Year's blotting-pads. The practical form and excellent finish of this annual are well known, while the insurance against railway accidents for £500, which it covers, provided an attached coupon be signed, may be instanced as another distinctive feature.

LEGAL INTELLIGENCE.

THE SANDING OF TRAMWAY TRACKS.

The Irish Court of Appeal, consisting of Lords Justices Fitzgibbon, Walker, and Holmes, have decided an important point relating to the liability of tramway undertakings to sand their tracks. Some time ago a Mr. Fitzgerald recovered in the Court of First Instance a sum of £1,000 damages from the Dublin United Tramways Company for personal injuries received through the slipping of his horse between the tramrails in Grafton-street, Dublin, the jury finding that the accident was due to the omission of the defendants to keep the pavement in good condition and repair by putting sand on it. An appeal was brought against this verdict, and judgment was delivered last Thursday.

Lord Justice Fitzgibbon, in giving judgment, said there was persuasive evidence at the trial that the only reasonable way of preventing slipperiness was by spreading sand on the pavement. When the defendants took off their own horses for electric traction they ceased sanding. Discussing some of the particular sections of the Electrical Power Act, 1897, and preceding Tramway Acts, his lordship said that as to one and all of these Acts, without qualification or exception, it had been laid down as a condition of the user of the streets by the defendants that they, at their own expense, should, "at all times," keep the roads in good condition, paved with such materials and in such way as the road authority "shall direct." The statutory obligation to maintain the road carried with it the implied power to do all reasonable acts necessary for the performance of that duty. The obligation of the company was subject to the limitation that they were not to ensure against all dangers and all accidents. In his opinion the defendants were liable, and the appeal should be dismissed with costs. Lord Justice Walker and Lord Justice Holmes concurred.

A stay of execution, pending an appeal to the House of Lords, was granted.

ELECTRICITY METERS.

Alleged Infringement of Patent.

Judgment was given by the Court of Appeal, consisting of Lords Justices Vaughan Williams, Romer, and Cozens-Hardy, on Friday in the case of Chamberlain and Hookham, Limited, v. the Mayor, etc., of Bradford. As reported in our issue of 6th inst., the action was one for alleged infringement of the plaintiffs' patent relating to electricity meters, and in the Chancery Division at the trial Mr. Justice Farwell decided in favour of the defendants. The Court of Appeal have now decided that there was no infringement of the patent in question by the defendants, and affirmed the decision below. The appeal was accordingly dismissed, with costs.

Pressure on our space compels us to hold over their lordships' full judgment till next week.

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NEW COMPANIES REGISTERED.

Stockport Engineering Company, Limited.—Capital, £5,000. Objects: to adopt an agreement with H. Pearson and J. H. Nuttall for the acquisition of the business carried on at Manchester as Pearson and Nuttall, or Pearson and Co., and to carry on the business of iron-founders, mechanical engineers, manufacturers of agricultural implements, boiler makers, tool makers, electric, gas and water supply engineers, manufacturers of electric apparatus, suppliers of electricity, etc.

Paris Singer Electric Carriage Company.—Capital, £5,000. Objects: to manufacture, sell, let on hire or otherwise deal with electric motors, cycles, carriages, vehicles, launches, flying machines and the like, and their parts and accessories.

Cape Town Consolidated Tramways and Land Company, Limited.—Capital, £400,000. Objects: to adopt an agreement with George Pauling; to acquire lands, buildings, and heriditaments of any tenure in South Africa, or elsewhere, to acquire any tramways, railways, bridges, ferries, canals, roads, telegraphs, telephones, or other means of communication, to acquire rights over or in connection with any such tramway, railway, bridge, ferry, canal, road, or other work or undertaking, to work the company's tramways or railways by horse, electrical, steam, or other power. etc.

APPOINTMENTS VACANT.

Assistant Engineer, Oldham Corporation Electricity Department, salary £100, Dec. 31. Particulars in our advertisement columns.

Distributing Engineer.—The Hackney Borough Council electricity works, £250 per annum. Full particulars in our advertisement columns.

Engineer-in-Chief, South Lancashire Electric Traction and Power Company, Limited, £500 per annum, Jan. 15. Full particulars in our advertisement columns.

Electrical Draughtsman, with knowledge and experience of station switchgear. Full particulars in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Barking.—The Urban District Council invite tenders for additional generating plant by Jan. 24.

Ghent.—The Municipality require tenders for the electric lighting of the town. Tenders must be posted before March 1, 1902.

Elstree (Herts).—The Parish Council invite tenders for lighting the parish of Elstree with 20 lights from January to April, 1902. Tenders by Jan. 6.

Bournemouth.—The Town Council invite tenders for feeder cables, pilots, arc lighting cables, conduits, etc. Tenders by Jan. 6. Details in our advertisement columns.

West Bromwich.—The Council invite tenders for the reconstruction and electrical equipment of about 12 miles of tramway in the borough. Tenders by Jan. 13. Details in our advertisement columns.

Brussels.—The administration of the Belgian Government Telegraphs will receive tenders for 7,300 telegraph posts by Jan. 8, 1902. Specification No. 12 may be obtained at the office of the department, Brussels.

Paris.—The Under-Secretary of State for Posts and Telegraphs, Rue de Grenelle, 103, requires tenders for three lots of submarine cable of 25 km., 60 km., and 60 km., and for 30,000 kg. of 8mm. iron wire. Tenders by Jan. 7, 1902.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of steam, exhaust, feed, and drain pipes, feed pumps, feed heater, feed tank, tools, etc. Tenders by Jan. 8. Details in our advertisement columns.

Brussels.—The Belgian Government Railways invite tenders for the plant, etc., for an electric lighting station at Marchienne au Pont. The estimate is 4,027,282fr. A deposit of 3,600fr. is required. Tenders by noon on Jan. 20, 1902.

Stepney.—The Electrical Committee invite tenders for the installation of electric wires, lamps, and other fittings on the premises of private consumers in the borough on the basis of a fixed annual charge per point wired. Details in our advertisement columns.

Cairo.—The Public Works Department require tenders for the public and private electric lighting of the towns of Suez and Damanhur. For particulars, application may be made to the Electrical Engineer's Office at the Public Works Department, Cairo, by Jan. 15.

Hornsey.—The Urban District Council invite tenders for the supply and erection of steam, exhaust, water, and other pipes, valves, tanks, footplates, and accessories, and elevator and transporter, electric motor and switch gear. Tenders by Jan. 15. Details in our advertisement columns.

Louvain (Belgium).—The contract for the lighting of Louvain by gas will expire on Jan. 1, 1905. The Municipality are therefore prepared to receive, before Dec. 31, 1901, proposals for lighting the city, either by gas or electricity, or by the two systems combined, from gas or electric light companies. Address the Burgomaster, Louvain, Belgium.

West Ham.—The Council invite tenders for four sets of surface condensing plant, each to deal with 40,000lb. of steam per hour, complete with electrically-driven air and circulating pumps; and one travelling crane, to carry 30 tons, span 67ft. Tenders by Jan. 14. Details in our advertisement columns.

Nantwich.—The Urban District Council invite tenders for the supply and erection of boiler-house plant: one water-tube tube and one Lancashire boiler, fittings, steam and exhaust pipes, etc.; engine-house plant: continuous-current steam dynamos, pumps, etc.; switchboard, etc., underground mains, lamp posts, etc., accumulators, meters, crane, etc., dust destructor. Tenders by Jan. 6, 1902.

Barnstaple.—The Town Council invite tenders for the supply and erection of three straight water-tube or Economic boilers, fittings, steam and exhaust piping, condensers, three high-speed engines (220 i.h.p. each), three 125-kw. c.c. dynamos, switchboard, underground mains, lamp-posts, etc., meters, accumulators, crane, etc. artesian well. Tenders by Jan 16. Details in our advertisement columns.

Madrid.—The Public Works Department invite tenders for an electric tramway from San Sebastion to Toloso, with power to work same for a maximum of 60 years, after which the undertaking becomes Government property without compensation. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m. Tenders by Jan. 27.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station of (a) main high-tension three-phase switchboards at generating station, (b) exciter and auxiliary switchboards at generating station, (c) high-tension three-phase switchboards at 10 sub-stations, (d) low-tension switchboards at 10 sub-stations. Tenders by Jan. 21. Details in our advertisement columns.

Middlesbrough.—The Electric Lighting Committee invite tenders for the supply and erection of—engine-house plant: one 300-kw. high-speed steam dynamo and accessories; switchboard panels: panels and instruments for dealing with the above plant, and three new feeders; condensing apparatus and pipework: ejector condenser for dealing with 8,100lb. of steam per hour, and steam, exhaust, and feed pipes; feed pump and economiser: one feed pump and extension to existing economiser. Tenders by Jan. 21. Details in our advertisement columns.

Reading.—The Corporation invite tenders for the supply and erection of the following plant, works, machinery, and rolling-stock for the purposes of the intended electrical tramways: (Section A) water-tube boilers, superheaters, and mechanical stokers; (B) fuel economiser; (C) piping, feed pumps, etc.; (D) compound condensing direct-coupled engines; (E) surface condensers, air-pumps, circulating pumps, piping, etc.; (F) electric generators; (G) switchboards and connections; (H) electric lighting; (I) overhead travelling crane; (K) motor trucks; (L) motors and electrical equipment for cars; (M) car bodies; (N) trolleys; (O) miscellaneous minor works and fittings. Specifications, etc., may be obtained from the Borough Engineer, Town Hall, Reading. Tenders by Dec. 28.

Rockhampton (Queensland).—The Municipality invite applications from companies desirous of undertaking the construction and working a system of electric tramways under the Queensland Tramways Act of 1882 and the Amendment Act of 1890, within the municipality of Rockhampton aforesaid. Rockhampton, with a population of 15,461, is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882 and the Amendment Act of 1890, copies of which may be seen at the office of this paper. Applications to be forwarded to Mr. H. W. Johnson, mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31.

RESULTS OF TENDERS.

Cardiff.—The tender of the British Insulated Wire Company has been accepted, at £12,656, for supply of cables.

Maidstone.—A tower telescopic ladder, for use on the arc lamps, has been purchased, at a cost of £21, from Heathman and Co.

London.—The London School Board have received the following tenders for electric light pendants in the evening continuation schools department at the head offices:

Peto and Radford	£45	0	0
Rashleigh Phipps and Co.	44	0	0
J. C. Christie	39	15	0
Lund Bros. and Co., 43, Parkhurst-road, N.*	34	13	0

* Recommended for acceptance.

Huddersfield.—The following is the list referred to in our last issue:

Mather and Platt, Limited, 750-kw. traction generator	£2,050	0	0
J. Horsfield and Co., Lancashire boiler and fittings	787	0	0
Babcock and Wilcox, Limited, steam and boiler feed pipes	290	8	0
T. and T. Vicars, Limited, mechanical stoker and conveyor	195	0	0
E. Green and Son, economiser	124	0	0
B. Thomas, switchboard	1,465	0	0
British Electric Car Company, car bodies, trucks, and electric car equipment	12,737	10	0
Fairburn, Lawson, Combe, Barbour, and Co., condensing engine	3,750	0	0
B. Thomas, cables, etc., and conduits	10,509	0	0
T. W. Broadbent, boosters (including spares)	1,440	0	0

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Hammersmith.—The following is the complete list of tenders for electricity meters referred to in our last issue:

175 5-ampere.			
Electrical Company	£402	10	0
Chamberlain and Hookham	568	15	0
Geipel and Lange	577	10	0
British Thomson-Houston Company	561	9	2
British Westinghouse Electric Company (accepted)	577	10	0
General Electric Company	612	10	0
80 10-ampere.			
Electrical Company	184	0	0
Chamberlain and Hookham (accepted)	280	0	0
Geipel and Lange	296	0	0
British Thomson-Houston Company	320	0	0
British Westinghouse Electric Company	360	0	0
General Electric Company	340	0	0
40 15-ampere.			
Electrical Company	139	10	0
Chamberlain and Hookham (accepted)	150	0	0
Geipel and Lange	166	0	0
British Thomson-Houston Company	168	0	0
British Westinghouse Electric Company	207	0	0
General Electric Company	195	0	0
50 25-ampere.			
Electrical Company	174	7	6
Chamberlain and Hookham (accepted)	187	10	0
Geipel and Lange	230	0	0
British Thomson-Houston Company	237	10	0
British Westinghouse Electric Company	281	5	0
General Electric Company	262	10	0
20 50-ampere.			
Electrical Company	76	10	0
Chamberlain and Hookham (accepted)	80	0	0
Geipel and Lange	96	10	0
British Thomson-Houston Company	100	0	0
General Electric Company	107	10	0
5 75-ampere.			
Electrical Company	19	2	6
Chamberlain and Hookham (accepted)	21	5	0
Geipel and Lange	25	0	0
British Thomson-Houston Company	26	5	0
British Westinghouse Electric Company	32	16	3
General Electric Company	27	10	0
5 100-ampere.			
Electrical Company	22	0	0
Chamberlain and Hookham (accepted)	21	5	0
Geipel and Lange	26	5	0
British Thomson-Houston Company	27	10	0
British Westinghouse Electric Company	35	12	6
General Electric Company	27	10	0

BUSINESS NOTES.

TRACTION.

Arkley.—The Parish Council have approved the proposed tramways extensions to Barnet *viâ* Pricklers Hill.

Swinton.—The Urban District Council have decided to dissent from the Barnsley to Doncaster light railway scheme.

Bath.—Several alterations in the route of the proposed electric tramways are suggested by the promoters of the scheme.

Southowram.—The running of the Halifax Corporation tramcars to this place was celebrated on Friday by a public meeting.

Sedgley.—There is a likelihood of the service of electric cars from Sedgley to the Fighting Cocks being opened shortly after Christmas.

Bardsley.—The Parish Council are in communication with the tramways company with reference to the introduction of halfpenny fares on the cars.

Wolverhampton.—It is expected that the official trial of the Lorain system of electric traction on the Bilston-road section of the tramways will be made soon after Christmas.

Gloucester.—Negotiations have now been reopened with reference to the proposed purchase by the Corporation of the undertaking of the City of Gloucester Tramways Company.

Shardlow.—With reference to the two rival schemes for the establishment of light railways between Derby and Nottingham, the District Council have decided to remain neutral for the present.

Renfrewshire.—The District Council of the upper district of the county have resolved to appoint Dr. J. T. Bottomley as an electrical expert to advise them in connection with the Paisley tramways.

Appointment.—The Tramways Committee of the Huddersfield Corporation recommend that the tramway electrical engineer, Mr. H. N. Thomas, be appointed general manager of the tramways.

Huddersfield.—The Town Council have agreed to the signing of contracts for carrying out the conversion of the whole of remaining steam tramways for electrical traction at a total cost of £47,987.

Soothill.—Notice was received at the last meeting of the Urban District Council that the British Electric Traction Company intend to shortly commence the construction of the Spen Valley light railways.

Wigan.—Major Druitt, R.E., has inspected on behalf of the Board of Trade the new electric tramway at Wigan, which runs between Rodney-street and Whelley. After the inspection the cars ran for passengers.

Slough.—The Urban District Council have agreed to consider the question of electric trams in committee before deciding whether they will assent to or dissent from the proposal to construct tramways from Hounslow to Slough.

Excessive Speed.—A driver of one of the electric cars at Dundee has been fined 10s for colliding with carriages on two different occasions. It was alleged that the collisions were due to excessive speed on the part of the tramcar.

Christchurch.—With reference to a letter from the tramway company intimating their intention to lay ordinary macadam between the rails, the Roads Committee recommend the Town Council that the company be asked to lay tar paving.

Stoke-on-Trent.—The Bill promoted by the Potteries Electric Traction Company has been referred to the Parliamentary Committee of the Town Council with a request to safeguard the interests of the Corporation so far as the highways are concerned.

Presentation.—Mr. C. C. Howard has been presented with a massive 18-carat half-hunter English lever centre-seconds watch and solid silver tea set by the staff of the Liverpool tramways on his appointment as traffic manager to the Bolton Corporation tramways.

Rhondda.—The Glamorganshire County Council have decided to oppose the scheme of the Rhondda District Council for powers to construct electric tramways, unless the system to be established provides continuous service from all districts within the area over which it would operate.

Wimbledon.—In reply to questions with reference to the tramway scheme for the district at the last meeting of the Urban District Council, it was stated that there would be a report as soon as it was possible to give any statement as to what the proposals of the tramway company were.

Yarmouth.—Having rejected the offer of the British Electric Traction Company for a lease of the new tramways now in course of construction, the Town Council on Thursday decided to work the lines themselves. An amendment that negotiations with the company be resumed was rejected.

Ipswich.—The Board of Trade have given their sanction to the borrowing by the Corporation of £17,552, being the amount payable by them under Sir Frederick Bramwell's award for the purchase of the tramway company's undertaking. A new committee is to be appointed to deal with all matters relating to tramways.

Exeter.—The City Council have obtained the consent of the Devon County Council as to the construction of tramways at Heavitree and Topsham, which are under the jurisdiction of the County Council. The Corporation of Exeter, it will be remembered, are introducing a Bill in the next session to authorise the scheme.

Lancaster.—Contracts to the amount of £12,455 for laying down the first sections of the electric tramways from the centre of the town to Scotforth and Williamson Park were agreed to by the Town Council at their last meeting. The permanent way will be laid by the Corporation employés at an additional cost of £9,500.

Torquay.—With regard to the proposal to construct an electric tramway from Torquay to Paignton, the Devon County Council have decided to remain neutral to the scheme. The opinion was expressed at the last meeting of the County Council, however, that the roads were very narrow in places and that the proposed tramways would be dangerous.

Chester.—Immediately on taking over the Tramway Company's undertaking on Jan. 1 next, the Town Council intend to take such measures as may be necessary for converting the section of the line from the Fountain, Bridge-street, to Saltney, for electric traction, and for constructing the short Saltney extension; this section to be worked on the overhead trolley system.

Dundee.—The promoters of the proposed new tramway between Dundee and Broughty Ferry and Monifieth have decided not to lodge the notice of the parliamentary Bill for the beginning of the forthcoming session, but to wait until April, when, under the new Procedure Act, notices of Bills are received. All the surveys have been made, and the arrangements are in a forward state.

Harrow.—The Urban District Council have passed a resolution expressing the opinion that no further agreement should be entered into by the Middlesex County Council respecting tramway matters which would have the effect of granting concessions to private companies or of binding the future actions of the County Council before the various districts have had an opportunity of discussing such policy.

Walsall.—The Corporation Tramways Committee have arranged with the South Staffordshire Tramway Company to take the proposed extension to Bell-lane, Bloxwich, on lease and work for the remainder of the term of three years at a fixed annual rental of £400, subject to the company undertaking to take from the Corporation a supply of current for working the whole of the Bloxwich section on terms to be agreed upon.

Teeside.—Important schemes for the extension of the Imperial Tramways Company's lines along both banks of the River Tees are under consideration. Within the last few weeks the deadlock in connection with the construction of the new road between Haverton Hill and Stockton on the north side of the river has been nearly removed, and it is hoped that the last remaining obstacle to the proposed extensions will be overcome early in the New Year.

Liverpool Overhead Railway.—An Exchange message says that as a train was drawing up at the Dingle Station on the Liverpool Overhead Electric Railway on Monday evening an explosion occurred in a fuse box, and the train caught fire. The terror-striken passengers rushed on to the platform and some down the tunnel leading to the station, and a great panic ensued. Several passengers were burned, and two women and two employés on the train are missing.

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Gateshead.—A deputation from the Gateshead Tramways Company has met the representatives of the Gateshead Corporation on the question of increasing their fares from ½d. to 1d. It was stated that the only section that was paying was that to Bensham, where there was a 20 minutes' service, the fare being 1d. from the High-Level Bridge to Coatsworth-road, and 1½d. to the terminus. The Corporation adjourned the question for the company to produce their books.

Acton.—The District Council have decided to oppose both the schemes deposited by the London United Tramways, Limited, for widening and extending their lines. The clerk has been instructed to write to the Middlesex County Council, calling attention to the fact that the London United Tramways propose to carry lines over the roads included in the County Council scheme, passed by the Light Railway Commissioners, and to ask for information on this matter.

Southampton.—The Town Council have resolved to refer to the Electricity Committee the maintenance of the electrical equipment of the tramways upon terms to be arranged, and to include in the duties of borough engineer, when making the new appointment, the construction of any further extension of tramways and the maintenance of the permanent way over the entire system. The Council have further decided not to make any appointment to the position of manager of the tramways at the present time.

Hastings.—Mr. Murphy has had an interview with the members of the Corporation, who have expressed themselves in favour of the introduction of electric tramways. As a result, Mr. Murphy is considering what clause he will insert in his present Bill to overcome, if possible, the difficulties that were raised by several of those present in respect to his front line scheme. On a question of traction, Mr. Murphy said that to put underground wires on the front instead of overhead would be extremely costly, and he would like further time to consider the point.

Bristol.—As a sequel to the tramway strike at this place a short time ago the directors of the Bristol Tramways Company on Friday entertained the whole of their 1,500 employés, with their wives and friends, to supper at the Colston Hall, the gathering being made the occasion for a presentation of medals to 300 men who were loyal to the company during the strike, and continued running the cars. The directors have given up the whole of their fees for the year, amounting to £2.000, for distribution among the men who remained in the company's employ.

Halifax.—The Bill which is being promoted by the Corporation for various purposes includes powers to carry out no less than 32 tramway extensions, 23 of them, however, being a doubling of the existing lines. Of the new lines the longest is 2 miles 4 furlongs 5 chains, and is the Mount Tabor extension from Spring Hall-lane to Folly Hall-road at the junction with Tree-lane. Another tramway, nearly a mile long, is to extend from King-street, Hebden Bridge, to the boundary between Blackshaw and Todmorden in Burnley-road. The estimated cost of the extensions is £82,000.

Hampstead "Tubes."—The Hampstead Heath Protection Society and a committee of residents intend to oppose the two electric railway schemes which, involve the boring of four tunnels under the Heath. These projects are the proposed "tubes" from Edgware, *via* Hendon, to Hampstead, and the Hampstead, Euston, and Charing Cross extension to Golder's Green. The opposition is based on the ground that if tunnels are made under the Heath there is danger that stations will be erected on the surface. As an alternative, it is proposed that the lines be carried round the Heath.

Deptford.—In reply to a communication from the Borough Council the London County Council state that the site of Fairlawn, New Cross-road, is not intended for an electricity generating station, but only for the purpose of erecting car-sheds and car works. The Council point out, further, that as the tramways are to be reconstructed for electrical traction the depôt would not be of the ordinary character with stabling for horses, but would be used only for constructing, repairing, and storing electrically-equipped cars, and it was not anticipated that any inconvenience would be experienced by the inhabitants in the neighbourhood of the depôt.

Southend.—In reply to a petition with reference to the speed of the tramcars, the Board of Trade state that they do not consider eight miles an hour an excessive speed. No less than 111 applications for the post of general manager and traffic superintendent of the tramways have been received by the committee, who will bring up three candidates to be interviewed by the Council. The Light Railways Committee have been empowered, in conjunction with the Law and Parliamentary Committee, to oppose the application for powers to construct and use light railways, extending to Rochford and Shoeburyness, part of which it is proposed should be within the borough of Southend.

Metropolitan District Railway Co.—A special meeting of the shareholders of this Company on Monday passed a resolution approving the promotion of the Metropolitan District Railway Bill. Under this new Bill it is proposed that both the Metropolitan and the Metropolitan District Companies shall take their supply of electrical current for the trains from the one power-house, which is about to erected at Lot's-road, Chelsea. It is further proposed to make the Metropolitan Company partners in the Bow and Whitechapel extension line on precisely the same conditions as the District Company. Powers to raise £250,000 additional capital on ordinary or preference stock are also sought in this Bill, which was unanimously approved by the shareholders on Monday. A second resolution was carried approving the Brompton and Piccadilly-circus Railway Bill.

Rawtenstall.—At the last meeting of the Town Council a letter was received from the town clerk of Haslingden stating that his Corporation were prepared to purchase now, along with the Corporations of Accrington and Rawtenstall, the whole of the tramway undertaking belonging to the Accrington Steam Tramway Company within the respective boroughs upon suitable terms, and asking if the Rawtenstall Corporation were prepared to purchase the tramlines in their borough. The Town Council resolved to reply in the affirmative and to agree to the appointment of a valuer. It was reported that the Rossendale Valley Tramways Company intend to apply to Parliament in the ensuing session for power to convert their existing steam tramways to electric traction, and to extend their Crawshawbooth section to Burnley and their Waterfoot section to Water.

Vienna.—The Town Council are at present engaged in a dispute with the Vienna Tramway Construction and Working Company in regard to the laying of cables for the transmission of the power for the operation of the tramways. An action has been brought by the company claiming that they alone have the right of carrying out the work, whilst the Town Council contend that the privilege is vested in them. According to a message from Vienna no clause on the subject is contained in the company's concession, and four whole days have been occupied in court in endeavouring to ascertain what the wishes of either party were before the concession was signed. The judge has suggested a compromise, to which both parties are willing, but as it appears that no agreement is possible, at present at all events, the case has been adjourned for a month.

Proposed Manchester City Circle Railway.—A Bill has been deposited in the Private Bill Office of the House of Commons for next session in respect of the proposed Manchester City Circle Railway. By this Bill a company is proposed to be incorporated, with a share and loan capital of £1,600,000, for the purpose of constructing a circular underground railway in Manchester of an aggregate length of over 2 miles 3 furlongs. The promoters named in the Bill are Mr. Henry Fishwick, Mr. Frederick John Davis, and Mr. Frederick Jones, who together will form the first directors of the company. The railway, if sanctioned, is intended to be constructed by means of metal shields driven forward by hydraulic pressure as the work proceeds, and, except at the stations, the internal diameter of the tunnel is not to exceed 12ft. The time sought within which to construct the railway is seven years from the passing of the Act.

Scarborough.—There has just been deposited in the Private Bill Office of the House of Commons a Bill to secure powers for the formation of a company to construct and work tramways within the borough of Scarborough. The capital of the company is to be £96,000 in 9,600 shares of £10 each, with power to borrow an additional amount of one-third that sum. The Corporation of Scarborough are to be empowered to subscribe or lend any sum not exceeding £10,000 towards the undertaking of the company. The routes of the tramways proposed to be laid down are those decided upon by the Corporation. In addition, there will be a tramway to the Spa Promenade over the carriageway of the Cliff Bridge Company. Power is taken to convey fish from the harbour to the goods yard of the North-Eastern Railway Company. The site for the generating station and car sheds is a sawmill and timber yard on Scalby-road.

Croydon.—The Town Council have decided to oppose the application for powers to construct a light railway from Dulwich to the Crystal Palace. The Tramways Committee report that they have considered the question of tramways included in the Bill proposed to be promoted in the next session of Parliament by the British Electric Traction Company, Limited, with regard to Croydon and district tramways, and certain terms which have been submitted to the committee on behalf of the company for the permission of the Council to the company to construct those portions of the tramways which are within the borough. The Town Council have decided not to consent to those portions of the lines which are proposed to be made in the borough, other than the Sutton and Mitcham extensions. Tenders will shortly be invited by the Corporation for 10 additional cars of a larger type than those at present in use. The present cars are constructed to carry, inside and out, 52 passengers. The proposed new cars are intended to hold, inside and out, 70 passengers. These new cars will be used entirely on the main route. The estimated cost of the cars is from £700 to £800 per car.

East Barnet. — Several recommendations of the Light Railways Committee with reference to the light railway scheme of the Herts County Council have been adopted by the Urban District Council. The recommendations are as follows: That the roadway be constructed or enlarged to 50ft. in width throughout the district, except at the railway bridge; the carriageway to be of the minimum width of 32ft.; that the County Council undertake the whole responsibility of the maintenance of the embankment on Barnet Hill; that the whole width between the rails and 18in. outside each outer rail be paved with granite setts, and that the County Council repay to the District Council the whole of the cost of repaving and maintaining the remainder of the highway; that the line be a double line throughout; that the County Council be requested to light the road by arc lamps suspended from their posts; that the maximum fare to be charged within the county be one penny; that the boundaries of the district be enlarged by the County Council so as to include all widened portions of the road, and any lands held or owned by the County Council adjoining the road, within this district, and that steam-engines be prohibited on this light railway as motive power.

Derby-Nottingham Light Railway Schemes.—Two deputations waited upon the Long Eaton District Council at their last meeting to explain the light railway schemes proposed for the district. The first deputation represented what is known as the Nottingham suburban light railways schemes. The proposed line would run between Derby and Nottingham, and, as was explained by the deputation, it was intended to have the line in the centre of the road, similar to the tramways in Nottingham. There are reasonable prospects that the whole system would be 4ft. 8½in. Any narrow parts of the road would be widened. If necessary, the promoters would be prepared to take current from any of the local bodies to work in their areas. They had the co-operation of the promoters of the power scheme, which had powers for the Long Eaton district. The deputation representing the

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Derby, Nottingham, and district light railway scheme, the rival proposal, was headed by Sir Bache Cunard, who pointed out the advantage of a 4ft. 8½in. gauge. The other scheme did not run through the town, whereas his scheme went through the town past the railway station. It was a little bit round, but it would be of service to the town. In course of time the light railways would be able to run into towns. The Long Eaton Council are considering which of the two schemes to support.

Baker-street and Waterloo Railway.—Details of the new Bill to confer further powers on the Baker-street and Waterloo Railway Company are to hand. The main object of this application to Parliament next session is to obtain an extension of time until August, 1905, within which to complete the railway originally authorised from Baker-street to Waterloo Station, and the extension subsequently sanctioned from Baker-street to Harewood-square. In support of the application the preamble of the Bill states that the company, in execution of the powers granted to them, have expended £345,203 in the purchase of lands and £599,499 in the execution of works and other matters incidental thereto, and have nearly completed so much of their authorised railways as will give a through communication between Waterloo Station and Oxford-circus. The Bill also proposes to amend the borrowing powers of the company by prohibiting the original borrowing powers of £416,000 from being exercised "until the whole of the original capital of £1,250,000 is issued and accepted and one-half thereof is paid up." The company, however, ask for new borrowing powers to be given them to the extent of £333,000 in respect of the further capital of £1,000,000 which was authorised to be raised under their Act of 1900. These borrowing powers are proposed to be exercised by the company from time to time to the extent of borrowing up to one-third of the actual share capital issued and accepted.

Tyneside Tramway Extensions.—A Bill will be promoted in the next parliamentary session by the Tyneside Tramways Company, who are now constructing lines between Gosforth, Wallsend, and North Shields, for further routes. The company are also, at the request of the municipal authorities, making extensions in Wallsend which will effectively serve the workmen employed at the riverside yards. In Gosforth they are promoting lines from Gosforth Station across the North-road to Satters-road and thence by a loop line through Coxlodge and down Jubilee-lane. Another of their proposed lines runs from Gosforth up the North-road through Gosforth Park, and thence through the growing districts of West Moor, Clousden Hill, Forest Hall, and Benton to join the company's authorised tramroad near Gosforth Row. These lines are, wherever possible, laid on private property, or off the carriageway of the road, with the object of securing at a moderate price a satisfactory form of permanent-way construction and the ability to run at a higher speed than would be permissible if the track occupied the same position on the road as the ordinary vehicular traffic. The aggregate length of the proposed new routes is about 11 miles, and the lines are laid out so as to communicate with or give easy access to the existing system of the Newcastle Corporation and the Tynemouth and Whitley Tramways. The inhabitants of the suburban districts, particularly Gosforth, Coxlodge, and Longbenton, will thus secure easy access to the country, city, or sea.

Middlesex Light Railways.—The tramway question was fully discussed at the meeting of the Middlesex County Council on Thursday. In connection with the agreement entered into with the London United Tramway Company relating to the southern half of the county, letters of protest were read from the urban district councils of Acton, Hampton, Sunbury, Hendon, and Harrow, the borough of Ealing, the Harlesden Ratepayers' Association, and a public meeting at Acton, the County Council's action being in some cases stigmatised as a "betrayal" of public interests. A motion was carried that the resolutions should be acknowledged, with an intimation that they were passed under a misapprehension of the facts. The proposed new agreement with the Metropolitan Tramway Company provides that, subject to the consent of the Board of Trade, the company shall purchase the Middlesex lines of the North Metropolitan Tramway Company, equip them electrically, and work them in conjunction with the light railways, the profits to be appropriated in payment of interest at 6½ per cent. on the expenditure occurred and the balance of the net profits to be divided in the proportion of 45 per cent. to the Council and 55 per cent. to the company. It is also proposed to lease to the company the following light railway lines in the north-eastern part of the county: (*a*) all the County Council's lines at present sanctioned by the Light Railway Commissioners; (*b*) lines applied for by the County Council in November, 1901; (*c*) lines to be applied for by the County Council in May, 1902; (*d*) lines included in the Waltham Cross and Enfield light railways order. The lines and extensions scheduled in this agreement are in all 23. In consideration of the 45 per cent. of the net profits on the North Metropolitan Tramways in Middlesex, it is proposed that the Council shall grant a lease of the light railways referred to until Dec. 31, 1930. A discussion took place on the motion to adopt this agreement, but it was eventually carried with only half a dozen dissentients, a clause being added to provide that the lease of the North Metropolitan Tramways shall be without prejudice to the rights of the local authorities under the Tramways Act of 1870.

LIGHTING AND GENERAL.

The Morgue.—The Paris Morgue is to be electrically lighted at a cost of £245.

Bognor.—With regard to the proposal to spend £12,000 on electric light a poll is to be taken.

Littleborough.—We understand that plans for an electric supply scheme are to be prepared.

Penge.—The Urban District Council are about to take definite steps with regard to electric lighting.

Bromley.—A committee has been appointed to make all arrangements for the erection of a dust destructor.

Rawtenstall.—The Board of Trade have extended the Rawtenstall Electric Lighting Order, 1899, for a period of one year.

Hastings.—Application is to be made for sanction to the borrowing of £59 for the purchase of a pressure variation recording apparatus.

Shildon.—The Urban District Council are urging the local supply company to commence operations for the installation of electric light.

Eastern Telegraph Co.—The directors announce an interim dividend of 1¼ per cent. on the ordinary stock for the quarter ended Sept. 30.

Eton.—Notices and plans in reference to the proposed electric light for Slough and Datchet are before the Highways Committee of the Rural District Council.

Long Eaton.—An enquiry will be held very shortly into the Urban District Council's application for sanction to borrow £15,000 for an electric lighting station.

Carnarvon.—The Town Council have sealed the memorial to the Board of Trade for a provisional order to supply electricity to the town for lighting and other purposes.

Brechin.—The effects of the breakdown of the electric supply for lighting purposes which occurred on Monday last week were soon repaired, and the light was again turned on on Tuesday evening.

St. Austell.—At the last meeting of the Rural District Council a letter was read from the electric power company giving the Council, as a matter of courtesy, some details as to their proposed power station at Par.

Copper.—On Friday, Dec. 20, the price of copper was £48. 12s. 6d. spot per ton in London, while for three months forward £49. 2s. 6d. was quoted. In America, Lake ingots were 13 cents per pound on the 19th, 20th, and 21st.

John Crossley and Sons.—The directors recommend a dividend of 3s. 6d. per share on the ordinary shares of £4, making 5s. 6d., less income tax, for the year ended Dec. 7. It is proposed to carry forward £740 to next year.

Falkirk.—The Town Council have decided to apply for the loan of £25,000 for electric lighting. Mr. Ronald is to prepare the necessary plans, etc., for the station according to the instructions of Messrs. Birstall and Monkhouse. A site has been chosen.

Royal Mail.—We are informed that the 1902-3 contracts for electric supplies for the New Zealand Royal Mail steamers and two other important Royal Mail steamship companies have been placed with Messrs. H. Binko and Co., 34, Leadenhall-street, London, E.C.

Ilford.—A resolution has been passed in favour of the proposal to remove the electric light standards from the centre to the side of the road in all places where the High-road is too narrow to allow of a continuous line of vehicular traffic on either side of the road between the trams and the kerbstones.

Chesham.—Last week the Urban District Council in committee received a deputation from the company who has put in a tender for supplying Chesham with electric light. It was said that it would be unfair to discuss the matter in open council, as it was possible the Council might ask for further tenders.

Halifax.—The Chamber of Commerce have appointed a deputation to meet representatives of the Corporation and the Halifax Drapers' and Hosiers' Association to consider a letter which had been received from the manager of the Nation l Telephone Company with respect to the rates for telephone service in Halifax.

Romsey.—At a meeting on Jan. 26 a proposal by the electrical lighting and wiring company of Swansea to light the town, at a cost of £6,000, will be discussed. The company propose to find half the capital, and to guarantee 4 per cent. on the outlay. They have just lighted Amfort and are in treaty for Broadlands.

Tees-side.—It is reported that Mr. Frank Roberts, an engineer who has returned to Philadelphia from England, has been engaged there by the Guest, King, the Bolckow, Vaughan, and the Consett Iron Companies to modernise their plants at a cost of £1,400,000, with the object of manufacturing engines for the English market.

Appropriate.—One evening last week the Paris Opera Comique was suddenly bereft of light in the midst of a performance. The breakdown in the electricity occurred just as the words "Déjà la nuit s'annonce" were being sung in "La Dame Blanche." Obscurity reigned only a short time, and the audience took the incident in good part.

East Barnet Valley.—The Urban District Council have resolved to hold a special meeting to further discuss the following resolution: "That the Council undertake the electric lighting of the district, and instal their own electricity generating station, combined with refuse destructor, on the basis of Mr. Adams's report, at an estimated cost of £11,602."

Grimsby.—An enquiry has been held into the Town Council's application for sanction to a loan for the erection of a refuse destructor adjoining their electricity works. A tender has been provisionally accepted for £8,507, which includes the destructor plant and machinery, and an additional £2,000 is required for boiler, weighing machine, and outbuildings.

Kingston.—The Council have agreed that the price to be charged to private consumers for electric current be modified as follows—namely, that the charge be at the rate of 7d. per unit, or at the option of the consumer, at the rate of 7d. per unit consumed during the first hour per day, and 3d. for the remaining hours of consumption each day, on the indicator system.

Manchester.—It is stated that several well-known spinning and manufacturing firms in Manchester and immediate adjoining towns are seriously contemplating running their mills with electricity. One firm

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in Bolton has already had electricity installed as a motive power in their mills, whilst the electric light has been tried for years with success in many Lancashire mills.

Dundee.—The Town Council are about to issue a circular with a view to ascertaining the amount of support likely to be extended to the proposed municipal telephone scheme. The rate to be charged will be £5. 5s. per annum to subscribers who desire a full service, and £3. 10s., with 1d. per call, to those whose requirements would be met by only occasional demands on the telephone.

Maidstone.—Last Thursday the Mayor and Corporation of Maidstone successfully opened the new electricity works. The Mayoress switched on the current for the public lighting. Congratulatory speeches by members of the Council followed the ceremony. There were some fireworks announcing the festive event, which contributed to anything but the improvement of the glass roof of the station.

Nairn.—At a recent special meeting of the Town Council the draft electric lighting provisional order was revised, the approximate sum to be spent on the work being fixed at £12,000, the maximum price per unit being fixed at 8d. It was stated that so far there had been no opposition, and no other application for an order. The application for the order and other necessary forms were executed.

Wireless Telegraphy.—The Rev. F. J. Crosland Fenton, Brooking Parsonage, Totnes, writes pointing out, now that wireless telegraphy is an accomplished fact, the necessity for some concise appellation for the system. He suggests "etherography," "dynamography," or "marcography," this last-named word being, Mr. Fenton remarks, "a syncopated form of the too unwieldy 'marconography.'"

Copper.—It is stated that the reduction in the price of copper by the American Trust on Dec. 18, amounting to 1½ cents per pound, was forced by secret reductions, independent of producers. These were caused by the action of consumers in holding off from the market in the expectation of still lower prices. Some consumers continue to assert that they will not buy at more than 12 cents per pound.

Lincoln Telephones.—The Chamber of Commerce have resolved to urge upon the Corporation the desirability of establishing a municipal system in Lincoln, and to endeavour to obtain a sufficient number of subscribers to such a system as would warrant the Corporation proceeding with the undertaking, providing that a reasonable rate was charged. It is thought that 300 promises at a rate of £6 per annum would be sufficient for a start.

Dartford (Kent).—The formal opening of the electric light works took place on the 18th. We note that Messrs. Reavell and Co., of Ranelagh Works, Ipswich, contracted for the steam dynamos at Dartford and at the works recently opened at Sutton Coldfield, supplying dynamos of the General Electric Company's make, direct coupled to high-speed engines manufactured by themselves. The dynamos are designed for either motor or lighting purposes.

Bath.—The report of the electric light inspector (Mr. Gatehouse), received at the last meeting of the City Council, stated that the lighting had been more satisfactory during the past fortnight. Several weaknesses had been found and remedied. The "red" circuit was still weak in parts. Private lighting had been well maintained, and that was a good report considering the difficulties encountered in maintaining the lighting until the new switchboard could be used.

Hastings.—The expenditure of the electric light works department of the Town Council for the year ending Dec. 31, 1900, amounted to £7,987. Of this total no less than £6,398 was spent on works' cost. From an analysis which has appeared in the local Press, we note the following figures respecting the works' cost: cost of fuel, £4,623 = 2·11d. per unit; oil, waste, water, etc., £496 = ·227d. per unit; repairs and maintenance, £392 = ·179d. per unit; wages at the works, £884 = 0·4d. per unit.

York.—The installation of the electric light in the York prison is now almost completed. Messrs. A. J. Beaumont and Co., of York, have carried out the work from the city supply, and the installation comprises 375 lamps. Each cell is provided with a 5-c.p. lamp; 8-c.p. lamps are used in the corridors, whilst in the chapel and other larger parts of the building 16-c.p. lamps are put in. The chapel will have two brass electroliers, each with 15 lights. In addition to the lighting, the prison has been fitted with electric bells and telephones.

Glasgow.—The Corporation have decided to enter into an agreement with the Glasgow and South-Western Railway Company to supply current for St. Enoch Station and certain other premises belonging to them within the city, to an estimated extent of at least 660,000 units per annum, for a period of three years as from June 1 last, and thereafter from year to year, until the agreement is terminated by either party on 12 months' previous notice. The price will be 1½d. per unit, and subject to such other terms and conditions as may be arranged between the parties.

Willesden.—As noted in our last issue, we endeavoured to obtain a complete list of the tenders recently received by the District Council. Mr. Ruthven Murray, however, informs us several of the firms who tendered have expressed a wish that the complete list of tenders should not be made public, especially as in some cases the plant tendered for is of a kind in which few makers have yet had practical experience. Mr. Murray states that a list of the tenders may be seen at his office, but that he will observe the tenderers' wishes by not publishing the full lists.

Benwell.—The Benwell and Fenham District Council are concerned in the fact that notice has been given that the Newcastle and District Electric Lighting Company intend to apply for power to supply electricity to various districts, including Benwell and Fenham. It appears that it is not the intention of the company to come into the Benwell district to distribute electricity, but that they wish to pass through the district. The Council have decided that the solicitor's opinion be taken on the matter, and that, if necessary, they take steps to protect the Council's interests.

New Electrical Wiremen's Association.—We are informed that at a recent meeting held for the purpose of opening a central branch of this association a number of qualified men were enrolled as members, while a number were refused, the chief aim of the association being to protect the thoroughly practical man and the electrical industry generally from the encroachments of inferior and cheap labour. It is proposed to hold meetings at the Pine Apple, Wilfred-street, Westminster, every Tuesday at 7.30 p.m., and at the Alma, Parson's Green-lane, Fulham, every Saturday at 8 p.m.

Wheatley.—At the last meeting of the Urban District Council a letter was read from the town clerk of Doncaster, urging the Council to obtain a provisional order to enable the Council to obtain a supply of electricity in bulk for the Corporation, or some other company, or, if the Council were not prepared to adopt that course, asking whether they would object to the Corporation obtaining a provisional order for supplying electricity in Wheatley. A resolution that a provisional order be applied for was rejected, and it was resolved to inform the Corporation that the Wheatley Council had not received any applications to supply anyone with electricity.

Luton.—Mr. Snell in his last report stated that the maximum demand for current was still increasing. Since Nov. 18 5,516 units had been generated, 396 8-c.p. lamps and one motor connected, making a total of 49 consumers and 3,769 8-c.p. lamps, and three motors equal to 7 h.p. At the present time premises were being wired equal to 315 8-c.p. lamps. The borough surveyor will interview the manager of the National Telephone Company and ascertain the cost of establishing telephonic communication from the electricity works to the company's exchange in Cheapside. The cable in John-street is to be extended, and other extensions are under consideration.

Aldershot.—The Local Government Board have declined to entertain an application for sanction to a loan for the execution of works beyond the consumers' terminals or the meter in houses in which electricity is to be supplied. When the matter was discussed at the last Council meeting it was said that Walthamstow had obtained from the Local Government Board a loan of £5,000 for laying on the wire to houses of those using the electric light. The Council are evidently under the impression that this includes wiring of consumers' premises, a fact which, however, does not appear from the correspondence. The matter has been referred to the Electric Light Committee.

Cardiff.—At a meeting of the Electric Lighting Committee last week the electrical engineer reported that no complaint had been received from consumers regarding the recent breakdown of the electric light in Cardiff, and he regarded this as showing that the consumers had believed that the officials at the works had done their very best to repair the damage done. Mr. Ellis said that the breakdown arose from the blowing of a fuse at the sub-station in Castle-street. These sub-stations were inspected periodically—every week in fact. It was impossible to discover the defect until the fuse had actually blown out. It was the porcelain covering of the fuse that gave way. They were doing away with these by degrees.

Fleetwood.—Mr. C. H. Wordingham, the electrical inspector appointed by the Board of Trade under the Fleetwood and district electric lighting order, has submitted reports to the Electric Lighting Sub-Committee with reference to the establishment of testing stations and the provision of recording instruments by the electric syndicate. Copies of the report have been forwarded to the syndicate, together with a request that the instruments named in the report be purchased and fixed on the earliest possible date, in order that a constant indication of the condition of the street-lighting mains, and of the pressure on both the private and public lighting systems, may be obtained and recorded. The approximate cost of the instruments is £70.

Hull.—The Corporation Electric Lighting Committee have resolved to supply Earle's Shipbuilding Yard (now the property of Mr. Chas. H. Wilson, M.P.) with electricity for three years on the following terms: exceeding 300,000 and not 750,000, 1½d. per unit; exceeding 750,000 and not exceeding 1,500,000, 1¼d. per unit; and exceeding 1,500,000, 1d. per unit. The electrical engineer in his report stated that to carry out this supply an expenditure of £9,202 would be necessary. They would require four transformers at a cost of £2,780, and the mains would cost about £6,000 The current will be required in about two months, a statement which fixes the date of the reopening of the yard. It is estimated that 900,000 units per annum will be required, of which fully 90 per cent. will be for motive power.

Wimbledon.—The electrical engineer reported at the last Council meeting that the Cottingham-park street-lighting failure was found to be due to an injury to the cable caused by a workman of the gas company, in searching for an escape of gas. It was decided to reduce terms for the supply of electrical energy to 4d. per unit. The electrical engineer is making enquiries as to illuminations proposed to be carried out by other local authorities in connection with the Coronation festivities, and report to the committee. The electrical engineer reported that on Nov. 30 the number of lamps (8-c.p. equivalent) to be provided for was 37,289, as against 35,261 on Oct. 31. The consumers numbered 617, an increase of 25 during the month, and the maximum load reached was 483 kw. on Nov. 30, as against 462 kw. on Oct. 31.

Presentation.—The staff of the Windsor Electrical Installation Company, Limited, last week gave a dinner as send-off to one of their former number, Mr. J. W. Hawes, who, after having completed his articles of apprenticeship in the service of the company, under the chief engineer, Mr. A. E. Farrow, has been appointed assistant engineer at the Bermondsey Corporation electric lighting works. Mr. Hawes was a candidate for a similar post at Hanley, and was selected for the situation, but being chosen at the same time by the Bermondsey Corporation, he preferred the latter as being the more advantageous of the two. His associates, proud of his success, with the substantial help of the directors, presented him with an illuminated address and various other gifts. Mr. A. W. Shipley, one of the directors, presided

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at the dinner, after which a number of complimentary speeches were delivered.

Guildford.—From correspondence passed between the Council and Mr. W. J. Perkins, the secretary of the electricity supply company, it appears that the directors consider it premature to state a price at which they would sell their undertaking until they feel satisfied that the Town Council would be *bona fide* buyers at the company's price, in case the expert should report favourably to the purchase. In reply, the Council stated that if they were advised by an expert that the acquisition of the electricity supply company's works would be to the interests of the burgesses, then the Council would be *bona fide* desirous of acquiring it; but that it must be obvious to the directors that it was impossible the Council should bind itself to purchase at any specific price or negotiate as to price until it had a report from Mr. Burstall, made after full investigation.

Finchley.—The electric light was switched on by R. Weatherill, Esq., at Broomhill House on Saturday last. The plant consists of a Crossley latest high-speed gas-engine, Hart accumulators, Cromptons dynamo, Ediswan switchboard, and Short's patent fuses. There are specially designed fittings for garden illuminations, and the house is fitted up with hot-water radiators, fire hydrants, electric motor for pumping water supply, and electric radiators. The engine-room is built so that the accumulators, saw bench, pump, etc., all come under the one roof, and make it very compact. The whole electrical plant has been carried out from plans and schemes prepared by Mr. F. W. Shenton, the architect for the building. The fitting-up of the entire installation was entrusted to Mr. A. E. Short, A.I.E.E., of Lower Edmonton, who has had many years' experience with the Ediswan's Company, London County Council, and his Majesty's Office of Works.

Birmingham.—A large installation of electrical power for manufacturing purposes has just been completed at the Saltley works of the Metropolitan Railway Carriage and Wagon Company. Electric power is now in use throughout the whole of the works, and it is generated and applied on the most advanced principles. Alternating current, two-phase, Westinghouse type, "C" motors, varying in size from 50 h.p. downwards, are used in all cases. These motors require no expert attention. They are efficient, self-starting under load, have no exposed electrical parts, and no wearing parts except the two shaft bearings. The electrical system is thus the most modern of any. The method of generating the electric power exhibits a still more striking advance. Steam-engines have been abandoned in favour of gas-engines. Instead of burning coal under steam-boilers, the coal is now served to a gas-producing plant, and engines, working with this gas supply, drive the dynamos. Westinghouse three-cylinder gas-engines are used.

London County Council.—The following notices under Electric Lighting Acts and Orders have been agreed to under the usual conditions: from the Brompton and Kensington Electricity Supply Company, under the House-to-House Order, 1889, of intention to lay mains of high and low tension along a portion of Drayton-gardens; the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, 1892, to lay low-tension mains along a portion of Upper Richmond-road and along Ravenna-road; the County of London and Brush Provincial Electric Lighting Company, under the County of London (North) Order, 1892, of intention to lay power and low-tension mains along Angel and Porter court, Golden-lane; the St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, to lay mains (*a*) along a portion of Warren-street and (*b*) along portions of Percy-street and Rathbone-place. The Council have also received a notice from the Islington Borough Council, under the Islington Order, 1893, of intention to lay mains along a portion of Huddleston-road.

Mansfield Telephones.—The Town Council have adopted a report, recommending: (*a*) That application be made to the Postmaster-General for a license for the Mansfield telephone area, and that, if possible, Kirkby-in-Ashfield be also included. (*b*) That a scale of charges be adopted not exceeding the following: Tariff No. 1—an annual payment in advance of £6 to cover an unlimited number of calls; tariff No. 2—an annual payment in advance of £3, with a toll of 1d. per originating call payable quarterly. Calls in excess of 720 in the year to be charged only ½d. each. The above charges to be for the supply of one instrument and a line to a subscriber one mile or less in actual distance from the exchange. Longer lines to be charged at 10s. per annum per quarter of a mile or fraction thereof, no addition being made to the toll charges. (*c*) That in case satisfactory terms can be arranged, Mr. A. R. Bennett, M.I.E.E., be engaged as consulting telephone engineer to the Corporation. (*d*) That the town clerk be instructed to communicate with the local authorities of Sutton-in-Ashfield, Mansfield Woodhouse, Pleasley, and Kirkby-in-Ashfield with a view to obtaining their support.

Coventry.—The Electric Light Committee have decided to make a change in the periodicity of the supply in connection with the extensions now in hand from 87 to 50 periods per second. The November report shows the units sold 46,351, against 38,427 last year; and the lights connected 25,911, against 22,381 The highest load during the month was 362 kw., which is the highest yet recorded. We are informed that under the new manager, Mr. Jeckell, things are already taking a turn for the better in the financial line. At the last committee meeting it was reported that, whereas for the six months ending Sept. 30, 1900, there was a deficit on the working expenses, without taking into account the interest and redemption, of some £70; for the six months ending Sept. 30, 1901, there was a profit of some £370—that is to say, calculating on the same basis as last year. For the month ending Nov. 30 the coal for 1900 cost £201, whereas the coal for the corresponding month this year only cost £95, the output having also increased from 38,000 units to 46,000 units, and the coal costs were reduced from 1·95d. to ·49d. The price of coal in the meantime had decreased from 10s. 4d. to 6s. 6d. per ton—namely, a decrease of 37 per cent.

Electric Progress in Devonshire.—Electricity is now the foremost topic of discussion in several of the chief towns of Devonshire. In the capital itself—Exeter—a hot controversy has raged round the questions, should electric trams be introduced, and if so, should they run through the principal streets? A postcard *plébiscite* of the inhabitants has resulted in a majority of about 4 to 1, not only in favour of electric trams instead of the present horse traction, but that the trams should also run through the main streets of the city, which they do not do at present. The opponents of the trams, thus defeated, are now energetically advocating the introduction of motorcars, in the hope that they will thus thrust aside the adoption of electricity, but the Exeter public, who want to have the tram system universal in their midst, object to be led off on a false scent. Warm discussion is also going on in Torquay on the question electric trams *v.* motorcars. The feeling, however, amongst the general public there is largely in favour of the former, but the "villa residents," as they are termed, are largely favouring the motorcar idea. The former, however, will doubtless prevail. Barnstaple is excited over a proposal to introduce the electric light, but the general feeling is to keep pace with the times and adopt the newest illuminant. Tiverton, too, is similarly agitated, and there it is proposed by certain of the councillors to take a postcard *plébiscite* as at Exeter. If that be done, there is no doubt as to which way the feeling of the townspeople lies, and there will be a big majority in favour of the light.

Croydon.—At the last meeting of the Lighting and Electricity Committee an application of the South London Electric Supply Company, Limited, for permission to supply current to two houses situate in Crown-lane, on the borders of Streatham Common within the borough, was read. The supply of current from the Corporation mains would necessitate an extension of cable for at least half a mile, and therefore the permission asked for will be granted, subject to an agreement, to be prepared by the town clerk, being entered into by the company by which the company shall pay a nominal sum of 1s. per annum by way of rent and covenant to remove their cables upon one month's notice so to do. With respect to the frequent failure of the electric lighting at South Croydon, the engineer reported as follows: "I have to report a serious failure of the arc lamps in the Brighton-road, due to the excessive fog causing moisture to enter the posts and destroy the insulation. The space available inside the base of the posts for switches is so small that although in dry weather no trouble has hitherto been experienced, it has been decided to remove these switches from the bases and put them in special boxes underground. It is anticipated that when this is done the risk of breakdown will be almost entirely removed. This accounts for the great number of lamps out, the remaining part of the circuit having been very free from failures." It was stated that the 137 arc lamps reported out were almost entirely in Brighton-road It was due to the switches being interfered with by water.

A Jubilee.—The electrical industry is still so much in its infancy that it will probably come as a surprise to many to learn that a firm of electrical engineers is already able to celebrate its twenty-fifth anniversary. Of course, it won't surprise the 170 and odd gentlemen who attended the highly successful dinner given on Saturday by Mr. Claud Johnson to the staff of Messrs. Johnson and Phillips on the occasion of the twenty-fifth anniversary of the firm. In the reception-room a silver bowl, which combined magnificent proportions with the most delicate workmanship, was exhibited. It bore an inscription showing it to be a presentation from the staff—we believe past and present—to Mr. Johnson, and constitutes in itself a most substantial piece of evidence of the good relations existing between the staff and the firm. If any other were needed, the presence of such a large gathering of men, with a few exceptions all on the firm's staff, who had braved the wintry weather to come from all parts of the United Kingdom, and of the speeches they made, both when on their legs and during the dinner, amply bore out the fact. The toast list was a short one. Mr. W. B Esson, who proposed the prosperity of the firm, said his instructions had been to be brief and humorous, and he succeeded in carrying them out in a very felicitous way. Mr. Johnson responded in the same strain, and then proposed the health of the staff, coupled with the various heads of departments. Mr. MacGregor toasted the chairman, which brought Mr. Johnson to his feet again, and amongst his remarks was a bit of news—namely, that the firm had just received an order to fit out two cable ships for the East. (These two ships are to be built for repairing the Eastern Extension Company's cables by Messrs. Armstrong, Whitworth, and by Messrs. Richardson, of Sunderland, respectively, and will be ready to leave by the end of next year.) The extremely well-got-up souvenir contained amongst its many illustrations a plan and view of the Charlton Works, 1901, and photographs of machinery new and old, a striking comparison being furnished by a 4-h.p. engine and boiler, which originally drove the Victoria Works, and the new engines, which develop over 2,500 h.p. Dr. Byrd-Page, well known as a prestidigitateur, Mr. Harrison as accompanist, and some of the guests contributed to what was a very harmonious evening.

Welsbach Co.—The report of the committee appointed to advise upon the affairs of the Welsbach Company has been transmitted to the shareholders. It is alleged, says the *Financial News*, that this is a violation of the arrangement made, which is that the committee should report to the directors in the first instance. According to the report, the company is greatly over-capitalised, because of the very large amounts taken by the vendors when the business was transferred: the committee recommend, therefore, the immediate reduction of capital on drastic lines. The position of the vendors, it will be remembered, was one of the bones of contention at the meeting in June, when the contest which took place resolved itself into vendors *v.* shareholders. The committee severely criticises and condemns the extravagance of the legal warfare in which the company is involved, and recommends that it be discontinued as speedily as possible, while

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to meet the trade exigencies which must arise from the throwing away of the patents in consequence of this tolerant attitude, the report recommend the adoption of an entirely fresh policy by the company, with a further reduction in the price of its goods amd in the cost of distribution. The committee finds that the management is inefficient, that the duties of the officials overlap, and it recommends the appointment of a new manager with a reorganised staff; and, in fact, as one writer has it, "it stigmatises the present Board as incapable, and calls for a new Board entirely." The next move will, we understand, be the calling of a meeting to discuss the whole matter.

Railway Signalling.—The North-Eastern Railway Company have just placed an order for the installation on their main line, near York, of the "Hall" electric automatic track circuit block signal apparatus. This system, extensively used in America, is designed to dispense with the services of signalmen except at points of junction. It is purely automatic, and is operated by electricity by means of connections set up by the trains themselves. When a train has passed a signal, the electric current is diverted from an electromagnet in the signal case, so that the signal automatically falls to "danger" through the force of gravity, and there it remains so long as a pair of wheels are on the track. Throughout the United States electric automatic signalling is in force over long distances. There is a signal post with three arms, which show automatically the state of not one section of the line ahead, but three. The top arm may be "off" the second one "on," and the third one "off." This tells the engine driver that the first and third sections ahead of him have no train on, but that the second has. Thus the driver knows as he goes along what the state of the line is in advance of him. For miles he has nothing but these automatic signals to guide him. No sooner does his train get past one of these posts than up goes the signal to "danger," and there it remains until he has got clear of that section and entered the next, which, of course, he will not do until the signal ahead of him shows that the next section is clear. It is claimed that, in addition to presenting the block system in perfection, by supplanting human intelligence with exact mechanism, the adoption of automatic signalling is calculated to reduce the wages bill by the abolition of intermediate boxes, and also materially increase the carrying capacity of railways by enabling the sections to be shortened without the expense of erecting and manning additional signal cabins.

The Telegraph System.—A petition has been addressed to the Postmaster-General by a number of merchants and brokers, members of the London Commercial Salerooms and of the General Produce Brokers' and kindred associations. They complain that grave injury is occasioned to the interests of the mercantile community by the recurring breakdown of the telegraphic communication with the country owing to the overhead wire system, and go on to say, "For five days—since Dec. 12—we have been practically cut off from Liverpool and the North of England, to our great inconvenience and loss. We respectfully ask that steps should be taken with the least possible delay by his Majesty's Government to have the present overhead lines altered to an underground system." Mr. J. Rigby Murray, president of the council of Associated Stock Exchanges, has writtten to the secretary of the General Post Office a letter from Manchester on the subject of the serious interruption of the telegraphic and telephonic communication between London and the provinces. Mr. Murray refers to previous communications of a like character, and particularly to a memorial to the Postmaster-General in February last urging the desirability of the extensions of the underground system of wires as a means of preventing interruptions caused by storms, and calls attention to the fact that the state of affairs that has existed on the telegraph and telephone systems during the past week has been more disastrous to business men than on any previous occasion, and has caused an entire cessation of business between the principal cities of the United Kingdom and incalculable loss to the commercial community. Mr. Murray asks whether the Post Office Department has the whole question under its earnest consideration, and whether such delays as have just occurred are likely to be obviated. He also asks when it will be convenient for the Postmaster-General to receive a deputation for the council to lay before his lordship the particular requirements of the provincial stock exchanges.—A letter has been forwarded to the Postmaster-General by the secretary of the Manchester Chamber of Commerce upon the same subject. The writer says: "The complaints which have reached the Chambers within the last few days have been conveyed in terms indicating a prevalent impression that the present paralysis of the telegraphic service ought not to have been possible in view of the length of time which has elapsed since the severe storms of February, 1900. I am respectfully to express to you the confident hope of the Chamber that the carrying out of the purpose of extending the underground wires northward from Birmingham, announced in the letter from your department of March 7, may be accomplished with the least possible delay."

Electrical Exhibition.—The electrical exhibition now open at the Royal Aquarium improves upon closer acquaintance. In the eastern section, Messrs. Hodges, McKrell, and Co., at Stand 1, make a speciality of switchboards, distribution boards, fuse boards, main switches, etc. Messrs. Pritchetts and Gold, at Stand 2, are the well-known manufacturers of accumulators, showing, amongst others, those especially suitable for yachts. Messrs. J. Defries and Son show their illuminating devices, etc. Messrs. Wilkins, Campbell, and Co. exhibit wax and other materials extensively used in electrical matters. Electric Lighting Boards make a brilliant show of their system of electric lighting on both the fountains. Messrs. Lowne and Sons show special electrical clocks and wind vanes, very ingeniously constructed. Messrs. Maurice Se Leon have a sand-blasting apparatus worked by one of the Acme Motor Company's motors. Messrs. Nunn, Watts, and Co. show electrical appliances and fittings; and the Automatic Electrical Advertising Syndicate exhibit an ingenious electrical apparatus for advertising purposes. Mr. T. Warren has a small model of an electric railway, which, it is said, has taken over seven years to complete. Further on, we found Messrs. Geipel and Lange's electricity meters, motor switches, etc., and the Bristol Electric Company's exhibit of small portable electric lamps suitable for theatrical and other purposes. Messrs. Vandom and Co.'s exhibit comprises a large assortment of electrical accessories, their stand being a very handsome one. The Simplex Steel Conduit Company are represented with their system of enamelled steel conduits; and Messrs. H. S. Taylor and Co. show electric light letters suitable for theatres, etc., also electric light generators for producing electric current by means of gas and water. Coming to the west section, we meet the Consolidated Telephone Company, with telephones, telegraphic apparatus, and general electric accessories. The Gardner Electric Drill Company exhibit an electrically-driven rock drill, the electricity being furnished by the Cassel self-regulating waterwheel—a novel and interesting stand. The D.P. Battery Company's well-known storage batteries follow next, while Messrs. Foxcroft and Duncan show gravity ammeters and voltmeters, switches, and arc lamps. The Renewable Electric Lamp Company have a large stand, at which several young ladies are at work showing the whole process of electric incandescent lampmaking—a most interesting show. The Excelsior Electric Company show electric apparatus for medical purposes, and Messrs. Harry Cox, Limited, have brought Röntgen-ray apparatus, and have installed a room where the public can gaze at their bones. The Crown Electric Heating Company show electric heating and cooking appliances. The Schattner Meter Company exhibit prepayment and standard electric meters of various sizes, also an accumulator charging meter. The Bastian Meter Company also show electric meters of various capacities. The Ingersoll-Sergeant Drill Company show rock drills, etc. The New Century Arc Light Company exhibit several of their arc lights, and Messrs. Flather and Co., of Leeds, exhibit motors. When one gets tired of walking around, there is a variety of excellent amusements provided on the stages and in the hall. A number of ingenious penny-in-the-slot machines are scattered about, those printing aluminium name-plates appearing to be greatly in demand. Mr. William Lynd is giving some extremely interesting demonstrations of Marconi's wireless telegraphy and of the Nikola Tesla coil, which, we are informed, will be repeated twice daily, about 3.45 and 8.45, in the World's Great Show, on the great central stage, and further illustrations will be given in the Bijou Theatre every hour, from 12 noon. Mr. C. B. Ward, principal of the School of Inland and Submariue Telegraphy, is officiating at the receiver, assisted by Mr. Dupree, late of the Central Telegraph Office, London.

The Recent Storms.—In reply to a recently published letter from the London Chamber of Commerce respecting the interruption of telegraphic communications caused by the storm, the following important explanation has been received: "General Post Office, London, Dec. 20, 1901. Sir,—I am directed by the Postmaster-General to acknowledge the receipt of your letter of the 18th inst. on the subject of telegraphic interruption through storms and other natural causes, and to request you to convey the following information to the London Chamber of Commerce. On March 7 last the Postmaster-General informed the Association of Chambers of Commerce of the United Kingdom that much had been done in recent years to provide against interruptions and to give stability to the service; the principal lines had been renewed with stouter timber; a large number of reserve wires had been provided on alternative routes in areas liable to storm damage; and an important experimental underground telegraph line to Birmingham had been constructed. He used the word 'experimental' because there were drawbacks to the use of the line, as, for example, the necessity to take two wires to form a circuit for certain methods of telegraphy where one wire would suffice on an aerial line, and there were several electrical problems which had to be solved before it could be said that the line was successful. He explained that until recently the great cost of guttapercha-covered wire and its electrical defects had stood in the way of the construction of long underground lines, and that it was only the introduction of paper-insulated cable—a material better from an electrical point of view and cheaper than guttapercha wire—which had justified the Department in undertaking the construction of the line to Birmingham. He added that the result of the experiment in this case, although leaving something to be desired, was sufficiently encouraging to justify him in proceeding with the extension of the system, although it was still necessary to proceed with caution. The fact, however, remains that underground lines are not fitted to afford efficient telephonic communication between distant towns. The Postmaster-General proceeded to act in the manner indicated in his reply to the association, and the construction of an extension of the London-Birmingham underground line to Stafford was undertaken without delay. At the same time an underground line was begun from Preston northwards in a district of the country where the aerial lines were much exposed to storms. Owing to financial exigencies, it has not been possible to make much progress with the last-mentioned line, but the Postmaster-General hopes to be in a position to proceed with its construction more rapidly during the next financial year. He can hold out no hope that the present aerial system will be replaced by underground wires. The efficient working of the trunk telephones can only be assured by a large use of overground wires, and there are several methods of telegraphy which it would be impossible to work if only underground lines were available. But Lord Londonderry feels as strongly as the chambers of commerce that efforts ought to be made to provide underground wires for telegraph purposes, by way of supplement to the aerial lines, to prevent a total interruption of communication between the principal towns. The initial difficulties having now to a large extent been overcome, the question becomes principally one of money, and it will be obvious that, in view of the present condition of the national finances, it will be impossible for this Department in the immediate future to undertake any large capital expenditure such as would be required in order to carry out a complete scheme of underground wires. The London Chamber of Commerce may feel assured, however, that the Postmaster-

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General will continue to give the matter his most earnest attention, and that he will extend the underground system as far as it is possible for him to do so. The area of country most subject to disturbance from gales is that lying between the Bristol Channel and the Wash, and the Postmaster-General had reason to think that, in constructing a line from London to Birmingham, he was giving stability to the communications, not merely of these two cities, but also of the whole country. The recent interruption, I am to explain, was caused, not by wind alone, but by snow falling at a temperature which caused it to cling to and accumulate on the wires, where it froze and added so largely to the weight as to drag the poles out of the ground.—I am, Sir, your obedient servant, (signed) G. H. MURRAY."

Stamford (Lincs.).—The electricity works are making good progress. At present only half the scheme is being carried out, a temporary end being put in the building, to be extended when the demand requires it. The works consist of a substantial building divided into three parts—viz., boiler-house, engine-room, and accumulator-room. The boilers are by the well-known firm of Babcock and Wilcox, and are fitted with chain grate stokers driven by an electric motor; superheaters will also be added. Two Belliss engines coupled direct to Parker dynamos are being put down. Each engine is capable of developing 135 b.h.p., with a steam pressure of 160lb. per square inch. Each set is capable of supplying 2,700 8-c.p. lamps, and provision is made in the present building for the addition of a larger set when required. A battery of accumulators is being supplied, consisting of 260 cells, and having a capacity of 350 ampere-hours when discharging at 35 amperes. The switchboard, which will at first consist of eight panels of enamelled slate, will control two dynamos, two feeders, two sets of accumulators, and a combined balancer and booster. The system adopted is the three-wire continuous-current system with a pressure of 240 volts at the lamps. Arrangements have been made so that the switchboard may easily be extended; the makers are Messrs. Kelvin and James White, of Glasgow. The first portion of the cables will be laid by Messrs. Callender, London. The mains will be composed of single cables laid on the solid system in wood troughs filled with bitumen and covered with tiles. It is hoped that the supply will be commenced in February. The whole of the work is being carried out by the Urban Electric Supply Company, under the direction of their resident engineer, Mr. W. E. Milns, A.I.E.E. Messrs. Edmundsons are the contractors. At the last meeting of the Council the Highway Committee reported that they had letters from Edmundson's Electricity Corporation, with a statutory notice of intention to lay mains in the borough for private lighting purposes, and a plan showing the position of such mains. The committee raised no objection to the notice or plan, and they further recommended that the Urban Electric Supply Company, Limited, be invited to submit a scheme for the public lighting of the streets in the borough. Three petitions were received asking for additional lamps, and a sub-committee was appointed to report thereon. This sub-committee laid their report before a meeting held on the 13th inst., and recommended that additional lamps be placed in Rock-road and Cemetery-road, and also improvements to the lighting of Roberts-row, Nag's Head-passage, and St. John's-terrace. They reported having found many lamps very dirty, and showing a very poor light. The Highway Committee recommended that the report of the sub-committee be adopted, and the town clerk be requested to call the attention of the gas company to that part relating to the state of the lamps in the town. A scheme from the Urban Electric Supply Company for the lighting of the public streets was received. The engineers presented three schemes, the cost being stated as follows: No. 1, £722. 7s. per annum; (2) £664. 6s.; and (3) £634. 12s. The company state: "In the main streets of the town we propose to use arc lamps, which are without doubt the best-known system of street-lighting. Each of these lamps would be supported on a tall post or by the bracket of the house supporting the lamp about 21ft. from the ground. There will be five or ten of these lamps according to the scheme adopted. These lamps would supersede a number of the present small lights. In the place of the rest of the small lamps shown on the plan, we propose to erect suitable lamp columns, having fitted to the top of them our special incandescent street lamp fitting, each of which would support an incandescent electric lamp fitting of 25 c.p. In schemes 1 and 2 the hours of burning are those similar to those in force at present. The arc lamps would run to 11.15, and two incandescents attached to the same post the rest of the night to daylight, the all-night, summer, and time-table lamps running the same hours as at present. In scheme No. 3 the arc lamps would run the same time, the all-night lamps would run all night, the summer lamps from dusk to 11.15, all the year round, and the ordinary lamps to the same hour for nine months in the year. We have worked out from the quotation for your present lighting published in the paper some months since that your present cost of lighting is about £684. It will, therefore, be seen that we are offering in scheme No. 3, which we venture to recommend, to light the borough for £50 per annum less, and we undertake to light all the roads as well as they are lit at present, and to light the main streets five times as well as they are at present, each of the arc lamps being of 1,000 c.p. In scheme No. 3 we propose that many of the lamps now running all night should be discontinued, but are proposing 34 lamps to run all night all the year round instead of the present 20. Our prices include a supply of all the necessary lamp columns, lamps, cables, and gear complete, and if our scheme meets with approval we will lay special cables for the whole town for this service, these cables being laid at the same time as those for private lighting. It is needless to point out that this will entail a very heavy expenditure, amounting to some thousands of pounds, and we therefore ask the Council to give us a contract for five years to enable us to sink this large amount of capital with due regard to good business principles." The committee resolved that a special sub-committee, consisting of the Mayor, Councillors Ward, Halliday, and Daniels, be formed to carefully consider the scheme and report thereon. The report was adopted.

COMPANIES' MEETINGS AND REPORTS.

ARON ELECTRICITY METER.

Directors: Sir James Pender, Bart. (chairman); G. B. Byng, M.I.E.E.; Lieut.-Colonel R. E. Crompton, C.B., M.I.C.E., M.I.E.E., etc.; Roger W. Wallace, K.C.; Hugo Hirst, M.I.E.E.; S. Barclay Heward. Managing director in Berlin: Geheimer Regierungsrath Prof. Dr. Hermann Aron.

Report of the directors (with abstract of accounts):

The balance to credit of profit and loss for the year ending Sept. 30, 1901, amounts to £7,888. 1s. 6d. To this is added the amount of £2,963. 13s. 2d. carried forward, making a total of £10,851. 14s. 8d. The directors propose to deal with the above available sum of £10,851. 14s. 3d. as follows: £7,493. 15s. 2d. for a dividend at 6 per cent. per annum on the preference shares, of which an interim dividend of £3,746. 17s. 7d. was paid on April 1 last; £1,212. 9s. 8d. to write off cancellation of management contract; £757. 15s. to write off cost of removing to new factory in Berlin; leaving an amount of £1,387. 14s. 10d. to be carried forward to next year. The directors ascribe the reduced net profits of the past year, and consequent inability to pay a dividend on the ordinary shares, to the prevailing severe depression of trade on the Continent, especially in electrical industries. The meter, in its improved form, is generally gaining favour, and the increased manufacturing resources will enable the Company to deal more efficiently with the various demands, and under normal trading conditions the prospects of the Company's business would be satisfactory. The business of the Company in France is now showing signs of improvement, and a French company for the better exploitation of the meter is being formed. The building of a new factory in Schweidnitz, sanctioned by the Board at the beginning of the year, is now completed, and the same is ready for the installation of machinery, and when completed it is anticipated that the cost of production will be greatly reduced. To carry out the above-mentioned extensions and to provide additional working capital, the Board have negotiated a debenture issue of £60,000. The details of such issue were at the time communicated to the shareholders. Two directors (Sir James Pender, Bart., and Mr. R. W. Wallace, K.C.) retire from office by rotation this year, but, being eligible, offer themselves for re-election. Dr. Julius Juttke, a former managing director, has resigned his position, and Mr. S. Barclay Heward, a shareholder, has joined the Board. His appointment is required to be confirmed by the meeting. Messrs. Price, Waterhouse, and Co. have acted hitherto as auditors, and offer themselves for re-election.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Directors' fees	1,200	0	0
Managing directors' salary and bonus	1,876	12	0
Secretarial, office, and general charges in London	1,055	11	8
Legal charges and audit fee and expenses	261	8	1
Travelling expenses	77	14	8
Maintenance of patents	765	9	1
Preliminary expenses written off	134	8	0
Income tax	375	0	0
Interest and exchange	674	0	0
Interest on debentures	271	0	3
Balance, net profit carried to balance-sheet	7,888	1	6
	£14,579	5	5

Cr.	£	s.	d.
Gross profit on trading, after deducting bonuses to managers	14,484	7	11
Transfer fees	94	17	6
	£14,579	5	5

The fourth ordinary general meeting of this Company was held on the 19th inst. under the presidency of Sir James Pender, Bart., at Winchester House, E.C.

The **Chairman,** in moving the adoption of the above report and accounts, said the results were not so successful as they had anticipated, but it might not be an unmixed evil if, after a period of 10 or 12 years' progressive and increasing profits in the Aron meter business, they should have the unpleasant experience of a relapse. After the most satisfactory result of the previous year's working the directors felt themselves justified in making arrangements for increasing the output, new premises being taken in Berlin and in London. The industrial *débacle* which had been in evidence all over the Continent, however, had hit them in almost every country on the Continent. In Germany, in Austria, in France the Company's business had decreased, not on account of the quality or price of the meter, but on account of the financial depression. Meters in those countries were ordered not so much on behalf of municipalities, as in Great Britain, but mostly by companies holding concessions in those countries, and those companies suffered by the prevailing financial embarrassment. The directors had continued to do their best for the exploitation of the meter during the past year wherever possible. For this reason they were on the point of forming a separate company in France, so as to give themselves a better standing there. This company would hold all the shares in the French company. A similar arrangement exists in Germany, and was found to work satisfactorily. The American company they hoped would within a short time start manufacturing. The meter had been improved under the supervision of Prof. Aron and, while competition continued keen, he believed that quality for quality they were well able to compete. As the result of successful litigation for infringement of their patents for multiphase meters, three of the most powerful companies on the Continent were now paying them satisfactory royalties. Only a small amount of these royalties was included in the present balance-sheet, for they only fell due at the end of the year. The profit available had been divided in giving 6 per cent. to the preference shareholders. He hoped the ordinary

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shareholders would find that the directors had tried to serve the best interests of the Company in using the surplus earnings over and above the amount required for the preference dividend for the purpose of writing off the various items in lieu of keeping them hanging over. That would enable the Company to start with a cleaner sheet this year, and the ordinary shareholders would reap the benefit next year.

Mr. Hugo Hirst seconded the motion, and in a few words stated that their order sheets from Germany during the last few weeks showed marked advancement.

In answering a question as to the advisability of writing off something for depreciation in goodwill and patents, **Mr. Wallace, K.C.,** one of the directors, expressed the view that if the business did not increase in the course of the present year, and did not warrant the original price paid for goodwill, then no matter what the courts might think it was their duty to write down the assets. There ought to be some depreciation for patents running on, while credit should be allowed for new inventions made. He attributed the disappointing results in Germany to the over-development of electrical traction in that country.

A **Shareholder** called attention to the expensive nature of the English business, and the rumours that this had arisen from imperfections in manufacture.

The **Chairman** replied that everything possible was being done to rectify mistakes.

The resolution was ultimately carried unanimously.

The meeting closed with a vote of thanks to the chairman.

RAND CENTRAL ELECTRIC WORKS.

The directors' report for 1900 states that the delay in the presentation of accounts is attributable to the abnormal condition of affairs consequent upon the war. The same reasons that militated against the operations of the Company during the latter part of 1899 apply to the year under review. Although the Company's earnings have been more than sufficient to cover the current expenses, a loss of £7,453 is recorded on account of the amount written off for depreciation—namely, £10,112. The total revenue received amounted to £25,395, as compared with £50,674 for the previous year, and the working expenses to £32,847. 17s. 8d., as against £49,834. 11s. for 1899. The receipts for power supplied amount to £24,470 against £49,640, the falling off being accounted for by the fact that mining operations were brought to a standstill, thus causing a very restricted demand for power; the average monthly kilowatt-hours generated during the year 1899 amounted to 617,760, whereas for 1900 this fell off to 277,660 kw. per month. The damage to the works occasioned by the Boer raid on Jan. 20 last has been so far repaired that the plant can be worked to the extent of three-fourths of its capacity, and it is anticipated that all damage will be made good in the near future. It is estimated that the cost of these repairs will not exceed £5,000. The Company is now supplying power to several of the mines that have resumed working, and a contract is about to be completed with the Johannesburg Municipality for supplying the town with light, from which source a good revenue may be expected to accrue.

Sir Charles Rivers Wilson presided over the annual general meeting of the shareholders in this Company at Winchester House, E.C., on Friday.

In submitting the above report for approval, the **Chairman** said he thought they had every reason to congratulate themselves upon the figures shown in the balance-sheet. In spite of all the difficulties which the Company had undergone owing to the war in South Africa, the result showed that they had earned enough to pay all working expenses, with a balance of about £2,000. Having dealt with several items in the accounts, he stated that during all the very trying times they had experienced in the administration of the Company's affairs in South Africa, they had maintained the most friendly and cordial relations with their customers. He proceeded at length to describe the loss they had sustained in the destruction of certain machinery by the Boers, and stated that the time had been occupied since the assault in getting the works into order again, and they were now working at about three-fourths of their power. The total expense of replacing the engine machinery was estimated at between £4,000 and £5,000. He then entered into the question of the charges which they were to make for the supply of current for power purposes. He explained that originally it was contemplated that the charge should be alternative in character—either the payment for continuous supply at the rate of £45 a year per horse-power, or a minimum payment of £25, and a sliding scale beyond that minimum charge, beginning at 1½d. for not less than 20 hours. This was supposed to work out at more or less the same result as £45 for continuous supply. Experience had shown that the estimate was too sanguine. The directors had felt it their duty to consider the question of remodelling the tariff upon the basis, not of what might be taken, but upon the basis of the power actually supplied to their customers. He was not in a position yet to make any distinct statement as to what that tariff would be, because they were in communication with their local Board on the other side, but he thought it was his duty to let them know at the very earliest opportunity that the directors had this important matter under consideration. The chairman concluded by moving the adoption of the report and accounts.

Mr. G. Von Chauvin seconded the motion, and after some criticism on the report it was adopted.

SOUTH STAFFORDSHIRE TRAMWAYS.

The directors in their report for 1900 state that the South Staffordshire Tramway (Lessee) Company took over the working of the lines as from Feb. 1, 1900, from which date an annual rental is payable by that company to this Company. The total receipts for the year amounted to £7,106. The total expenditure for the year was £3,629, and the balance carried to the net revenue account was, therefore, £3,477, of which £977 remained after the payment of the interest on the debentures, to which must be added £154, interest and discounts, and £4 balance from last year's accounts, making a total of £1,135 available for distribution. The directors recommend a dividend of 2s. 11½d. per share on the preference shares, which will absorb £1,124, leaving £11 to be carried forward. The delay in holding the meeting had been caused entirely by the complications which arose in connection with the sale of part of the undertaking to the Corporation of Walsall. The directors are advised that the delay was entirely caused by the Walsall Corporation. The purchase price agreed upon—namely, £18,500 (which should have been paid on Dec. 31, 1900)—was paid on Oct. 24, 1901, and part of the debentures have been duly paid off with the money. The money was received by this Company entirely without prejudice, and the terms upon which the matter is to be referred to arbitration have been agreed upon. The price which the West Bromwich Corporation has agreed to pay to this Company for its tramways within their district having been agreed upon, and the agreement being subject to the approval of the shareholders, the directors thought it well to delay holding the meeting until they could lay the agreement before the shareholders. The price to be paid by West Bromwich is £32,000, which the directors are advised is a fair one.

PROVISIONAL PATENTS, 1901.

DEC. 13.

25458. An apparatus for converting direct or continuous current into alternating current. George Beckett Batten, 2, Underhill-road, Lordship-lane, London.

25464. To obviate the magnetising of watches. William Routledge, 5, Evelyn-terrace, Blaydon-on-Tyne.

25466. Improvements in methods of determining the permanent magnetism of iron ships and in instruments for use therein. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

25474. Improvements in electric arc lamps. Frederick Robert Hill and Thomas Hamilton-Adams, 36, Chancery-lane, London.

25490. Improvements in and connected with electric arc lamps. Thomas Hamilton-Adams, of the firm of Wirtz and Co., 36, Chancery-lane, London.

25491. Improvements in and relating to electrical starting resistances. R. Waygood and Co., Limited, and Henry Claude Walker, 60, Queen Victoria-street, London.

25496. Improvements in telautographs. Foster Ritchie, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25526. Improvements in the construction of incandescent electric lamps. Harry Hogg and Emile Pulsford, 22, Southampton-buildings, Chancery-lane, London.

DEC. 14.

25540. A pillar for use in supporting an electric trolley cable or several cables or for use in supporting a lamp or the like. Alfred William Turner, 67A, Corporation-street, Birmingham.

25554. A new or improved appliance for preventing trolley wheels leaving the overhead wire in electric traction. Matthew Fitzmaurice Tilson Deane, 32, Garville-avenue, Rathgar, Dublin.

25558. The electric cable, gas, and water conduit. Robert William Pollard and J. Lewis Davis, 3, Bartholomew's Town Hall, Brighton.

25660. Improvements in or relating to automatic controllers for electric motors. Alfred Julius Boult, 111, Hatton-garden, London. (Walter Joseph Richards, United States.) (Complete specification.)

25580. Improvements in trolley standards for electric tramways and railways. Armistead Keith Baylor, 83, Cannon-street, London.

25583. Improvements in hand-feed electric arc lamps. Edward Sanger Shepherd. 4, South-street, Finsbury. London.

25613. Improvements in and relating to electrical measuring instruments. Friedrich Wilhelm Schneider and Abraham Strauss-Collin, 27, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Jan. 4.

1901.

409. Apparatus for wireless telegraphy. Marconi and Marconi's Wireless Telegraph Company, Limited.

2293. Electrical switches. Carter and Reason Manufacturing Company, Limited.

2461. Conduits for electric wires. Page.

2607. Electrical transformers. Berry and British Electric Transformer Manufacturing Company, Limited.

2619. Electrically-heated smoothing irons. Loacker and Riedl.

2741. Electrode plates for forming Plante cells. Hager.

2776. Electric fuses. Callender's Cable and Construction Company, Limited, and Callender.

2836. Manufacture of thermo-electric couples. Hermite and Cooper.

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3111. Systems of electrical distribution. Lamme. (Date applied for under International Convention, July 14, 1900.)

3113. Rotary field magnets for electrical machines. Lamme. (Date applied for under International Convention, July 14, 1900.)

3310. Electrical ignition devices for internal-combustion engines. Browne and Martineau.

7576. Electric signalling. Thomson and Thomson-Davis Telephone System, Limited.

13986. Electric cables. Hardingham. (Felten und Guilleaume Carlswerk Actien-Gesellschaft.)

22582. Telephone system. Amberg.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Dec. 14	579	599	– 19	21,817	19,911
Birmingham Tramways	—	—	—	—	—	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 13	450	432	+ 18	25,093	22,293*b*
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 14	135	147	– 12	20,649	19,999*b*
Bolton Corporation	,, 15	1,306	1,267	+ 39	72,202	59,831*b*
Bradford Corporation	,, 15	921	756	+ 165	45,661	24,049
Bristol Tramways Company	,, 20	3,854	3,802	+ 52	—	—
Carlisle Tramways Company	,, 14	116	121	– 5	4,238	4,223
Central London Railway	,, 14	6,858	6,006	+ 852	148,110	—
City and South London Railway	,, 22	3,242	1,920	+ 1,322	55,570	41,569
Cork E. T. and L. Company	,, 19	343	379	– 36	23,196	20,746*b*
Darwen Corporation	,, 13	179	175	+ 4	9,415	7,789
Dover Corporation	,, 16	167	163	+ 4	10,795	10,250*b*
Dublin & Lucan Electric Railway	,, 15	70	70	—	2,749	2,373
Dublin U. T., electric cars	,, 13	3,285	3,355	– 60	—	—
Dublin S. District, Electric	,, 13	690	794	– 104	—	—
Dundee Tramways Company	,, 18	613	478	+ 135	—	—
Glasgow Corporation	,, 14	10,189	9,083	+ 1,106	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 21	1,650	1,664	– 14	42,993	35,929
Liverpool Corporation	,, 7	8,817	8,050	+ 767	440,032	387,653*b*
Liverpool Overhead Railway	,, 15	1,336	1,527	– 191	37,739	39,658
Portsmouth Corporation	,, 14	816	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 15	3,129	—	—	—	—
Southampton Corporation	,, 12	725	644	+ 81	—	—

* Fortnightly. *b* From Jan. 1.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £312 decrease.

Barcelona Ensanche y Gracia, £54 decrease. Barcelona, £170 increase.

Brisbane, £302 increase (month of Nov., £1,286 increase).

Buenos Ayres and Belgrano Electric, £450 increase.

Calcutta, £20 decrease.

Cape Town (month of Oct.), receipts, £14,063; expenditure, £6,817.

La Capital Traction and Electric, Buenos Ayres (month of Oct.), £1,350 increase.

Mexico Electric (month of Nov.), receipts, £17,300; expenditure, £10,500.

Perth Electric, £100 increase.

Port Elizabeth (month of Oct.), receipts, £3,240; expenditure, £1,960.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	7/8-7/8
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	7/8-7/8
—— Ordinary, 1-125,000	1 ..	7/8-7/8
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-5¾
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5-5¼
Brush Electrical Engineering, Ordinary	2 ..	1⅞-1⅞
—— Nos. 90,001-105,731	2 ..	1⅞-1⅞
— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	99-102
Callender's Cable, Debentures	100 ..	112-116
—— Ordinary	5 ..	15½-16½
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	7/8-7/8
—— 5 per cent. Debentures	5 ..	1½-2¼
—— 4 per cent. Deb. Stock, Red.	100 ..	80-85
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10½
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16½-17½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	23-24
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	38-42
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10¼-11¼
—— 5 per cent. Cum. Pref.	5 ..	5¼-6½
Willans and Robinson, Ordinary, 1-30,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6-6½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	103-105

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	7/8-7/8
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-102
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	8½-9
—— 7 per cent. Preference	5 ..	8½-8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7½-8½
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5-5½
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105 xd
Chelsea Electricity Supply	5 ..	5¾-6¼
—— 40,501-50,936	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	8½-9½
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5½-6
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4¾
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	102-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10½
London Electric, Ordinary	3 ..	1¼-1¾
—— 6 per cent. Pref.	5 ..	3¼-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	190 ..	94-98 xd
Metropolitan, Ordinary	10 ..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	113-116
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6¾
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1¾
—— £5 Shares	5 ..	7¼-8
—— £4½ Shares, New	4½ ..	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15½-16½
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	11½-12½
Electric Railways.—		
Central London, Ordinary	100 ..	106-109
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	107-110
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-119
City and South London, Consolidated Ordinary	100 ..	64-66
—— Ordinary	10 ..	6-6¼
—— 4 per cent. Debenture Stock	100 ..	113-117
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	3⅜-3⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-128
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2½-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¼-6¾
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	8¾-9¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14½ xd
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-12½
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¾-2
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5¾
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
—— Prov. Cert., all paid	100 ..	100-103
Cape Electric Tramways, Nos. 1-400,000	1 ..	1¾-2⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11½-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¾-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	104-106
New General Traction, Ordinary	5 ..	2½-3½
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	98-102
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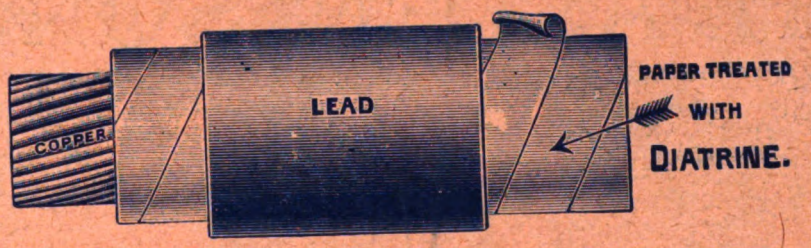

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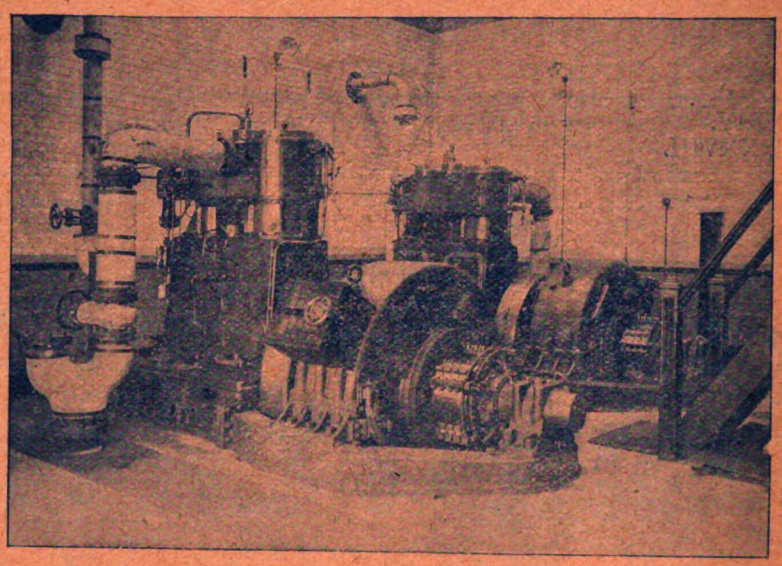

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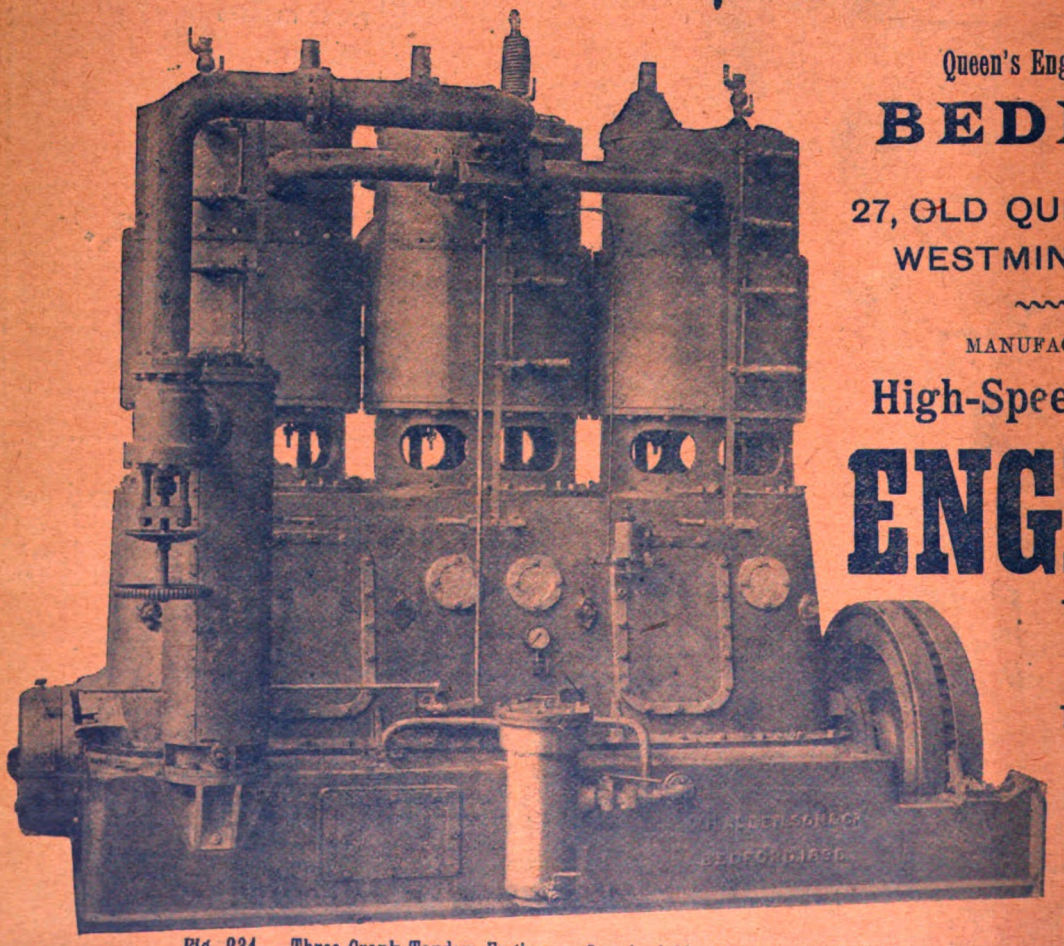

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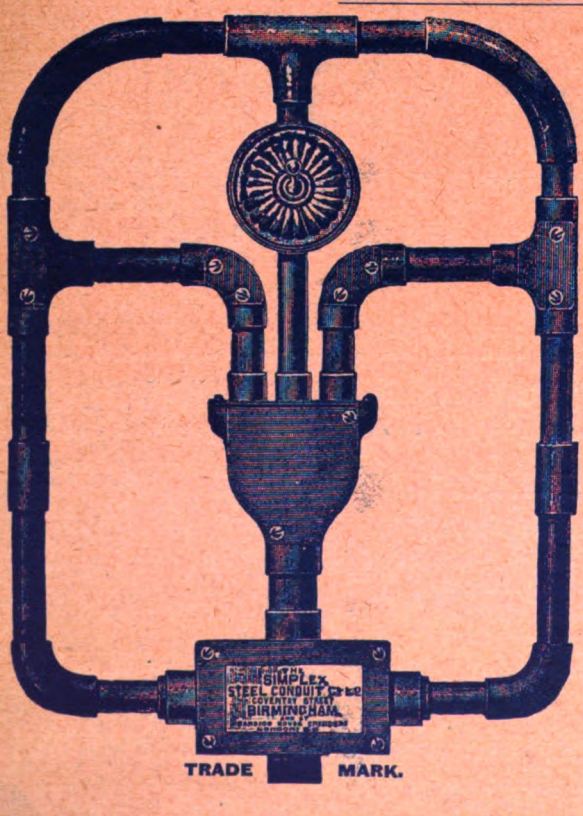

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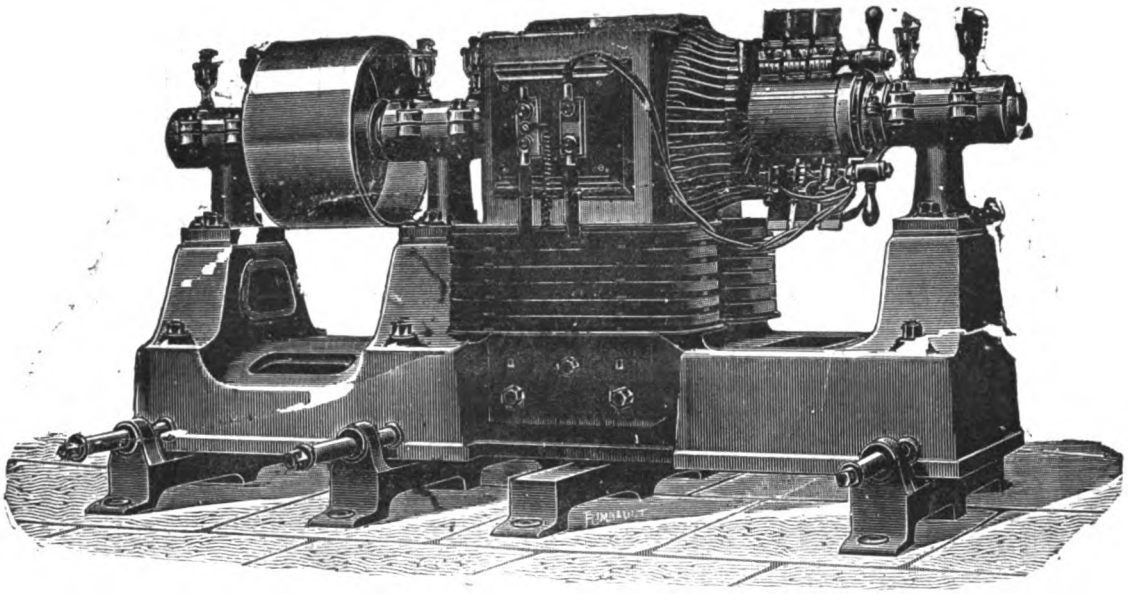

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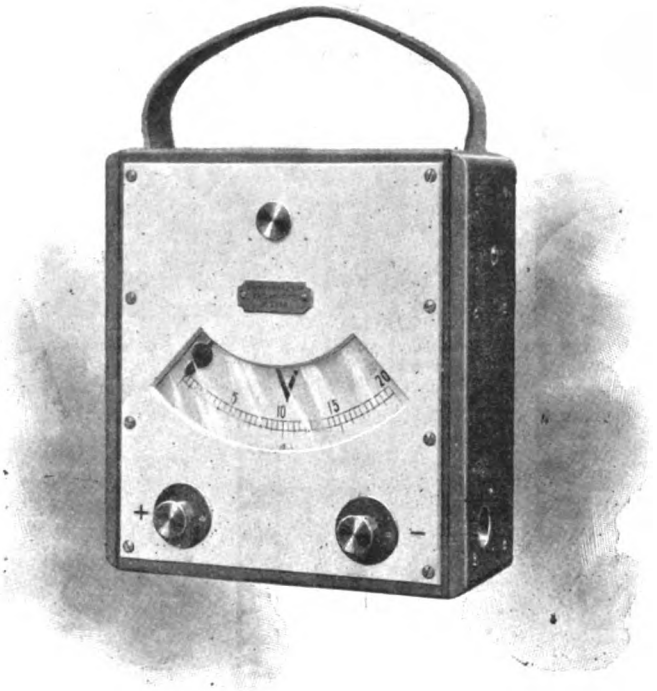

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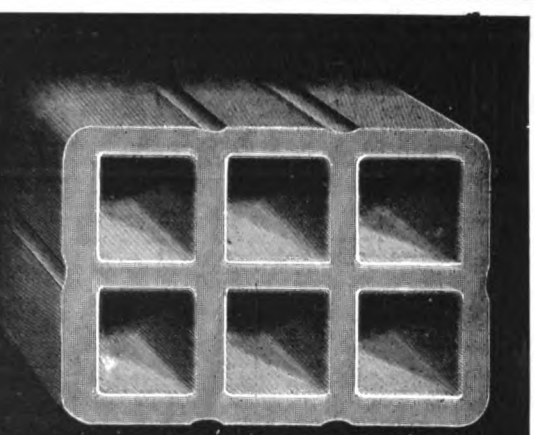

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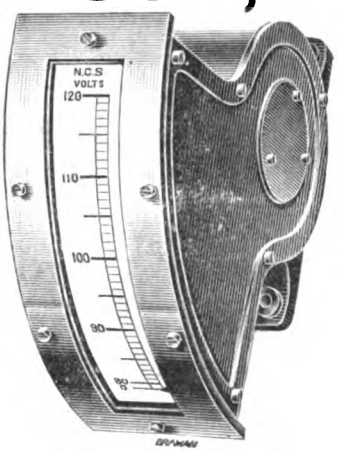

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Accumulators.

Ashmore, Benson, Pease, and Co., Stockton-on-Tees.
Chloride Electrical Storage Syndicate, Clifton Junction, near Manchester.
Edison and Swan Co., 36-37, Queen-street, E.C.
Electrical Power Storage Co., 4, Great Winchester-street, E.C.
Hart Accumulator Company, Marshgate-lane, Stratford.
Johnson and Phillips, 14, Union-court, E.C.
Rooper, W. O., and Co., Victoria-rd., Stafford.
Tudor Accumulator Co., Limited, 16, Victoria-street, S.W.

Arc Lamps.

Braulik, G. (agent for Korting and Mathieson), 217-218, Upper Thames-street, E.C.
British Thomson-Houston Company, Rugby.
Brockie-Pell Arc Lamp, Limited, 60, Worship-street, London, E.C.
Chamberlain and Hookham, Birmingham.
Crompton and Co., Chelmsford.
Edison and Swan Co., 36-37, Queen-street, E.C.
Electrical Company, Limited, 122-124, Charing Cross-road, S.W.
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.
General Electric Co., 71, Queen Victoria-street.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, 14, Union-court, E.C.
Newton Electrical Works, Taunton.
Scott and Mountain, Newcastle-on-Tyne.
Union Electric Co., 151, Queen Victoria-st., E.C

Batteries (Primary) and Accessories.

Edison and Swan Co., 36-37, Queen-street, E.C.
General Electric Co., 71, Queen Victoria-street.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton.

Belting.

Hendry, J., 252, Main-st., Bridgeton, Glasgow.
Webb and Son, Combs Tannery, Stowmarket.
Wilcox and Co., 36, Southwark-street, S.E.

Boilermakers.

Davey, Paxman, and Co., Colchester.
Hopkinson and Co., Britannia Works, Huddersfield.
Ransomes, Sims, and Jefferies, Ipswich.

Cable and Wire-Covering Machinery.

Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Charlton, Kent.

Cable and Wire Makers.

British Insulated Wire Company, Prescot.
Callender's Company, Hamilton House, Victoria-embankment, E.C.
Edison and Swan Co., 36-37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, S.W.
Frankenburg, I., Manchester.
General Electric Co., 71, Queen Victoria-st., E.C
Glover, W. T., and Co., Salford, Manchester.
Henley's, W. T., 27, Martin's-lane, Cannon-street, E.C.
Howard Conduit Co., Trafford Park, Manchester
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, 14, Union-court, E.C.
London Electric Wire Co., Playhouse-yd., E.C.
Société Industrielle des Téléphones, Paris.
St. Helens Cable Co., Limited, Warrington.
Telegraph Mfg. Company, Helsby, Warrington.
Union Cable Company, 23, College-hill, E.C.
Western Electric Company, Bridge-chambers, 171, Queen Victoria-street, E.C.

Carbon Plates.

Blackwell, R. W., and Co., 59, City-road, E.C.
Edison and Swan Co., 36-37, Queen-street, E.C.

Carbons (Arc Light).

Blackwell, R. W., and Co., 59, City-road, E.C.
Crompton and Co., Arc Works, Chelmsford.
Edison and Swan Co., 36-37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, W.C.
General Electric Company, 69, 71, and 88, Queen Victoria-street, E.C.
India Rubber, etc., Co., Silvertown, Essex.
Johnson and Phillips, Charlton, S.E.

Casings and Cleats.

Cripps, E. H., 161, Kennington-road, S.E.
Edison and Swan Co., 36-37, Queen-street, E.C.
General Electric Company, 71, Queen Victoria-street, E.C.
Harris, J. F. and G., 58D, Wilson-st., Finsbury
Simplex Steel Conduit Co., Coventry-street Birmingham

Dynamo Brushes.

Blackwell, R. W., and Co., 59, City-road, E.C.
Edison and Swan Co., 36-37, Queen-street, E.C.

Dynamo Oil.

Englebert and Co., 44-47, Bishopsgate-street Without, E.C.
Stern Bros., 57, Gracechurch-street, E.C.
Wilcox and Co., Southwark-street, S.E.

Dynamos, Transformers, Motors, etc.

Allen, W. H., Son, and Co., Queen's Engineering Works, Bedford.
British Schuckert Electric Company, Clun House, Surrey-street, Strand.
British Thomson-Houston Company, Rugby.
British Westinghouse Electric and Mfg. Co. Westinghouse Building, Norfolk-st., W.C.
Chamberlain and Hookham, Birmingham.
Crompton and Co., Chelmsford.
Edison and Swan Co., 36-37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, W.C.
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.
Ferranti, S. Z. de, Hollinwood, Lancs.
Fowler, John, and Co., Leeds.
Geipel and Lange, Parliament-mansions, S.W
General Electric Co., 71, Queen Victoria-street.
Haigh, W. B., and Co., Oldham.
Holmes and Co., Newcastle-on-Tyne.
India Rubber, etc., Company, Silvertown
Johnson and Phillips, Old Charlton, S.E.
McClure and Whitfield, Stockport.
Newton Bros., Full-street, Derby.
Newton Electrical Works, Taunton.
Peebles, D. B., and Co., Tay Works, Edinburgh
Phœnix Dynamo Company, Bradford, Yorks.
Rooper, W. O., Victoria Works, Stafford.
Scott and Mountain, Newcastle-on-Tyne.
Union Electric Co., 151, Queen Victoria-st., E.C
Witting Bros., 49, Cannon-street, E.C.

Electric Cranes.

Chamberlain and Hookham, Birmingham.
Crompton and Co., Chelmsford.
Edison and Swan Co., 36-37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, W.C
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.
General Electric Co., 71, Queen Victoria-street E.C

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Classified Directory of Electrical Trades *(continued)*:

Electrical Fittings.

Bergtheil and Young, 12, Camomile-street, E.C
British Mannesmann Tube Company, Limited, Landore, R.S.O., South Wales.
Dorman and Smith, Ordsal Station Electrical Works, Salford.
Edison-Swan Co., 36 and 37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, W.C.
Geipel and Lange, Parliament-mansions, Westminster, S.W.
General Electric Co., 71, Queen Victoria-street.
Lundberg, A. P., Pioneer Electrical Works, 477 to 487, Liverpool-road, N.
Simplex Steel Conduit Co., Coventry-street, Birmingham.

Electric Cooking Apparatus.

Crompton and Co., Salisbury House, London-wall, E.C.
Edison and Swan Co., 36-37, Queen-street, E.C.
General Electric Co., 71, Queen Victoria-street.

Electric Light Contractors.

Ashmore, Benson, Pease, and Co., Stockton-on-Tees.
Belliss and Morcom, Ledsam-st., Birmingham.
British Schuckert Electric Company, Clun House, Surrey-street, Strand.
British Thomson-Houston Company, Rugby.
British Westinghouse Electric and Mfg. Co., Westinghouse Building, Norfolk-st., W.C.
Brockie-Pell Arc Lamp, Limited, 60, Worship-street, London, E.C.
Crompton and Co., Salisbury House, London-wall, E.C.
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.
Electrical Power Storage Company, 4, Great Winchester-street, E.C.
Ferranti, S. Z. de, Hollinwood, Lancs.
Fowler, John, and Co., Leeds.
Graham, Morton, and Co., Leeds.
Holmes, J. H., and Co., Newcastle-on-Tyne.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, 14, Union-court, Old Broad-street, E.C. [W.C.
London Electric Supply Co., 3, Adelphi-terrace,
Newton Bros., Full-street, Derby.
Prism Globe Company, 57-58, Chancery-lane, W.C.
Rooper, W. O., and Co., Victoria Works, Stafford.
Scott and Mountain, Close Works, Newcastle.
White, J. G., and Co., 22A, College-hill, E.C.

Electric Locomotives.

British Thomson-Houston Company, Rugby.
British Westinghouse Electric and Mfg. Co., Westinghouse Building, Norfolk-st., W.C.
Chamberlain and Hookham, Birmingham.
Electrical Co., 122, Charing Cross-road, W.C.
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.

Engines and Engine Fittings.

Allen, W. H., Son, and Co., Queen's Engineering Works, Bedford.
Bailey, W. H., and Co., Manchester.
Belliss and Morcom, Ledsam-st., Birmingham.
Blackwell, R. W., and Co., 59, City-road, E.C.
Crossley Bros., Limited, Openshaw.
Davey, Paxman, and Co., Colchester.
Fowler, John, and Co., Leeds.
Hopkinson and Co., Britannia Works, Huddersfield.
Ransomes, Sims, and Jefferies, Ipswich.
Shanks, Alex., and Co., Bush-lane House, Bush-lane, Cannon-street.
Willans and Robinson, Rugby.

[All the above are accustomed to build engines especially suitable for electric light work.]

Engineers' Furnishers.

Engelbert and Co., 44-47, Bishopsgate-street Without, E.C.
Wilcox, W. H., and Co., 36, Southwark-street, S.E.

Fire-Extinguishing Appliances.

Heathman, J. H., and Co., 72, Rectory-road, Parson's Green, S.W.

Fuel Economisers.

Green, E. & Son, 2, Exchange-st., Manchester.

Hose Pipes.

Heathman, J. H., and Co., 72, Rectory-road, Parson's Green, S.W.

Incandescent Lamps.

British Thomson-Houston Company, Rugby.
Brockie-Pell Arc Lamp, Limited, 60, Worship-street, E.C.
Edison and Swan Co., 36-37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, W.C.
General Electric Co., 71, Queen Victoria-street, E.C.
Henley's Telegraph Works Company, 27, Martin's-lane, Cannon-street.
Improved Electric Glow Lamp Company, 7, Great Newport-st., St. Martin's-lane, W.C.
Prism Globe Company, 57-58, Chancery-lane, W.C.
Sir Hiram Maxim Electrical and Engineering Co., 65, 66, and 67, Gracechurch-street, E.C.

Indiarubber Goods.

India Rubber, etc., Co., 106, Cannon-st., E.C.

Insulators and Insulating Materials.

Blackwell, R. W., and Co., 59, City-road, E.C.
Edison and Swan Co., 36-37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, W.C.
General Electric Co., 71, Queen Victoria-st., E.C.
Griffiths Bros. and Co., Macks-rd., Bermondsey.
Johnson and Phillips, Old Charlton.
Price, Sons, and Co., Bristol.
Sanders, Wake, and Co., 23, Great St. Helens, London, E.C.

Ladders and Steps.

Heathman, J. H., and Co., 72, Rectory-road, Parson's Green, S.W.

Lamp Columns for Arc Lighting.

Edison and Swan Co., 36-37, Queen-street, E.C.
General Electric Co., 71, Queen Victoria-st., E.C.
Johnson and Phillips, Old Charlton.

Lampholder Makers.

Dorman and Smith, Ordsal Station Electrical Works, Salford.
Edison-Swan Co., 36 and 37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, W.C.
General Electric Co., 71, Queen Victoria-street, E.C.
Holmes, J. H., and Co., Newcastle-on-Tyne.

Lead-Covered Cables.

British Insulated Wire Co. Prescot, Lancs.
Callender Company, Hamilton House, Victoria Embankment, E.C.
Edison and Swan Co., 36-37, Queen-street, E.C.
Frankenburg, I., Manchester.
Glover, W. T. and Co., Salford.
Henley's, W. T., 27, Martin's-lane, E.C.
Howard Conduit Co., Trafford Park, Manchester
Johnson and Phillips, Old Charlton.
London Electric Wire Co., Anchor Works, Playhouse-yard, E.C.
St. Helens Cable Co., Limited, Warrington.
Telegraph Mfg. Company, Helsby, Warrington.
Union Cable Company, Limited, 23, College-hill, Cannon-street, E.C.
Western Electric Co., Bridge Chambers, 171, Queen Victoria-street, E.C.

Motors (Electric).

Allen, W. H., Son, and Co., Queen's Engineering Works, Bedford.
Bergtheil and Young, 12, Camomile-street. E.C
British Thomson-Houston Company, Rugby.
Chamberlain and Hookham, Birmingham.
Crompton and Co., Arc Works, Chelmsford.
Edison and Swan Co., 36-37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, W.C.
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.
General Electric Co., 71, Queen Victoria-st., E.C.
Haigh, W. B., and Co., Oldham.
Holmes, J. H., and Co., Newcastle-on-Tyne.
Johnson and Phillips, Old Charlton.
McClure and Whitfield, Stockport.
Newton Bros., Full-street, Derby.
Newton Electrical Works, Taunton.
Peebles, D. B., and Co., Tay Works, Edinburgh.
Phœnix Dynamo Company, Bradford, Yorks.
Union Electric Co., 151, Queen Victoria-st., E.C
Witting Bros., 49, Cannon-street, E.C.

Non-Magnetic Watches.

Smith, A. and J., St. Nicholas-st., Aberdeen.

Oil and Stores.

Englebert and Co., 44-47, Bishopsgate-street Without, E.C.
Kaye, J., and Sons, Leeds.
Stern Bros., 57, Gracechurch-street, E.C.
Willcox and Co., 36, Southwark-street, S.E.

Measuring Instruments (Electrical).

British Thomson-Houston Company, Rugby.
Chamberlain and Hookham, Birmingham.
Crompton and Co., Chelmsford.
Edison-Swan Co., 36-37, Queen-st., Cheapside.
Electrical Co., 122, Charing Cross-road, W.C.
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.
General Electric Co., 71, Queen Victoria-st., E.C.
Holmes, J. H., and Co., Newcastle-on-Tyne.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton.
Nalder Bros. and Thompson, 34, Queen-st., E.C.

Platinum Utensils.

Derby and Co., 44, Clerkenwell-road, E.C.
Smith and Co., 2, Ranelagh-road, East Ham.

Projectors.

Chamberlain and Hookham, Birmingham.
Crompton and Co., Arc Works, Chelmsford.
Edison and Swan Co., 36-37, Queen-street, E.C.
Holmes, J. H., and Co., Newcastle-on-Tyne.
Johnson and Phillips, 14, Union-court, E.C.
Scott and Mountain, Close Works, Newcastle-on-Tyne.

Publishers—Technical—Electrical.

Biggs and Co., 139-140, Salisbury-court, E.C.
Whittaker and Co., White Hart-street, Paternoster-row.

Slate.

Congdon and Powell, Bravington Works, Bravington-road, Harrow-road, W.

Stabilit.

Electrical Co., 122, Charing Cross-road, W.C

Switches, Cut-Outs, etc.

Blackwell, R. W., and Co., 59, City-road, E.C.
British Thomson-Houston Company, Rugby.
Chamberlain and Hookham, Birmingham.
Crompton and Co., Salisbury House, London-wall, E.C.
Dorman and Smith, Ordsal Station Electrical Works, Salford.
Edison-Swan Co., 36-37, Queen-st., Cheapside.
Electrical Co., 122, Charing Cross-road, W.C.
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.
General Electric Co., 71, Queen Victoria-street.
Geipel and Lange, Parliament-mansions, Westminster, S.W.
Holmes, J. H., and Co., Newcastle-on-Tyne.
Johnson and Phillips, 14, Union-court, E.C.
Lundberg, A. P., Pioneer Electrical Works, 477 to 487, Liverpool-road, N.
Nalder Bros. and Thompson, 34, Queen-st., E.C.
Newton Electrical Works, Taunton.
Peebles, D. B., and Co., Tay Works, Edinburgh.

Telephones.

Edison and Swan Co., 36-37, Queen-street, E.C.
General Electric Co., 71, Queen Victoria-street.
Western Electric Co., Bridge Chambers, 171, Queen Victoria-street, E.C.

Tools and Accessories.

Scott Bros., Halifax.

Tower Wagons.

Heathman, J. H., and Co., 72, Rectory-road, Parson's Green, S.W.

Tramway Equipments.

Blackwell, R. W., and Co., 59, City-road, E.C.
British Mannesmann Tube Company, Limited, Landore, R.S.O., South Wales.
British Schuckert Electric Company, Clun House, Surrey-street, Strand.
British Thomson-Houston Company, Rugby.
Dick, Kerr, and Co., 110, Cannon-street, E.C.
Electric Railway and Tramway Carriage Works, Limited, Preston, Lancs.
Himmelsbach Bros., Freiburg, Baden.
Milnes, Geo. F., and Co., Castle Car Works Hadley, Salop.
White, J. G., and Co., 22A, College-hill, E.C
Witting Bros., 49, Cannon-street, E.C.

Turbines.

Gilbert Gilkes and Co., Kendal.

Ventilating Fans.

Belliss and Morcom, Limited, Ledsam-street Works, Birmingham.
Bergtheil and Young, 12, Camomile-street, E.C
Edison and Swan Co., 36-37, Queen-street, E.C.
Electric Railway & Tramway Carriage Works, Preston, Lancs.
Gibbs, Jno., and Son, 72-76, Duke-st., Liverpool.
Keith, J., and Blackman Company, Limited 27, Farringdon-avenue, E.C.
Walker, W. G., 47, Victoria-street, S.W.

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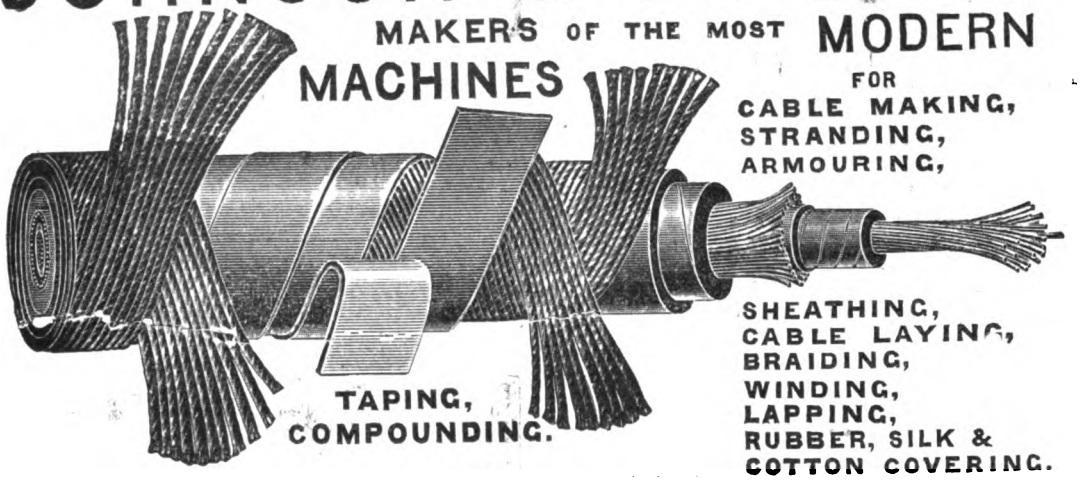

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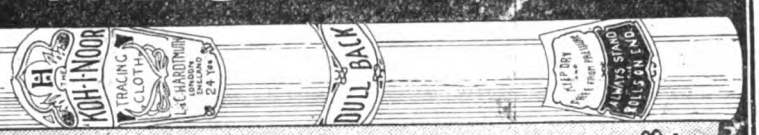

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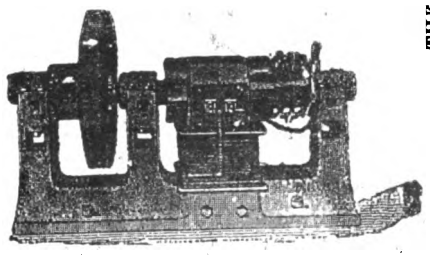

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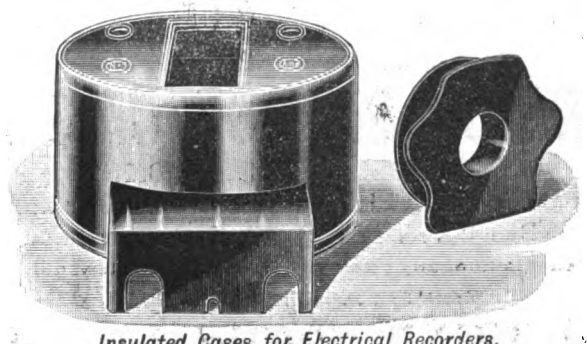

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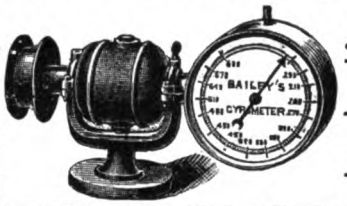

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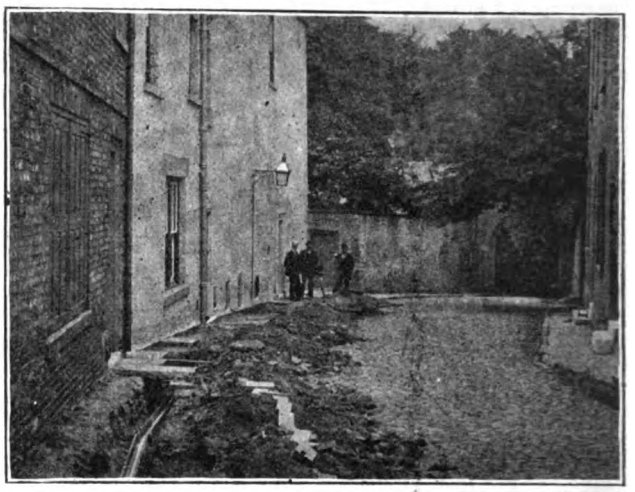

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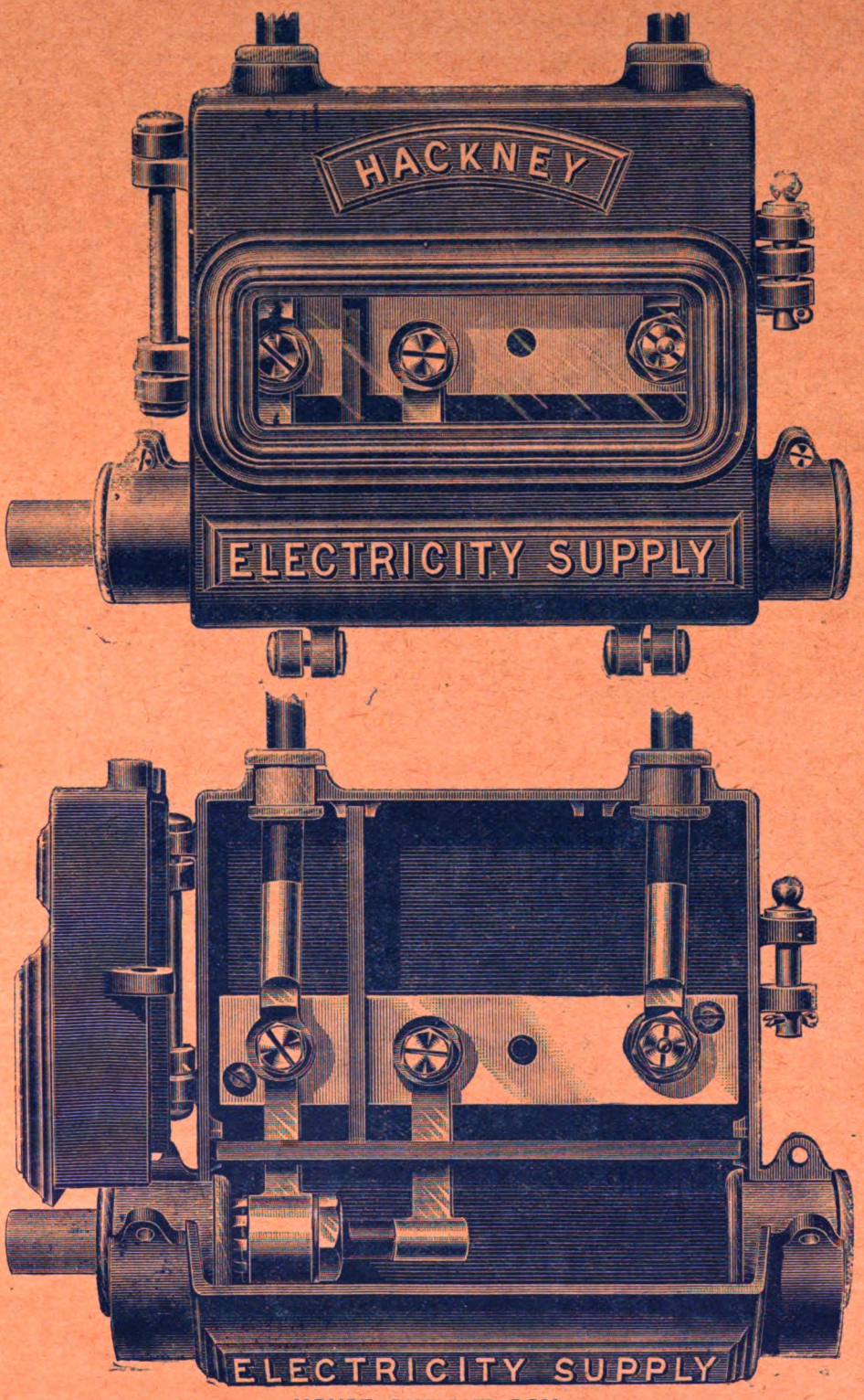

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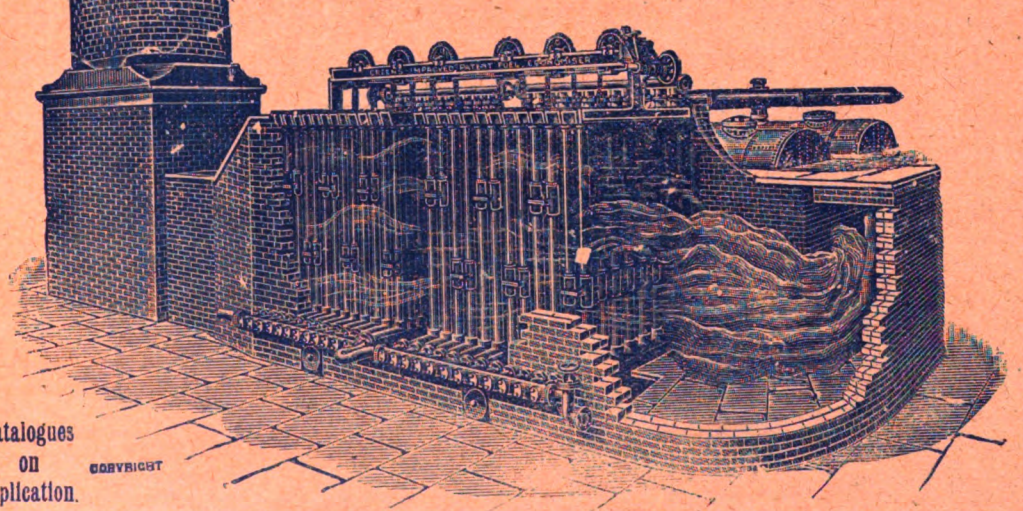

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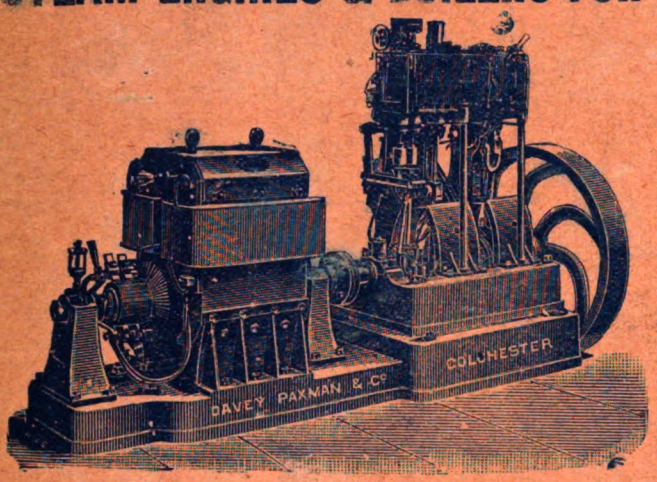

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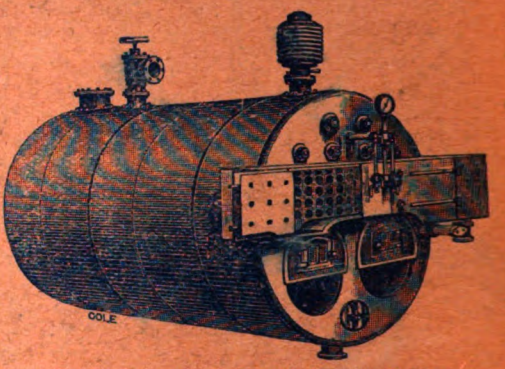

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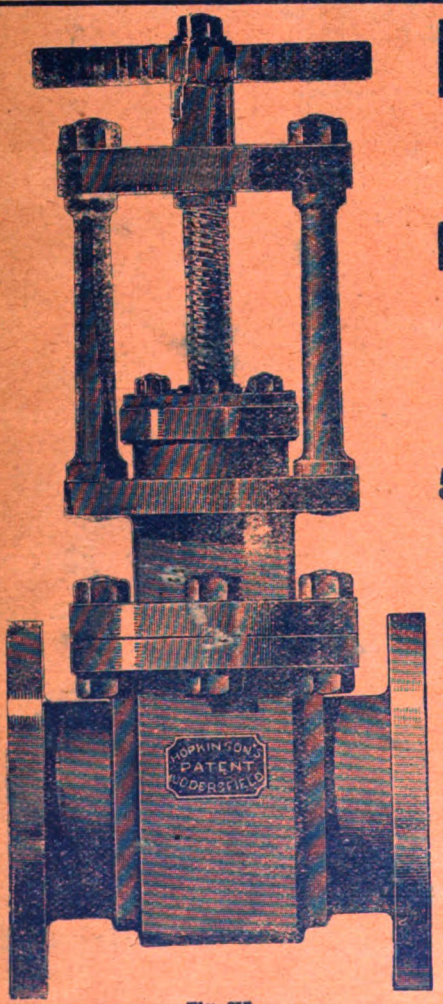

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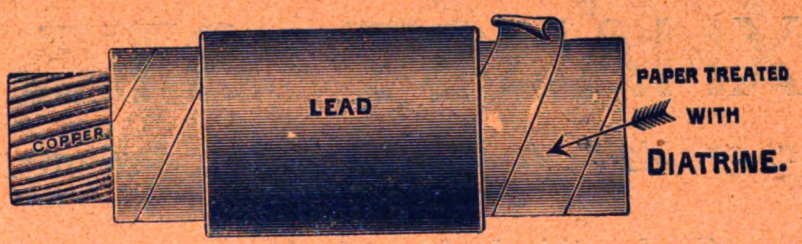

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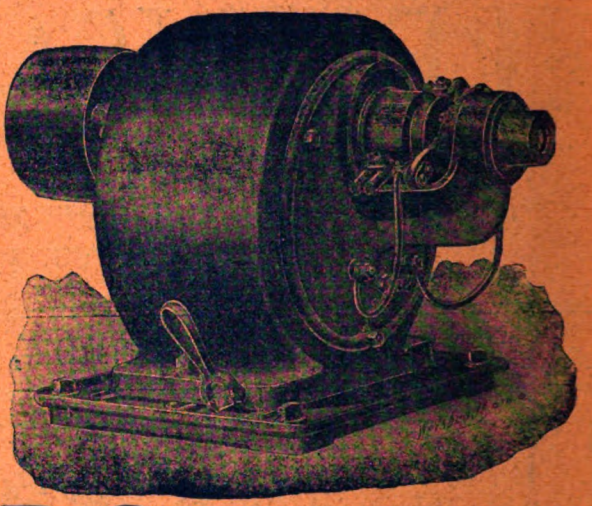

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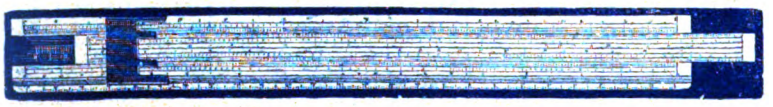

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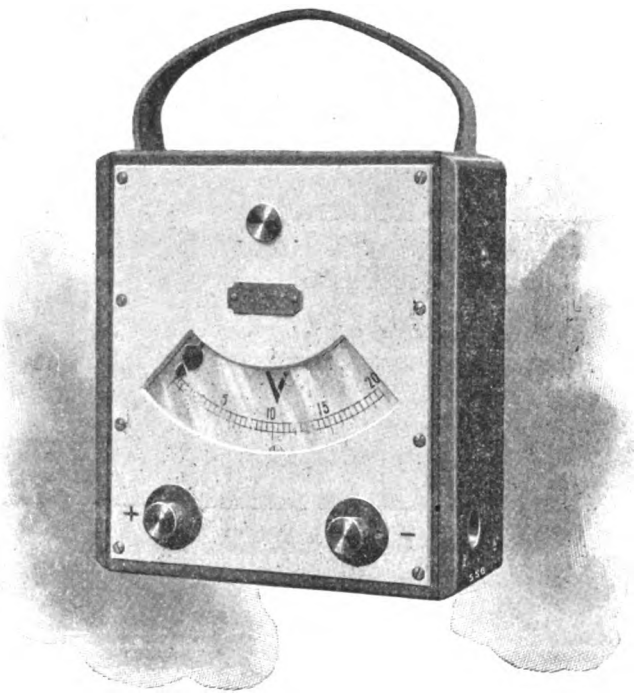

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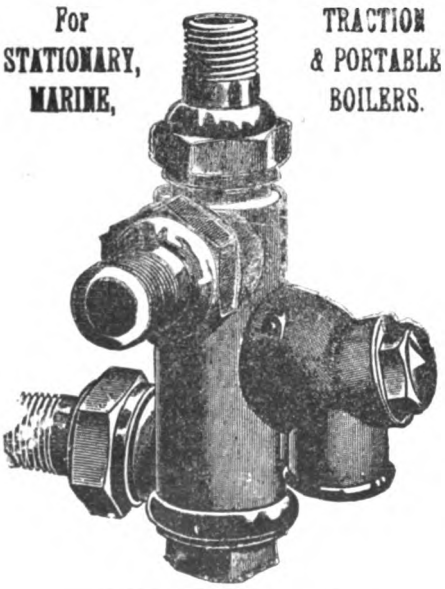

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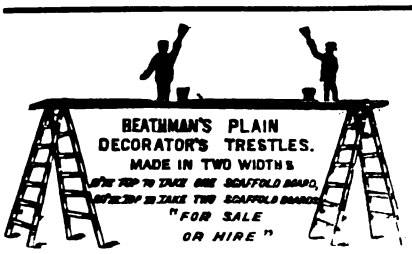

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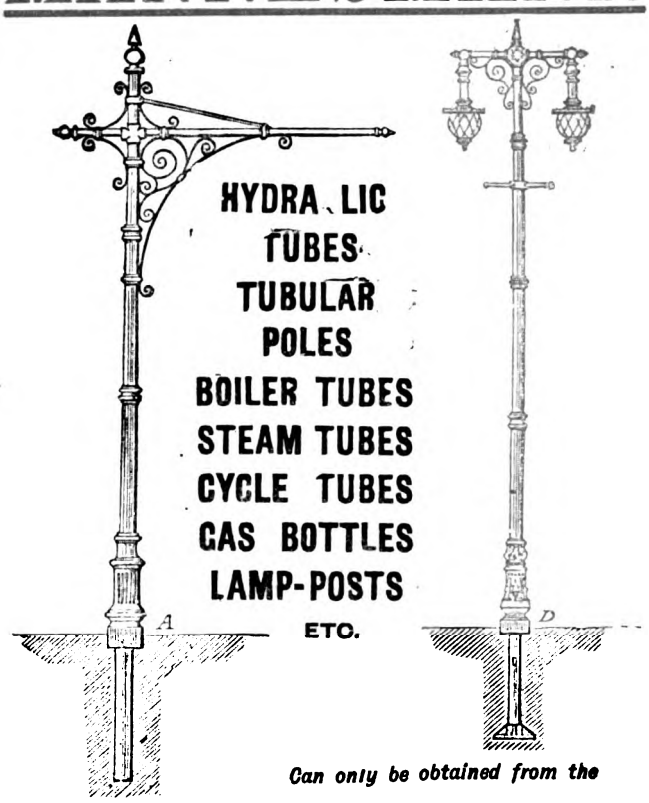

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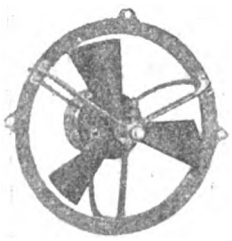

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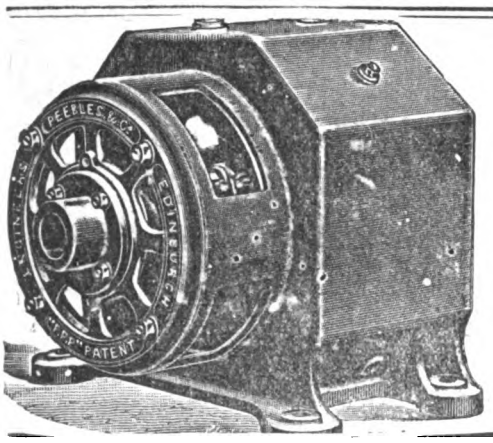

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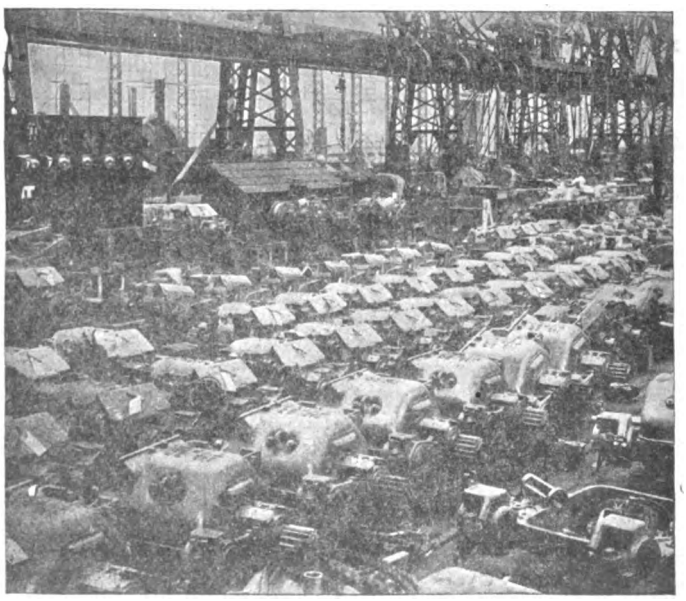

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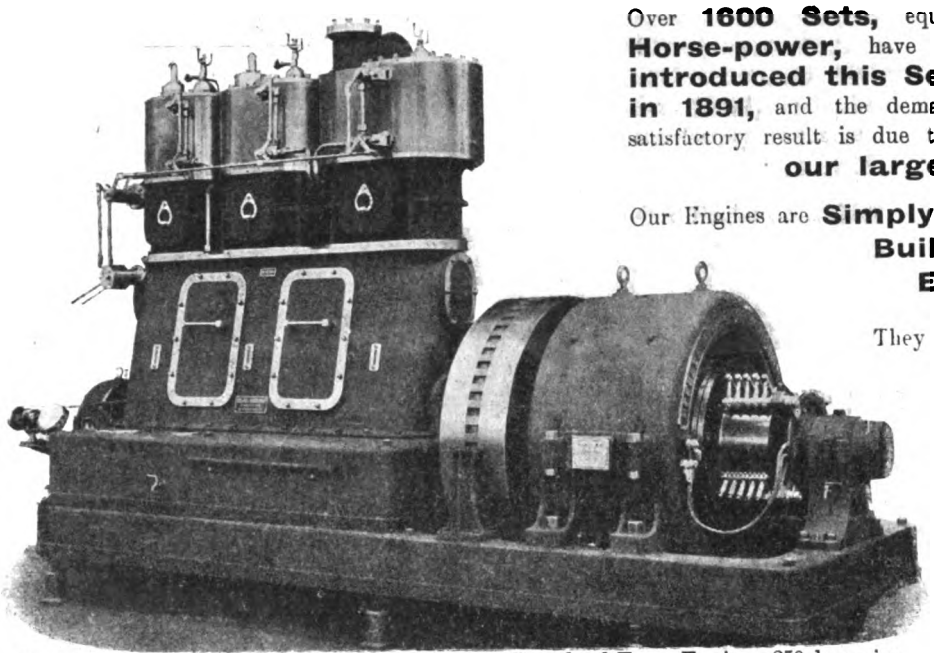

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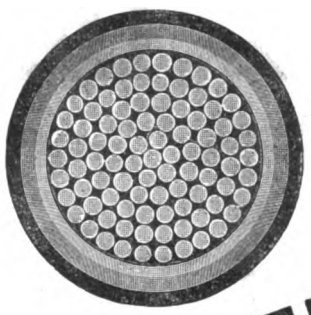

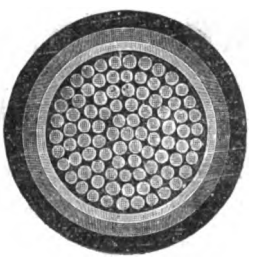

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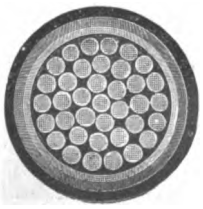

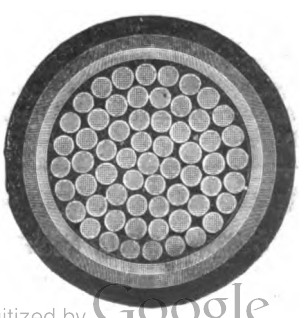

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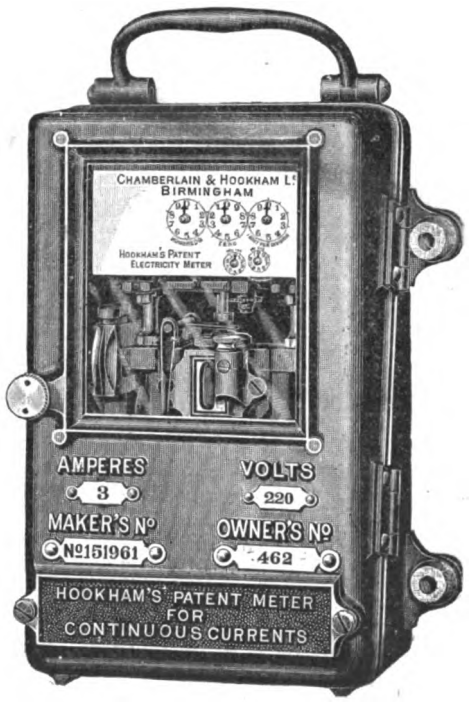

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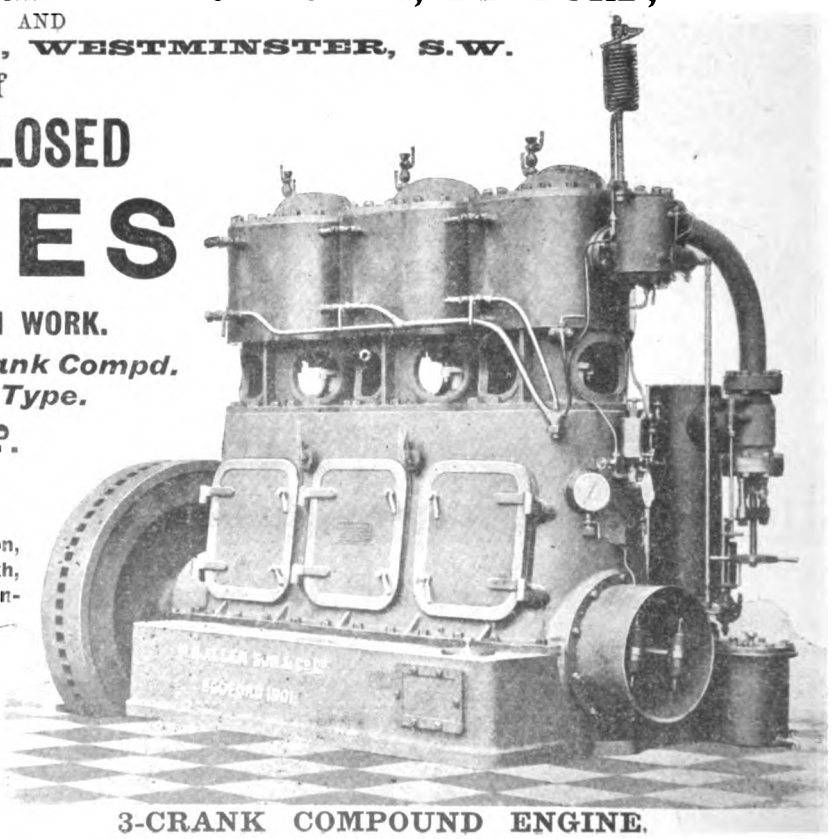

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Phœnix Dynamo Company, Bradford, Yorks.
Rooper, W. O., Victoria Works, Stafford.
Scott and Mountain, Newcastle-on-Tyne.
Union Electric Co., 151, Queen Victoria-st., E.C
Witting Bros., 49, Cannon-street, E.C.

Electric Cranes.

Chamberlain and Hookham, Birmingham.
Crompton and Co., Chelmsford.
Edison and Swan Co., 36-37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, W.C
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.
General Electric Co., 71, Queen Victoria-st., E.C
Lahmeyer Electrical Co., Limited, 109-111, New Oxford-street, W.C.

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Classified Directory of Electrical Trades *(continued)*:

Electrical Fittings.
Bergtheil and Young, 12, Camomile-street, E.C
Braulik, G., 217-218, Upper Thames-st., E.C.
British Mannesmann Tube Company, Limited, Landore, R.S.O., South Wales.
Dorman and Smith, Ordsal Station Electrical Works, Salford.
Edison-Swan Co., 36 and 37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, W.C.
Geipel and Lange, Parliament-mansions, Westminster, S.W.
General Electric Co., 71, Queen Victoria-street.
Lundberg, A. P., Pioneer Electrical Works, 477 to 487, Liverpool-road, N.
Simplex Steel Conduit Co., Coventry-street, Birmingham.

Electric Cooking Apparatus.
Crompton and Co., Salisbury House, London-wall, E.C.
Edison and Swan Co., 36-37, Queen-street, E.C.
General Electric Co., 71, Queen Victoria-street.

Electric Light Contractors.
Ashmore, Benson, Pease, and Co., Stockton-on-Tees.
Belliss and Morcom, Ledsam-st., Birmingham.
British Thomson-Houston Company, Rugby.
British Westinghouse Electric and Mfg. Co., Westinghouse Building, Norfolk-st., W.C.
Brockie-Pell Arc Lamp, Limited, 60, Worship-street, London, E.C.
Crompton and Co., Salisbury House, London-wall, E.C.
Davis and Son, All Saint's Works, Derby.
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.
Electrical Power Storage Company, 4, Great Winchester-street, E.C.
Ferranti, S. Z. de, Hollinwood, Lancs.
Fowler, John, and Co., Leeds.
Graham, Morton, and Co., Leeds.
Holmes, J. H., and Co., Newcastle-on-Tyne.
India Rubber, etc., Co., 106, Cannon-st., E.C.
International Electrical Engineering Company, Clun House, Surrey-street, Strand.
Johnson and Phillips, 14, Union-court, Old Broad-street, E.C.
Lahmeyer Electrical Co., Limited, 109-111, New Oxford-street, W.C. [W.C.
London Electric Supply Co., 3, Adelphi-terrace,
Newton Bros., Full-street, Derby.
Rooper, W. O., and Co., Victoria Works, Stafford.
Scott and Mountain, Close Works, Newcastle.
White, J. G., and Co., 22A, College-hill, E.C.

Electric Locomotives.
British Thomson-Houston Company, Rugby.
British Westinghouse Electric and Mfg. Co., Westinghouse Building, Norfolk-st., W.C.
Chamberlain and Hookham, Birmingham.
Electrical Co., 122, Charing Cross-road, W.C.
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.
Lahmeyer Electrical Co., Limited, 109-111, New Oxford-street, W.C.

Engines and Engine Fittings.
Allen, W. H., Son, and Co., Queen's Engineering Works, Bedford.
Bailey, W. H., and Co., Manchester.
Belliss and Morcom, Ledsam-st., Birmingham.
Blackwell, R. W., and Co., 59, City-road, E.C.
Crossley Bros., Limited, Openshaw.
Davey, Paxman, and Co., Colchester.
Fowler, John, and Co., Leeds.
Hopkinson and Co., Britannia Works, Huddersfield.
Ransomes, Sims, and Jefferies, Ipswich.
Shanks, Alex., and Co., Bush-lane House, Bush-lane, Cannon-street.
Willans and Robinson, Rugby.
[All the above are accustomed to build engines especially suitable for electric light work.]

Engineers' Furnishers.
Engelbert and Co., 44-47, Bishopsgate-street Without, E.C.
Wilcox, W. H., and Co., 36, Southwark-street, S.E.

Fire-Extinguishing Appliances.
Heathman, J. H., and Co., 72, Rectory-road, Parson's Green, S.W.

Fuel Economisers.
Green, E. & Son, 2, Exchange-st., Manchester.

Heating Apparatus.
Rosse and Russell, 22, Charing Cross, S.W.

Incandescent Lamps.
Braulik, G., 217-218, Upper Thames-st., E.C.
British Thomson-Houston Company, Rugby.
Brockie-Pell Arc Lamp, Limited, 60, Worship-street, E.C.
Edison and Swan Co., 36-37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, W.C.
General Electric Co., 71, Queen Victoria-street, E.C.
Henley's Telegraph Works Company, 27, Martin's-lane, Cannon-street.
Improved Electric Glow Lamp Company, 7, Great Newport-st., St. Martin's-lane, W.C.
Sir Hiram Maxim Electrical and Engineering Co., 65, 66, and 67, Gracechurch-street, E.C.

Indiarubber Goods.
India Rubber, etc., Co., 106, Cannon-st., E.C.

Insulators and Insulating Materials.
Blackwell, R. W., and Co., 59, City-road, E.C.
Braulik, G., 217-218, Upper Thames-st., E.C.
Conduit and Insulation Company, 63, Queen Victoria-street, E.C.
Edison and Swan Co., 36-37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, W.C.
General Electric Co., 71, Queen Victoria-st., E.C.
Griffiths Bros. and Co., Macks-rd., Bermondsey.
Johnson and Phillips, Old Charlton.
Price, Sons, and Co., Bristol.
Sanders, Wake, and Co., 23, Great St. Helens, London, E.C.

Ladders and Steps.
Heathman, J. H., and Co., 72, Rectory-road, Parson's Green, S.W.

Lamp Columns for Arc Lighting.
Edison and Swan Co., 36-37, Queen-street, E.C.
General Electric Co., 71, Queen Victoria-st., E.C.
Johnson and Phillips, Old Charlton.

Lampholder Makers.
Braulik, G., 217-218, Upper Thames-st., E.C.
Dorman and Smith, Ordsal Station Electrical Works, Salford.
Edison-Swan Co., 36 and 37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, W.C.
General Electric Co., 71, Queen Victoria-street.
Holmes, J. H., and Co., Newcastle-on-Tyne.

Lead-Covered Cables.
British Insulated Wire Co. Prescot, Lancs.
Callender Company, Hamilton House, Victoria Embankment, E.C.
Edison and Swan Co., 36-37, Queen-street, E.C.
Frankenburg, I., Manchester.
Glover, W. T. and Co., Salford.
Henley's, W. T., 27, Martin's-lane, E.C.
Howard Conduit Co., Trafford Park, Manchester
Johnson and Phillips, Old Charlton.
London Electric Wire Co., Anchor Works, Playhouse-yard, E.C.
St. Helens Cable Co., Limited, Warrington.
Telegraph Mfg. Company, Helsby, Warrington.
Union Cable Company, Limited, 23, College-hill, Cannon-street, E.C.
Western Electric Co., Bridge Chambers, 171, Queen Victoria-street, E.C.

Motors (Electric).
Allen, W. H., Son, and Co., Queen's Engineering Works, Bedford.
British Thomson-Houston Company, Rugby.
Chamberlain and Hookham, Birmingham.
Crompton and Co., Arc Works, Chelmsford.
Edison and Swan Co., 36-37, Queen-street, E.C.
Electrical Co., 122, Charing Cross-road, W.C.
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.
General Electric Co., 71, Queen Victoria-st., E.C.
Haigh, W. B., and Co., Oldham.
Holmes, J. H., and Co., Newcastle-on-Tyne.
International Electrical Engineering Company, Clun House, Surrey-street, Strand.
Johnson and Phillips, Old Charlton.
Lahmeyer Electrical Co., Limited, 109-111, New Oxford-street, W.C.
McClure and Whitfield, Stockport.
Newton Bros., Full-street, Derby.
Newton Electrical Works, Taunton.
Peebles, D. B., and Co., Tay Works, Edinburgh.
Phœnix Dynamo Company, Bradford, Yorks.
Union Electric Co., 151, Queen Victoria-st., E.C
Witting Bros., 49, Cannon-street, E.C.

Non-Magnetic Watches.
Smith, A. and J., St. Nicholas-st., Aberdeen.

Oil and Stores.
Englebert and Co., 44-47, Bishopsgate-street Without, E.C.
Kaye, J., and Sons, Leeds.
Stern Bros., 57, Gracechurch-street, E.C.
Willcox and Co., 36, Southwark-street, S.E.

Measuring Instruments (Electrical).
British Thomson-Houston Company, Rugby.
Chamberlain and Hookham, Birmingham.
Crompton and Co., Chelmsford.
Edison-Swan Co., 36-37, Queen-st., Cheapside.
Electrical Co., 122, Charing Cross-road, W.C.
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.
General Electric Co., 71, Queen Victoria-st., E.C.
Holmes, J. H., and Co., Newcastle-on-Tyne.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton.
Nalder Bros. and Thompson, 34, Queen-st., E.C.

Platinum Utensils.
Derby and Co., 44, Clerkenwell-road, E.C.
Smith and Co., 2, Ranelagh-road, East Ham.

Projectors.
Chamberlain and Hookham, Birmingham.
Crompton and Co., Arc Works, Chelmsford.
Edison and Swan Co., 36-37, Queen-street, E.C.
Holmes, J. H., and Co., Newcastle-on-Tyne.
Johnson and Phillips, 14, Union-court, E.C.
Scott and Mountain, Close Works, Newcastle-on-Tyne.

Publishers—Technical—Electrical.
Biggs and Co., 139-140, Salisbury-court, E.C.

Slate.
Congdon and Powell, Bravington Works Bravington-road, Harrow-road, W.

Stabilit.
Electrical Co., 122, Charing Cross-road, W.C.

Switches, Cut-Outs, etc.
Blackwell, R. W., and Co., 59, City-road, E.C.
British Thomson-Houston Company, Rugby.
Chamberlain and Hookham, Birmingham.
Crompton and Co., Salisbury House, London-wall, E.C.
Dorman and Smith, Ordsal Station Electrical Works, Salford.
Edison-Swan Co., 36-37, Queen-st., Cheapside.
Electrical Co., 122, Charing Cross-road, W.C.
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.
General Electric Co., 71, Queen Victoria-street.
Geipel and Lange, Parliament-mansions, Westminster, S.W.
Holmes, J. H., and Co., Newcastle-on-Tyne.
Johnson and Phillips, 14, Union-court, E.C.
Lundberg, A. P., Pioneer Electrical Works 477 to 487, Liverpool-road, N.
Nalder Bros. and Thompson, 34, Queen-st., E.C.
Newton Electrical Works, Taunton.
Peebles, D. B., and Co., Tay Works, Edinburgh.

Telephones.
Braulik, G., 217-218, Upper Thames-st., E.C.
Edison and Swan Co., 36-37, Queen-street, E.C.
General Electric Co., 71, Queen Victoria-street.
Western Electric Co., Bridge Chambers, 171, Queen Victoria-street, E.C.

Tools and Accessories.
Scott Bros., Halifax.

Tower Wagons.
Heathman, J. H., and Co., 72, Rectory-road, Parson's Green, S.W.

Tramway Equipments.
Blackwell, R. W., and Co., 59, City-road, E.C.
British Mannesmann Tube Company, Limited Landore, R.S.O., South Wales.
British Thomson-Houston Company, Rugby.
Dick, Kerr, and Co., 110, Cannon-street, E.C.
Electric Railway and Tramway Carriage Works Limited, Preston, Lancs.
Himmelsbach Bros., Freiburg, Baden.
International Electrical Engineering Company, Clun House, Surrey-street, Strand.
Milnes, Geo. F., and Co., Castle Car Works Hadley, Salop.
White, J. G., and Co., 22A, College-hill, E.C
Witting Bros., 49, Cannon-street, E.C.

Turbines.
Gilbert Gilkes and Co., Kendal.

Ventilating Fans.
Belliss and Morcom, Limited, Ledsam-street Works, Birmingham.
Bergtheil and Young, 12, Camomile-street, E.C
Edison and Swan Co., 36-37, Queen-street, E.C.
Electric Railway & Tramway Carriage Works Preston, Lancs.
Gibbs, Jno., and Son, 72-76, Duke-st., Liverpoo
Keith, J., and Blackman Company, Limited 27, Farringdon-avenue, E.C.
Walker, W. G., 47, Victoria-street, S.W.

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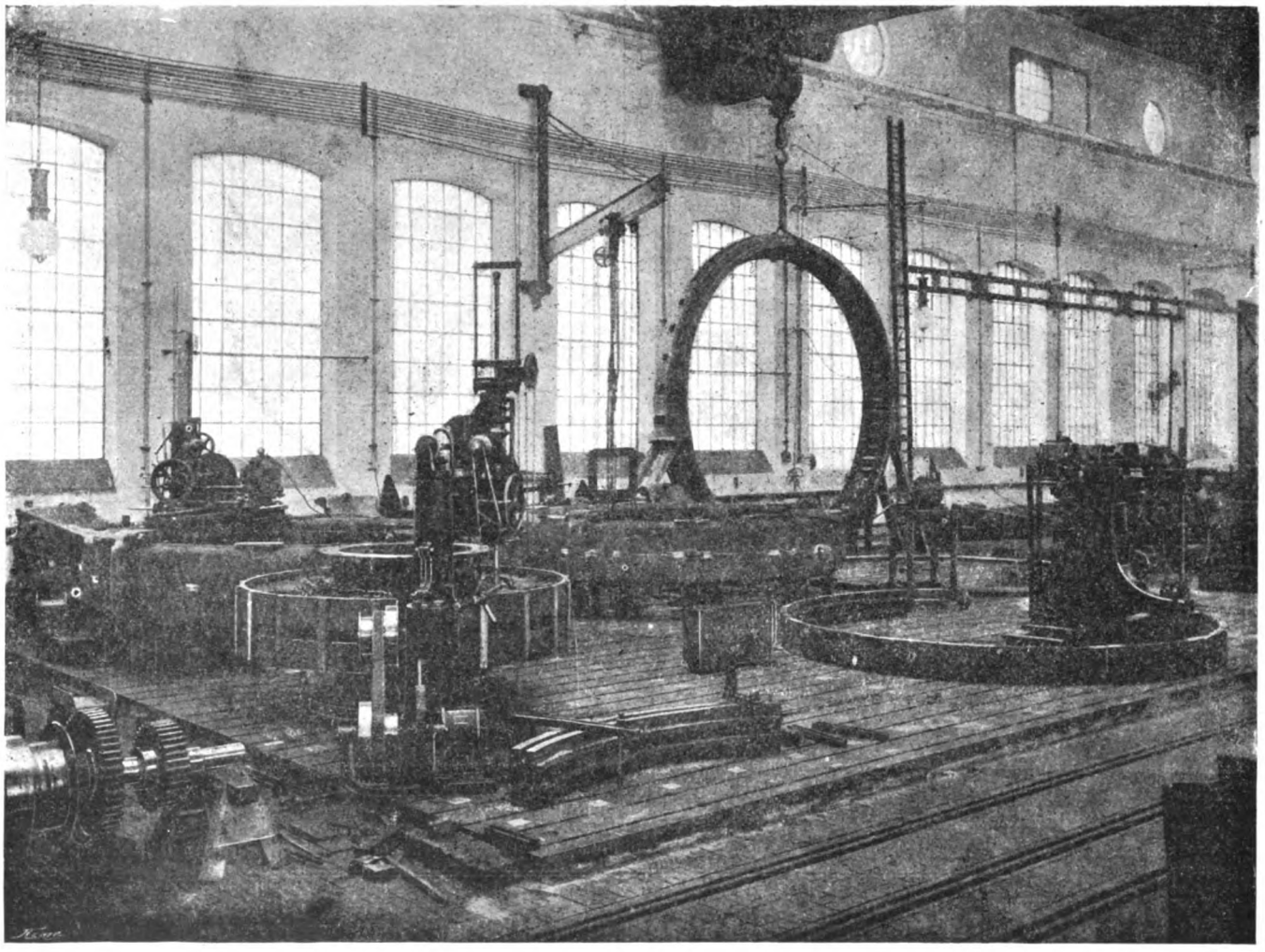

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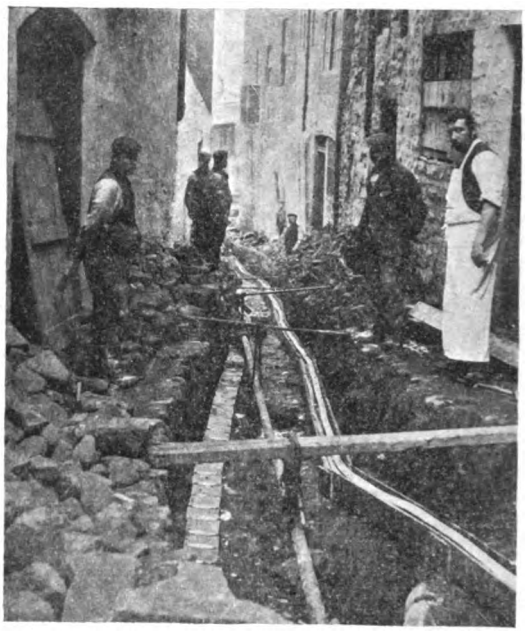

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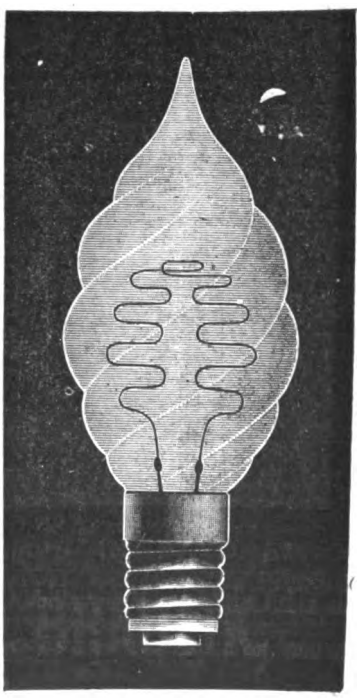

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Adams, W. P., 35, Queen Victoria-street, E.C.
Aldridge, J. G. W., Westminster-chambers, 9, Victoria-street, S. W.
Allpress, V. S., 25, Queen Anne's-gate, S.W.
Anderson and Hay, Pearl Assurance-buildings, Liverpool.
Bennett & Ward-Thomas, 13, Victoria-buildings Manchester.
Boot, H., Electricity Works, Tunbridge Wells.
Booth and Ravenshaw, 110, Cannon-st., E.C.
Bramwell and Harris, 5, Great George-street, London, S.W.
Bright, C., F.R.S.E., 21, Old Queen-st., S.W.
Dickinson, A., Telephone-bldgs, Birmingham.
Dolby and Williamson, 8, Prince's-street, S.W.
Ekin, 12, Little Queen-street, S.W.
Enright, J., 47, Victoria-street, S.W.
Fahie and Son, 9, Westland-row, Dublin
Forbes, Prof. G., F.R.S., 34, Gt. George-st., S.W.
Gibbings and Baker, Old Bank Chambers, 1, Cheapside, Bradford, and Piccadilly-mansions, 17, Shaftesbury-avenue, London.
Hammond, R., 64, Victoria-street, S.W.
Handcock and Dykes, 5, Victoria-street, S.W.
Hawtayne, W. C. C., 9, Queen-st. Place, E.C.
Heaphy, M., 19, Lombard-street, E.C.
Hedges, Killingworth, 1, Emery Hill-street, Ashley-gardens, Victoria-street, S.W.
Hopkinson and Talbot, 26, Victoria-st., S.W.
Jamieson, Prof. Andrew, 16, Rosslyn-terrace, Kelvinside, Glasgow.
Kennedy and Jenkin, 17, Victoria-st., S.W.
Kirkland and Capper, 17, Victoria-street, S.W
Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, S.W. [gate, S.W.
Massey, W. H., M.I.C.E., 25, Queen Anne's-
Manville, E., 29, Great George-street, S.W.
Maycock, Perren, 10, Beech House-rd., Croydon
Medhurst, F. H., 13, Victoria-street, S.W.
Melhuish, T. W. W., Schenkenstr. 10, Vienna I
Miller, T., 7, Tower-buildings, Water-street, Liverpool.
Mordey and Dawbarn, Grosvenor-mansions, Victoria-street, S.W.
O'Gorman & Cozens-Hardy, 82, Victoria-st., S.W
Popham, W. V. M., 9, Arundel-street, Strand
Peers, G. R., 96, Deansgate, Manchester
Preece and Cardew, 13, Queen Anne's-gate, S.W
Rimington, E. C., 19, Queen Victoria-st., E.C.
Robinson, Prof. H., 13, Victoria-street, S.W.
Shoolbred, J. N., 32, Victoria-street, S.W.
Snell, Albion T., A.M.I.C.E., M.I.EE., Suffolk House, Cannon-street, E.C.
Swinburne, J., 82, Victoria-street, Westminster.
Swinton, A. A. Campbell, 66, Victoria-st., S.W.
Trentham, W. H., 30, Victoria-street, S.W.
Walker, Sydney F., 2, Kensington Gardens-square, S.W.
Wallis-Jones and Dent, 36, Gt. George-street, S.W.
Warden-Stevens, F. J., Connaught-mansions, Victoria-street, S.W., and Town Hall-chambers, Guildford.
Webber, C. E., Major-General (ret. R.E.), C.B., 27, Chancery-lane, W.C.
Weekes, R. W., 65, Hayes-road, Bromley, Kent.
Wilkinson, Geo., Kirkside, Bilton, Harrogate.
Williams, Morgan, I. M., 39, Victoria-street, S.W.
Wordingham, C. H., 19, Brasennose-street, Manchester.

Electrical Engineers.

Acland, R. L., Electricity Works, Chesterfield.
Allen, W. H., and Co., Queen's Engineering Works, Bedford.
Andrews, L., Hastings Corporation.
Ansell, F. G., Wickwar.
Appelbee N., Electricity Works, Ashton-under-Lyne.
Armstrong, Mitchell, and Co., Newcastle-on-Tyne.
Arnot, W., Govan Town Council.
Aron Electricity Meter, Limited, 46, Upper Thames-street, E.C.
Ayrton, Prof., Central Institution, Exhibition-road, S.W.
Bailey, J., India Rubber, etc., Company, Silvertown.
Bailey, F., City of London Electric Lighting Station, Bankside, S.E.
Baker, Sir B., 2, Queen-square-place, S.W.
Baker, C. Ashmore, 27, Burnaby-gardens, Gunnersbury.
Barnard, A. S., Hull Corporation.
Barton, Thos., Electric Works, Blackburn.
Bastow, S. E., Electricity Works, Barnsley.
Bates, W., Birkenhead Corporation.
Bathurst, F., 63, Queen Victoria-street, E.C.
Baynes, S. W., St. Pancras Vestry.
Beaumont, W. W., Outer Temple, 222, Strand.
Belfield, R., Westminster-building, Norfolk-street.
Bell, G. G., Electricity Works, Hammersmith.
Bell, J. A., Aberdeen Corporation.
Bennett, A. R., 65, Renfield-street, Glasgow.
Bentley, C. W., Electricity Works, Alderley Edge, Cheshire.
Bergtheil and Young, 12, Camomile-street, E.C.
Birkett, R., Burnley Corporation.
Blackburn, A. B., Electric Construction Co., Wolverhampton.
Blackman, A. S., Town Hall, Poplar, E.
Bottomley, W. F., Telephone Company, Dame-street, Dublin.
Brandreth, W. E., Electric Light Works, Burton-on-Trent.
British Electric Traction Co., Donington House, Norfolk-street, W.C.
British Thomson-Houston Limited, 83, Cannon-street, E.C.
Brockie-Pell Arc Lamp, Limited, 60, Worship-street, Finsbury.
Brydges, J. K., Eastbourne Corporation.
Burnet, C. D., Electricity Works, Carlisle.
Burnett, H. R., Electricity Works, Barrow-in-Furness
Caldwell, H., Electric Light Station, Altrincham.
Callender, T., Hamilton House, Victoria-embankment.
Campion, R. H., Electricity Works, Dewsbury
Canning, Sir S., 3, Great Winchester-street E.C.
Carr, G., Narva Flax Mills, Narva, Russia.
Carter, Geo. H., Electricity Works, Heckmondwike.
Cawthra, J. A., Electricity Works, South Shields
Chamberlain and Hookham, Birmingham.
Chamen, W., Glasgow Corporation, Glasgow.
Chatterton, G., 46, Queen Anne's-gate, S.W.
Chattock, R. A., Corporation Electricity Works, Bradford.
Christie, E. J. H., Salford Rolling Mills, Manchester.
Clark, Gordon, 7, Red Lion-square, W.C.
Clegg, S., Corporation Electricity Works, Lincoln.
Clothier, T. D., Electricity Works, Bootle.
Cooper, A. G., Town Hall, Colne.
Cottam, G. H., Hampstead Vestry.
Cox-Walker, E., Eastern Electrical Works, Darlington.
Crompton, R. E. B., Thriplands, Kensington Court, W.
Crookes, Sir W., 7, Kensington-park-gardens, London, W.
Cross, W. E. E., Lawrie-park-road, Sydenham.
D'Alton, P. W., Central London Railway, 125, High Holborn.
Davey, Paxman, and Co., Colchester.
Davis and Son, All Saints' Works, Derby.
Day, A. A., Electricity Works, Bolton.
Denny Bros., Dumbarton.
Dewey, J., Electric Light Station, Notting Hill-gate.
Dickinson, H., Corporation Electricity Works, Leeds.
Dorman and Smith, Ordsal Station Electrical Works, Salford.
Drewett, H., Morley Corporation.
Dunton, E. W., London Exhibitions, Limited, Earl's Court, S.W.
Edison-Swan United Electric Light Company, 36 and 37, Queen-street, E.C.
Edgcome, J. E., Electric Light Station, Kingston-on-Thames.
Edmunds, H., 2 Queen Anne's-gate, S.W.
Edmundson, J. W., Sunbeam Lamp Company, Gateshead-on-Tyne.
Edmundson's Electricity Corporation, Limited, Broad Sanctuary-chambers, Westminster.
Electric Construction Company, Dashwood House, New Broad-street, E.C.
Electrical Company, Limited, 122-124, Charing Cross-road, W.C.
Ellis A., Electricity Works, Cardiff.
Elphinstone G. K., 86, Canonbury-road, N.
Esson, W. B., Victoria Works, Old Charlton.
Evered and Co., 27, Drury-lane, W.C.
Ewing, Prof. J. A., Cambridge.
Fedden S. E., Borough Electrical Engineer, Sheffield.
Ferguson, R. T., Town Hall, Fulham.
FitzGerald, D. G., 94, Loughborough-rd., S.W
Flood-Page, Major J., 102, St. George's-square, S.W.
Foster, H. F., Electricity Works, Epsom.
Foster, H. Ll., care of Mr. M. Longridge, 12, King-street, Manchester.
Fowler and Co., Leeds.
Francis and Spilsbury, Mansion House-chambers, 20, Bucklersbury, E.C.
Fraser, A., Town Hall, Nelson.
French, A. H., Electricity Works, Chelmsford.
Fuller, A. J., Electricity Works, Ayr.
Fyfe, A. L., 89, Angel-road, Brixton.
Gamlen, R. L., Electricity Works, Bromley Kent.
Garcke, E., Donnington House, Norfolk-st., W.C
Garnet, C., Darwen Corporation
Garnett, Prof. W., London County Council. Spring-gardens, S.W.
Gatehouse, T. E., 60, Gresham-road, S.W.
Gay, Albert, Electricity Works, Islington.
General Electric Co., 71, Queen Victoria-st., E.C
Gibbs, J., and Son, 72, 74, Duke-st., Liverpool.
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Gray, R. Kaye, Silvertown, Essex.
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Grigg, W., 33, Eastbourne-terrace, Hyde Park
Gwynne and Co., Brook-street Works, Holborn.
Hailey and Co., Pentagon Works, 30, Pavilion road, S.W.
Hall, J. P., and Co., Blackriding Ironworks Werneth, Oldham.
Harris and Co., 58, Wilson-st., Finsbury, E.C.

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Holmes, A. B., 15, Highfield-street, Liverpool.
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Hopkinson, Dr., E., Salford Ironworks, Manchester.
Hughes, T. V. Greenfield, Holywell, near Chester.

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Johnson, W. C., The Dignaries, Westcombe-park, Blackheath, S.E.
Johnston, C. M., Corporation Electricity Works, Shrewsbury.
Joyce, S., Altrincham Electric Light Station.

Kelvin, Lord, Glasgow.
Kempe, H. R., General Post Office, E.C.
Kempster, J. W., Queen's Engineering Works, Bedford.
Kilgour, H., Electric Light Station, Cheltenham.
Kimmins, P. J., Electricity Works, Lynmouth, Barnstaple, N. Devon.
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Knight, J. D., Electricity Works, Ealing, W.

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Laing, Wharton, and Cunnington, 93, St. Martin's-lane, W.C.
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Long, E. D., Electricity Works, Grays Thurrock
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Newington, S. W., Oldham Corporation.
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Robinson, Wm., University College, Nottingham.
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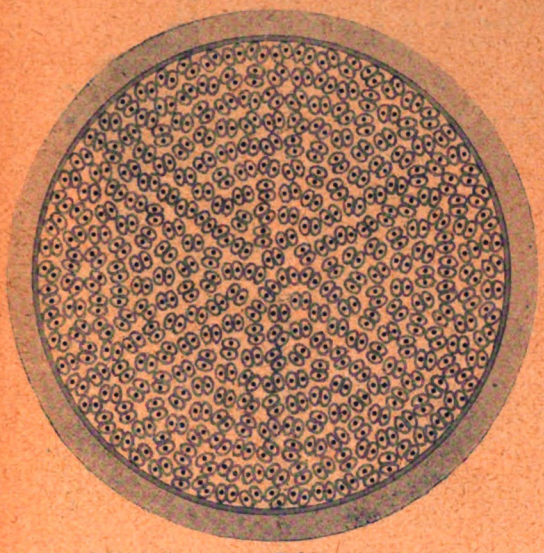

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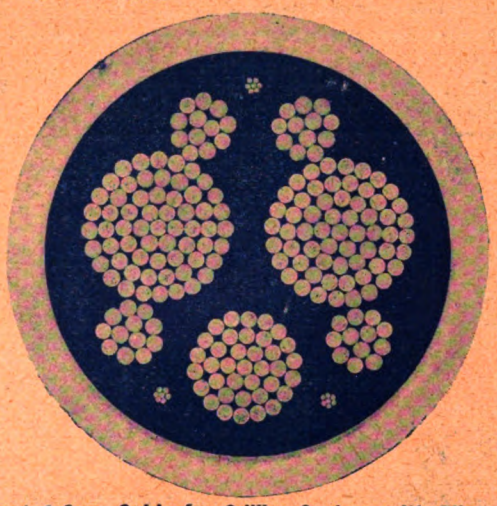

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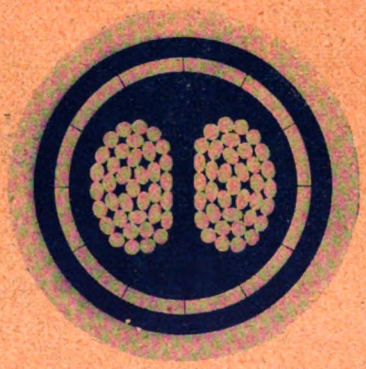

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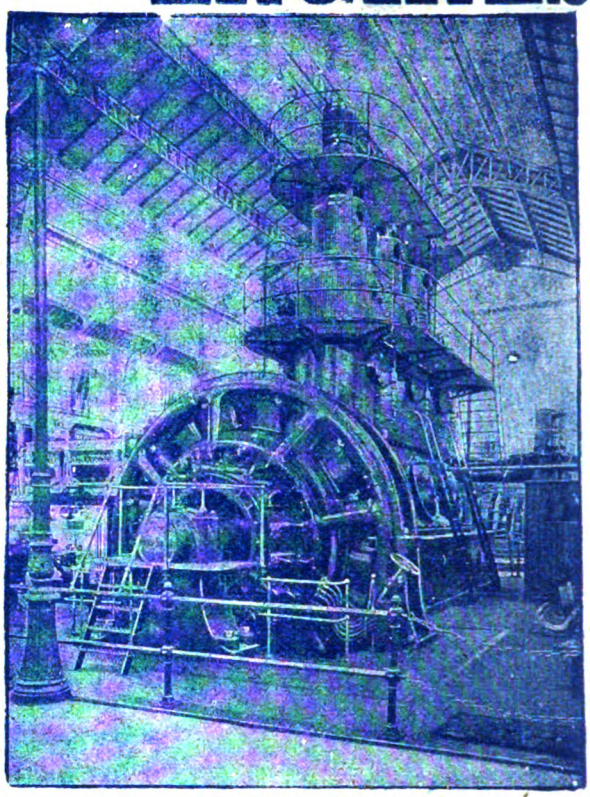

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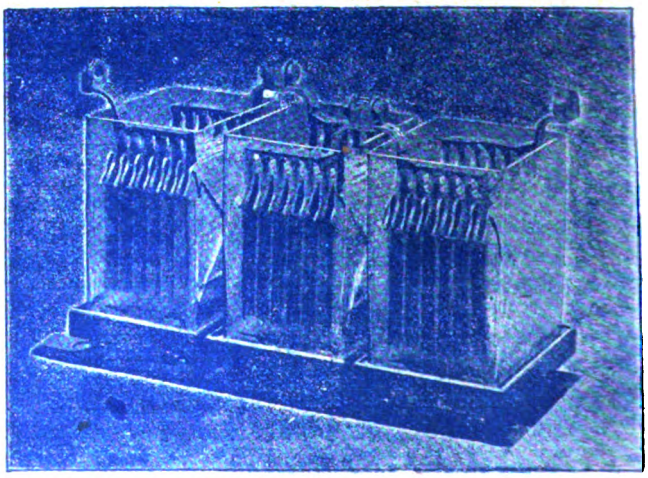

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